F.R.M.

[Final Revision Module]

JEE Main - PHYSICS

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FINAL REVISION MODULE JEE - MAIN

PHYSICS

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Questions marked with (*) are Logical Question

IIT-JEE SYLLABUS

The syllabus contains two Sections - A and B. Section - A pertains to the Theory Part having 80% weightage, while Section - B contains Practical Component (Experimental Skills) having 20% weightage.

SECTION – A

UNIT 1: PHYSICS AND MEASUREMENT
Physics, technology and society, S I units, Fundamental and derived units. Least count, accuracy and precision of measuring instruments, Errors in measurement, Dimensions of Physical quantities, dimensional analysis and its applications.

UNIT 2: KINEMATICS
Frame of reference. Motion in a straight line: Position-time graph, speed and velocity. Uniform and non-uniform motion, average speed and instantaneous velocity Uniformly accelerated motion, velocity-time, position-time graphs, relations for uniformly accelerated motion. Scalars and Vectors, Vector addition and Subtraction, Zero Vector, Scalar and Vector products, Unit Vector, Resolution of a Vector. Relative Velocity, Motion in a plane, Projectile Motion, Uniform Circular Motion.

UNIT 3: LAWS OF MOTION
Force and Inertia, Newton's First Law of motion; Momentum, Newton's Second Law of motion; Impulse; Newton's Third Law of motion. Law of conservation of linear momentum and its applications, Equilibrium of concurrent forces. Static and Kinetic friction, laws of friction, rolling friction.
Dynamics of uniform circular motion: Centripetal force and its applications.

UNIT 4: WORK, ENERGY AND POWER
Work done by a constant force and a variable force; kinetic and potential energies, workenergy theorem, power. Potential energy of a spring, conservation of mechanical energy, conservative and nonconservative forces; Elastic and inelastic collisions in one and two dimensions.

UNIT 5: ROTATIONAL MOTION
Centre of mass of a two-particle system, Centre of mass of a rigid body; Basic concepts of rotational motion; moment of a force, torque, angular momentum, conservation of angular momentum and its applications; moment of inertia, radius of gyration. Values of moments of inertia for simple geometrical objects, parallel and perpendicular axes theorems and their applications. Rigid body rotation, equations of rotational motion.

UNIT 6: GRAVITATION
The universal law of gravitation. Acceleration due to gravity and its variation with altitude and depth. Kepler's laws of planetary motion. Gravitational potential energy; gravitational potential. Escape velocity. Orbital velocity of a satellite. Geo-stationary satellites.

UNIT 7: PROPERTIES OF SOLIDS AND LIQUIDS
Elastic behaviour, Stress-strain relationship, Hooke's Law, Young's modulus, bulk modulus, modulus of rigidity. Pressure due to a fluid column; Pascal's law and its applications. Viscosity, Stokes' law, terminal velocity, streamline and turbulent flow, Reynolds number. Bernoulli's principle and its applications. Surface energy and surface tension, angle of contact, application of surface tension - drops, bubbles and capillary rise. Heat, temperature, thermal expansion; specific heat capacity, calorimetry; change of state, latent heat. Heat transfer-conduction, convection and radiation, Newton's law of cooling.

UNIT 8: THERMODYNAMICS
Thermal equilibrium, zeroth law of thermodynamics, concept of temperature. Heat, work and internal energy. First law of thermodynamics. Second law of thermodynamics: reversible and irreversible processes. Carnot engine and its efficiency.

UNIT 9: KINETIC THEORY OF GASES
Equation of state of a perfect gas, work done on compressing a gas.Kinetic theory of gases - assumptions, concept of pressure. Kinetic energy and temperature: rms speed of gas molecules; Degrees of freedom, Law of equipartition of energy,applications to specific heat capacities of gases; Mean free path, Avogadro's number.

UNIT 10: OSCILLATIONS AND WAVES
Periodic motion - period, frequency, displacement as a function of time. Periodic functions. Simple harmonic motion (S.H.M.) and its equation; phase; oscillations of a spring -restoring force and force constant; energy in S.H.M. - kinetic and potential energies; Simple pendulum - derivation of expression for its time period; Free, forced and damped oscillations, resonance. Wave motion. Longitudinal and transverse waves, speed of a wave. Displacement relation for a progressive wave. Principle of superposition of waves, reflection of waves, Standing waves in strings and organ pipes, fundamental mode and harmonics, Beats, Doppler effect in sound

UNIT 11: ELECTROSTATICS
Electric charges: Conservation of charge, Coulomb's law-forces between two point charges, forces between multiple charges; superposition principle and continuous charge distribution.
Electric field: Electric field due to a point charge, Electric field lines, Electric dipole, Electric field due to a dipole, Torque on a dipole in a uniform electric field. Electric flux, Gauss's law and its applications to find field due to infinitely long uniformly charged straight wire, uniformly charged infinite plane sheet and uniformly charged thin spherical shell. Electric potential and its calculation for a point charge, electric dipole and system of charges; Equipotential surfaces, Electrical potential energy of a system of two point charges in an electrostatic field. Conductors and insulators, Dielectrics and electric polarization, capacitor, combination of capacitors in series and in parallel, capacitance of a parallel plate capacitor with and without dielectric medium between the plates, Energy stored in a capacitor.

UNIT 12: CURRRENT ELECTRICITY
Electric current, Drift velocity, Ohm's law, Electrical resistance, Resistances of different materials, V-I characteristics of Ohmic and nonohmic conductors, Electrical energy and power, Electrical resistivity, Colour code for resistors; Series and parallel combinations of resistors; Temperature dependence of resistance. Electric Cell and its Internal resistance, potential difference and emf of a cell, combination of cells in series and in parallel. Kirchhoff's laws and their applications. Wheatstone bridge, Metre bridge. Potentiometer - principle and its applications.

UNIT 13: MAGNETIC EFFECTS OF CURRENT AND MAGNETISM

Biot - Savart law and its application to current carrying circular loop. Ampere's law and its applications to infinitely long current carrying straight wire and solenoid. Force on a moving charge in uniform magnetic and electric fields. Cyclotron. Force on a current-carrying conductor in a uniform magnetic field. Force between two parallel current-carrying conductors-definition of ampere. Torque experienced by a current loop in uniform magnetic field; Moving coil galvanometer, its current sensitivity and conversion to ammeter and voltmeter. Current loop as a magnetic dipole and its magnetic dipole moment. Bar magnet as an equivalent solenoid, magnetic field lines; Earth's magnetic field and magnetic elements. Para-, dia- and ferro- magnetic substances. Magnetic susceptibility and permeability, Hysteresis, Electromagnets and permanent magnets.

UNIT 14: ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENTS

Electromagnetic induction; Faraday's law, induced emf and current; Lenz's Law, Eddy currents. Self and mutual inductance. Alternating currents, peak and rms value of alternating current/ voltage; reactance and impedance; LCR series circuit, resonance; Quality factor, power in AC circuits, wattless current. AC generator and transformer.

UNIT 15: ELECTROMAGNETIC WAVES

Electromagnetic waves and their characteristics. Transverse nature of electromagnetic waves. Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, Xrays, gamma rays). Applications of e.m. waves.

UNIT 16: OPTICS

Reflection and refraction of light at plane and spherical surfaces, mirror formula, Total internal reflection and its applications, Deviation and Dispersion of light by a prism, Lens Formula, Magnification, Power of a Lens, Combination of thin lenses in contact, Microscope and Astronomical Telescope (reflecting and refracting) and their magnifyingpowers. Wave optics: wavefront and Huygens' principle, Laws of reflection and refraction using Huygen's principle. Interference, Young's double slit experiment and expression for fringe width. Diffraction due to a single slit, width of central maximum. Resolving power of microscopes and astronomical telescopes, Polarisation, plane polarized light; Brewster's law, uses of plane polarized light and Polaroids.

UNIT 17: DUAL NATURE OF MATTER ANDRADIATION

Dual nature of radiation. Photoelectric effect, Hertz and Lenard's observations; Einstein's photoelectric equation; particle nature of light. Matter waves-wave nature of particle, de Broglie relation. Davisson-Germer experiment.

UNIT 18: ATOMS AND NUCLEI

Alpha-particle scattering experiment; Rutherford's model of atom; Bohr model, energy levels, hydrogen spectrum. Composition and size of nucleus, atomic masses, isotopes, isobars; isotones. Radioactivity-alpha, beta and gamma particles/rays and their properties; radioactive decay law. Mass-energy relation, mass defect; binding energy per nucleon and its variation with mass number, nuclear fission and fusion.

UNIT 19: ELECTRONIC DEVICES

Semiconductors; semiconductor diode: I-V characteristics in forward and reverse bias; diode as a rectifier; I-V characteristics of LED, photodiode, solar cell and Zener diode; Zener diode as a voltage regulator. Junction transistor, transistor action, characteristics of a transistor; transistor as an amplifier (common emitter configuration) and oscillator. Logic gates (OR, AND, NOT, NAND and NOR). Transistor as a switch.

UNIT 20: COMMUNICATION SYSTEMS

Propagation of electromagnetic waves in the atmosphere; Sky and space wave propagation, Need for modulation, Amplitude and Frequency Modulation, Bandwidth of signals, Bandwidth of Transmission medium, Basic Elements of a Communication System (Block Diagram only).

SECTION –B

UNIT 21: EXPERIMENTAL SKILLS

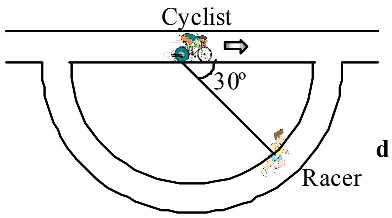
Familiarity with the basic approach and observations of the experiments and activities:

1. Vernier callipers-its use to measure internal and external diameter and depth of a vessel.
2. Screw gauge-its use to determine thickness/diameter of thin sheet/wire.
3. Simple Pendulum-dissipation of energy by plotting a graph between square of amplitude and time.
4. Metre Scale - mass of a given object by principle of moments.
5. Young's modulus of elasticity of the material of a metallic wire.
6. Surface tension of water by capillary rise and effect of detergents.
7. Co-efficient of Viscosity of a given viscous liquid by measuring terminal velocity of a given spherical body.
8. Plotting a cooling curve for the relationship between the temperature of a hot body and time.
9. Speed of sound in air at room temperature using a resonance tube.
10. Specific heat capacity of a given (i) solid and (ii) liquid by method of mixtures.
11. Resistivity of the material of a given wire using metre bridge.
12. Resistance of a given wire using Ohm's law.
13. Potentiometer –
(i) Comparison of emf of two primary cells.
(ii) Determination of internal resistance of a cell.
14. Resistance and figure of merit of a galvanometer by half deflection method.
15. Focal length of:
(i) Convex mirror (ii) Concave mirror, and (iii) Convex lens using parallax method.
16. Plot of angle of deviation vs angle of incidence for a triangular prism.
17. Refractive index of a glass slab using a travelling microscope.
18. Characteristic curves of a p-n junction diode in forward and reverse bias.
19. Characteristic curves of a Zener diode and finding reverse break down voltage.
20. Characteristic curves of a transistor and finding current gain and voltage gain.
21. Identification of Diode, LED, Transistor, IC, Resistor, Capacitor from mixed collection of such items.
22. Using multimeter to:
(i) Identify base of a transistor (ii) Distinguish between npn and pnp type transistor
(iii) See the unidirectional flow of current in case of a diode and an LED.
(iv) Check the correctness or otherwise of a given electronic component (diode, transistor or IC)

1 Mechanics

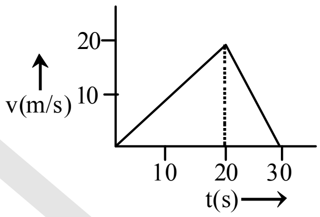
EXERCISE

1. A cyclist is moving with a constant acceleration of 1.2 m/s^2 on a straight track. A racer is moving on a circular path of radius 150 m at constant speed of 15 m/s. Find the magnitude of velocity of racer which is measured by the cyclist has reached a speed of 20 m/s for the position represented in the figure -



(A) 18.03 m/s (B) 25 m/s (C) 20 m/s (D) 15 m/s

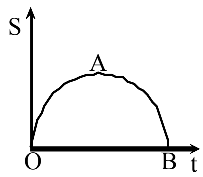
2.* v-t graph of an object of mass 1 kg is shown.
Select the wrong statement-



(A) Work done on the object in 30 s is zero
(B) The average acceleration of the object is zero
(C) The average velocity of the object is zero
(D) The average force on the object is zero

3. A train starting from rest travels the first part of its journey with constant acceleration a, second part with constant velocity v and third part with constant retardation a, being brought to rest. The average speed for the whole journey is $\frac{7v}{8}$. The train travels with constant velocity for ...of the total time -
(A) 3/4 (B) 7/8 (C) 5/6 (D) 9/7

4. The graph of displacement-time for a body travelling in a straight line is given. We can conclude that -



(A) the velocity is constant
(B) the velocity increases uniformly
(C) the body is subjected to acceleration from O to A
(D) the velocity of the body at A is zero

5.* A particle is projected vertically upwards and it reaches the maximum height H in time T seconds. The height of the particle at any time t will be-
(A) g (t - T)2 (B) H - g (t - T)2 (C) g (t - T)2 (D) H - g (t - T)

6. A body moves with uniform velocity of
u = 7 m/s from t = 0 to t = 1.5 sec. For t > 1.5 s, it starts moving with an acceleration of 10 m/s2. The distance travelled between t = 0 to
t = 3 sec will be -
(A) 47.75 m (B) 32.25 m (C) 16.75 m (D) 27.50 m

7. A person is standing on a truck moving with a constant velocity of 14.7 m/s on a horizontal road. The man throws a ball in such a way that it returns to the truck after the truck has moved 58.8 m. What is the speed of the ball as seen from the truck?
(A) 9.8 m/s (B) 19.6 m/s (C) 29.4 m/s (D) 24.5 m/s

8. A stone is thrown from a bridge at an angle of 30º down with the horizontal with a velocity of 25 m/s. If the stone strikes the water after 2.5 sec then calculate the height of the bridge from the water surface-
(A) 61.9 m (B) 35 m (C) 70 m (D) None

9.* A cannon ball has a range R on a horizontal plane. If h and h' are the greatest heights in the two paths for which this is possible, then-

(A) $R = 4\sqrt{(hh')}$ (B) $R = \frac{4h}{h'}$ (C) R = 4 h h' (D) $R = \sqrt{hh'}$

10. If retardation produced by air resistances to projectile is one-tenth of acceleration due to gravity, the time to reach maximum height approximately-
(A) increase by 9% (B) decrease by 9%
(C) increase by 11% (D) decrease by 11%

11.* A particle starts from the origin of coordinates at time t = 0 and moves in the xy plane with a constant acceleration α in the y-direction. Its equation of motion is $y = \beta x^2$. Its velocity component in the x-direction is -

(A) variable (B) $\sqrt{\frac{2\alpha}{\beta}}$ (C) $\frac{\alpha}{2\beta}$ (D) $\sqrt{\frac{\alpha}{2\beta}}$

12.* Two particles are projected from the same point with the same speed, at different angles θ_1 and θ_2 to the horizontal. They have the same horizontal range. Their times of flight are t_1 and t_2 respectively incorrect statement is.

(A) $\theta_1 + \theta_2 = 90^\circ$ (B) $\frac{t_1}{t_2} = \tan\theta_1$ (C) $\frac{t_1}{t_2} = \tan\theta_2$ (D) $\frac{t_1}{\sin\theta_1} = \frac{t_2}{\sin\theta_2}$

13. A particle moves along the positive branch of the curve $y = \frac{x^2}{2}$ where $x = \frac{t^2}{2}$, where x and y are measured in metre and t in second. At t = 2 sec, the velocity of the particle is -

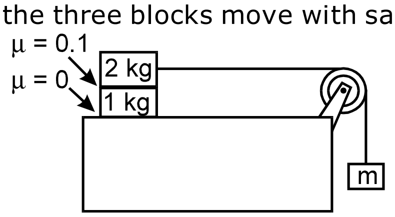
(A) $(2\hat{i} - 4\hat{j})$ m/sec (B) $(2\hat{i} + 4\hat{j})$ m/sec (C) $(2\hat{i} + 2\hat{j})$ m/sec (D) $(4\hat{i} - 2\hat{j})$ m/sec

14. A boy standing on a long railroad car throws a ball straight upwards. The car is moving on the horizontal road with an acceleration of $1 m/s^2$ and the projection velcoity in the vertical direction is 9.8 m/s. How far behind the boy will the ball fall on the car -
(A) 1 m (B) 2 m (C) 3 m (D) 4 m

15. A block of mass 4 kg is kept over a rough horizontal surface. The coefficient of friction between the block and the surface is 0.1. At t = 0, 3 m/s $(\hat{i})$ velocity is imparted to the block and simultaneously 2N $(-\hat{i})$ force starts acting on it. Its displacement in first 5 second is $(g = 10 m/s^2)$ -

(A) $8\hat{i}$ (B) $-8\hat{i}$ (C) $3\hat{i}$ (D) $-3\hat{i}$

16. Mass of upper block and lower block kept over the table is 2 kg and 1 kg respectively and coefficient of friction between the blocks is 0.1. Table surface is smooth. The maximum mass M for which all the three blocks move with same acceleration is $(g = 10 m/s^2)$ -

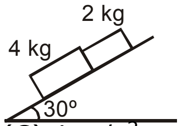


(A) 1 kg (B) 2/3 kg (C) 1/3 kg (D) 3/4 kg

17. A block slides down an inclined surface of inclination 30º with the horizontal. Starting from rest it covers 8m in the first two seconds. Find the coefficient of kinetic friction between the two.
(A) 0.11 (B) 0.5 (C) 0.8 (D) 0.2

18. A body of mass 2 kg is lying on a rough inclined plane of inclination 30º. Find the magnitude of the force parallel to the incline needed to make the block move (a) up the incline (b) down the incline. Coefficient of static friction = 0.2
(A) 13 N, 5 N (B) 13 N, 13 N (C) 13 N, 0 N (D) 5 N, 13 N

19. Figure shows two blocks in contact sliding down an inclined surface of inclination 30º. The friction coefficient between the block of mass 2.0 kg and the incline is μ_1, and that between the block of mass 4.0 kg and the incline is μ_2. Calculate the acceleration of the 2.0 kg block if μ_1 = 0.30 and μ_2 = 0.20, Take g = 10 m/s^2



(A) 2 m/s^2 (B) 2.7 m/s^2 (C) 4 m/s^2 (D) 2.4 m/s^2

20.* A box of mass 8 kg is placed on a rough inclined plane of inclination θ. Its downward motion can be prevented by applying an upward pull F and it can be made to slide upwards by applying a force 2F. The coefficient of friction between the box and the inclined plane is -

(A) $\frac{1}{3}\tan\theta$ (B) $3\tan\theta$ (C) $\frac{1}{2}\tan\theta$ (D) $2\tan\theta$

21. The rear side of a truck is open and box of mass 20 kg is placed on the truck 4 meters away from rest with an acceleration of 2 m/sec^2 on a straight road. The truck starts from rest with an acceleration of 2 m/sec^2 on a straight road. The box will fall off the truck when it is at a distance from the starting point equal to (μ = 0.15) -
(A) 4 m (B) 8 m (C) 16 m (D) 32 m

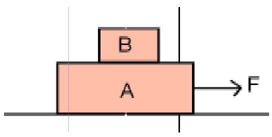
22.* A uniform rope of length ℓ lies on a table if the coefficient of friction is μ, then the maximum length ℓ, of the part of this rope which can over hang from the edge of the table without sliding down is -

(A) $\frac{\ell}{\mu}$ (B) $\frac{\ell}{\mu+1}$ (C) $\frac{\mu\ell}{\mu+1}$ (D) $\frac{\mu\ell}{\mu-1}$

23. A particle is projected along a line of greatest slope on a rough plane inclined at an angle of 45º with the horizontal, if the coefficient of friction is 1/2, then the retardation is-

(A) $\frac{g}{\sqrt{2}}$ (B) $\frac{g}{2\sqrt{2}}$ (C) $\frac{g}{\sqrt{2}}\left(1+\frac{1}{2}\right)$ (D) $\frac{g}{\sqrt{2}}\left(1-\frac{1}{2}\right)$

24. A body A of mass 1 kg rests on a smooth surface. Another body B of mass 0.2 kg is placed over A as shown. The coefficient of static friction between A and B is 0.15. B will begin to slide on A, if A is pulled with a force greater than -



(A) 1.764 N (B) 0.1764 N
(C) 0.3 N (D) it will not slide for any F

25. A heavy uniform chain lies on a horizontal table top. If the coefficient of friction between the chain and the table surface is 0.25, then the maximum fraction of the length of the chain that can hang over one edge of the table is -
(A) 20% (B) 25% (C) 35% (D) 15%

26. A block rests on an inclined plane that makes an angle θ with the horizontal, if the coefficient of sliding friction is 0.50 and that of static friction is 0.75, the time required to slide the block 4 m along the inclined plane is -
(A) 25 s (B) 10 s (C) 5 s (D) 2 s

27.* A force F accelerates a block of mass m on horizontal surface. The coefficient of friction between the contact surface is μ. The acceleration of m will be -

(A) $\frac{F-\mu mg}{M}$ (B) zero (C) may be (A) or (B)(D) none of these

28. A horizontal force F is exerted on a 20 kg block to push it up an inclined plane having an Inclination of 30º. The frictionalforce retarding the motion is 80 N. For the acceleration of the moving block to be zero, the force F must be-
(A) 206 N (B) 602 N (C) 620 N (D) 260 N

29. A person wants to drive on the vertical surface of a large cylindrical wooden 'well' commonly known as 'death well' in a circus. The radius of the well is R and the coefficient of friction between the tyres of the motorcycle and the wall of the well is μ_s. The minimum speed the motor cyclist must have in order to prevent slipping should be -

(A) $\sqrt{\frac{gR}{\mu_s}}$ (B) $\sqrt{\frac{\mu_s}{gR}}$ (C) $\sqrt{\frac{\mu_s g}{R}}$ (D) $\sqrt{\frac{R}{\mu_s g}}$

30. A spherical ball of mass 1/2 kg is held at the top of an inclined rough plane making angle 30º with the horizontal the coefficient of limiting friction is 0.5. If the ball just slides down the plane without rolling its acceleration down the plane is -

(A) $\left[\frac{2-\sqrt{3}}{4}\right]g$ (B) g (C) $\left[\frac{2\sqrt{3}-1}{4}\right]g$ (D) $\left[\frac{\sqrt{3}-1}{2}\right]g$

31. An object is placed on the surface of a smooth inclined plane of inclination θ. It takes time t to reach the bottom of the inclined plane. If the same object is allowed to slide down rough inclined plane of same inclination θ, it takes time nt to reach the bottom where n is a number greater than 1. The coefficient of friction μ is given by -

(A) $\mu = \tan\theta \left(1-\frac{1}{n^2}\right)$ (B) $\mu = \cot\theta \left(1-\frac{1}{n^2}\right)$

(C) $\mu = \tan\theta \left(1-\frac{1}{n^2}\right)^{1/2}$ (D) $\mu = \cot\theta \left(1-\frac{1}{n^2}\right)^{1/2}$

32. A given object takes n times as much time to slide down a 45º rough incline as it takes to slide down a perfectly smooth 45º incline. The coefficient of kinetic friction between the object and the incline is given by -

(A) $1 - \frac{1}{n^2}$ (B) $\frac{1}{1-n^2}$ (C) $\sqrt{1-\frac{1}{n^2}}$ (D) $\sqrt{\frac{1}{1-n^2}}$

33. A 15 kg mass is accelerated from rest with a force of 100 N. As it moves faster, friction and air resistance create an oppositively directed retarding force given by $F_R = A + Bv$, where A = 25 N and B = 0.5 N/m/s. At what velocity does the acceleration equal to one half of the initial acceleration?
(A) 25 ms^{-1} (B) 50 m/s (C) 75 m/s (D) 100 m/s

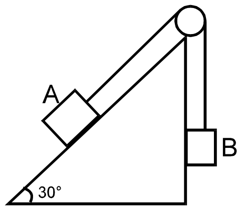
34. Two blocks of masses M = 3 kg and m = 2 kg, are in contact on a horizontal table. A constant horizontal force F = 5 N is applied to block M as shown. There is a constant frictional force of 2 N between the table and the block m but no frictional force between the table and the first block M, then the acceleration of the two blocks is-

(A) 0.4 ms^{-2} (B) 0.6 ms^{-2} (C) 0.8 ms^{-2} (D) 1 ms^{-2}

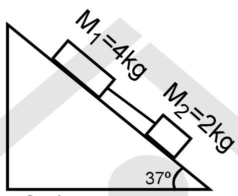
35. Block A of mass M in the system shown in the figure slides down the incline at a constant speed. The coefficient of friction between block A and the surface is $\frac{1}{3\sqrt{3}}$.

The mass of block B is-

(A) M/2 (B) M/3
(C) 2M/3 (D) $M/\sqrt{3}$



36. Two blocks connected by a massless string slide down an inclined plane having angle of inclination 37º. The masses of the two blocks are M_1 = 4 kg and M_2 = 2 kg respectively and the coefficients of friction 0.75 and 0.25 respectively-



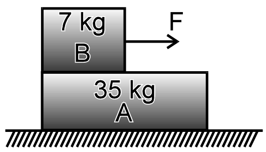
(A) The common acceleration of the two masses is 1.3 ms^{-2}
(b) The tension in the string is 14.7 N
(c) The common acceleration of the two masses is 2.94 ms^{-2}
(d) The tension in the string is 5.29 N

(A) a, d (B) c, d (C) b, d (D) b, c

37. A block of mass m is placed on a rough inclined plane of inclination θ kept on the floor of the lift. The coefficient of friction between the block and the inclined plane is μ. With what acceleration will the block slide down the inclined plane when the lift falls freely ?

(A) Zero
(B) $g \sin \theta - \mu g \cos \theta$
(C) $g \sin \theta + \mu g \cos \theta$
(D) None of these

38 Block A of mass 35 kg is resting on a frictionless floor. Another block B of mass 7 kg is resting on it as shown in the figure. The coefficient of friction between the blocks is 0.5 while kinetic friction is 0.4. If a force of 100 N is applied to block B, the acceleration of the block A will be ($g = 10 \text{ m s}^{-2}$) :

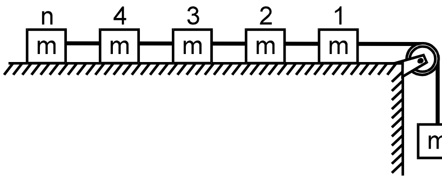


(A) 0.8 m s^{-2} (B) 2.4 m s^{-2} (C) 0.4 m s^{-2} (D) 4.4 m s^{-2}

39. A wooden block of mass M resting on a rough horizontal surface is pulled with a force F at an angle ϕ with the horizontal. If μ is the coefficient of kinetic friction between the block and the surface, then acceleration of the block is -

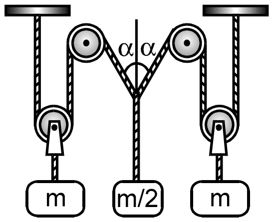
(A) $\frac{F}{M}(\cos \phi + \mu \sin \phi) - \mu g$ (B) $F \sin \phi / M$
(C) $\mu F \cos\phi$ (D) $\mu F \sin \phi$

40. In the given arrangement, n number of equal masses are connected by strings of negligible masses. The tension in the string connected to n^{th} mass is -



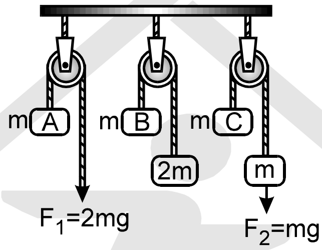
(A) $\frac{mMg}{nm+M}$ (B) $\frac{mMg}{nmM}$ (C) mg (D) mng

41. In the given figure, pulleys and strings are massless. For equilibrium of the system, the value of α is -



(A) 60° (B) 30° (C) 90° (D) 120°

42. In the figure, the blocks A, B and C each of mass m have accelerations a_1, a_2 and a_3 respectively. F_1 and F_2 are external forces of magnitude 2 mg and mg respectively. Then -

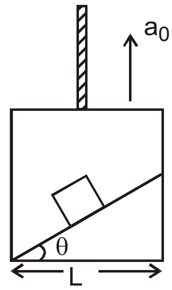


(A) $a_1 = a_2 = a_3$ (B) $a_1 > a_3 > a_2$ (C) $a_1 = a_2$, $a_2 > a_3$ (D) $a_1 > a_2$, $a_2 = a_3$

43. A particle slides down a smooth inclined plane of elevation θ, fixed in an elevator going up with an acceleration a_0 (figure). The base of the incline has a length L. Find the time taken by the particle to reach to the bottom -

(A) $\left[\frac{2L}{g\sin\theta\cos\theta}\right]^{1/2}$ (B) $\left[\frac{2L}{(g-a_0)\sin\theta\cos\theta}\right]^{1/2}$

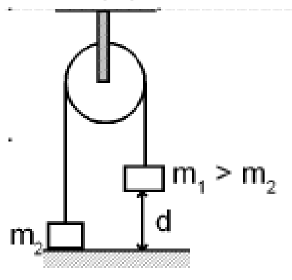
(C) $\left[\frac{2L\sin\theta}{(g+a_0)\cos\theta}\right]^{1/2}$ (D) $\left[\frac{2L}{(g+a_0)\sin\theta\cos\theta}\right]^{1/2}$



44. A chain has five rings. The mass of each ring is 0.1 kg. This chain is pulled upwards by a froce F producing an acceleration of 2.50 m/sec^2 in the chain. Then the force of action (reaction) on the joint of second and third ring from the top is -
(A) 0.25 N (B) 1.23 N (C) 3.69 N (D) 6.15 N

45. If the masses are released from the position shown in figure then the speed of mass m_1 just before it strikes the floor is -

(A) $[2m_1gd/(m_1+m_2)]^{1/2}$
(B) $[2(m_1 - m_2)gd/(m_1+m_2)]^{1/2}$
(C) $[2(m_1 - m_2)gd/m_1]^{1/2}$
(D) None of the above



46. The linear momentum P of a body varies with time and is given by the equation $P = x + yt^2$, where x and y are constants. The net force acting on the body for a one dimensional motion is proportional to-

(A) t^2 (B) a constant (C) 1/t (D) t

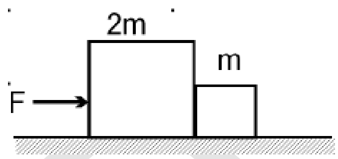
47. A rope of legth L is pulled by a constant force F. What is the tension in the rope at a distance x from the end where the force is applied ?

(A) $\frac{Fx}{L-x}$ (B) $F\frac{L}{L-x}$ (C) FL/x (D) F(L – x)/L

48. The acceleration with which an object of mass 100 kg be lowered from a roof using a cord with a breaking strength of 60 kg weight without breaking the rope is- (assume g = 10 m/sec^2)

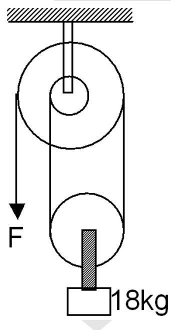
(A) 2 m/sec^2 (B) 4 m/sec^2 (C) 6 m/sec^2 (D) 10 m/sec^2

49. Two blocks are in contact on a frictionless table one has a mass m and the other 2m. A force F is applied on 2m as shown is Figure. Now the same force F is applied on m. In the two cases respectively the ratio of force of contact between the two blocks will be-



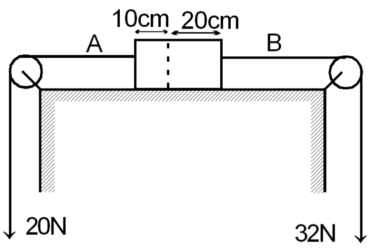
(A) 1 : 1 (B) 1 : 2 (C) 1 : 3 (D) 1 : 4

50. In the figure at the free end a force F is applied to keep the suspended mass of 18 kg at rest. The value of F is-



(A) 180 N (B) 90 N (C) 60 N (D) 30 N

51. Figure shows a uniform rod of mass 3 kg and of length 30 cm. The strings shown in figure are pulled by constant forces of 20 N and 32 N .The acceleration of the rod is-



(A) 2 m/s^2 (B) 3m/s^2 (C) 4 m/s^2 (D) 6 m/s^2

52. In the above question tension in rod at a distance 10 cm from end A is-

(A) 18 N (B) 20 N (C) 24 N (D) 36 N

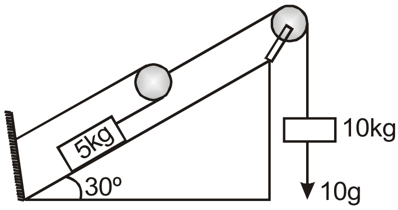
53. A balloon of mass M and a fixed size starts coming down with an acceleration f(f<g). The ballast mass m to be dropped from the ballon to have it go up with an acceleration f. Assuming negligible air resistance is find the value of m

(A) $\left(\frac{M}{g+f}\right)f$ (B) $\frac{Mf}{2(g+f)}$ (C) $\left(\frac{2Mf}{g+f}\right)$ (D) $\frac{M(g+a)}{g}$

54. A conveyor belt is moving horizontally with a uniform velocity of 2 m/sec. Material is dropped at one end at the rate of 5 kg/sec and discharged at the other end. Neglecting the friction, the power required to move the belt is-

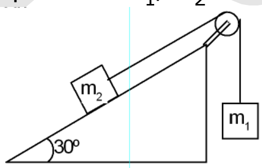
(A) 10 watts (B) 15 watts (C) 20 watts (D) 40 watts

55. In fig, a mass 5 kg slides without friction on an inclined plane making an angle 30º with the horizontal. Then the acceleration of this mass when it is moving upwards, the other mass is 10 kg. The pulleys are massless and frictionless. Take g = 10 m/sec^2.-



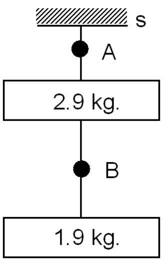
(A) .33 m/sec^2 (B) 3.3 m/sec^2 (C) 33 m/sec^2 (D) None of these

56. Two masses m_1 and m_2 are connected by light string, which passes over the top of a smooth plane inclined at 30º to the horizontal, so that one mass rests on the plane and the other hangs vertically as shown in fig. It is found that m_1, hanging vertically can draw m_2 up the full length of the plane in half the time in which m_2 hanging vertically draws m_1 up. Find m_1/m_2 . Assume pulley to be smooth-



(A) $\frac{2}{3}$ (B) $\frac{3}{2}$ (C) $\frac{4}{7}$ (D) $\frac{7}{4}$

57. Two blocks of masses 2.9 kg and 1.9 kg are suspended from a rigid support S by two inextensible wires each of length 1 m. The upper wire has negligible mass and the lower wire has a uniform mass of 0.2 kg/m. Thewhole system of block, wire and support have an upward acceleration of 0.2 m/s^2. g = 9.8 m/s^2. The tension at the mid-point of lower wire is-



(A) 10 N (B) 20 N (C) 30 N (D) 50 N

58. Body A is placed on frictionless wedge making an angle θ with the horizon. The horizontal acceleration towards left to be imparted to the wedge for the body A to freely fall vertically, is-

(A) g sinθ (B) g cos θ (C) g tanθ (D) g cotθ

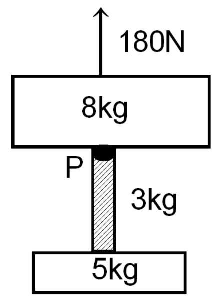
59. A triangular block of mass M with angle 30º, 60º, 90º rests with its 30º– 90º side on a horizontal smooth fixed table. A cubical block of mass m rests on the 60º – 30º sideofthe triangular block. What horizontal acceleration a must M have relative to the stationary table so that m remains stationary with respect to the triangular block [M = 9 kg, m = 1 kg]

(A) 2.8 m/s^2 (B) 5.6 m/s^2 (C) 8.4 m/s^2 (D) Zero

60. A body of mass 8 kg is hanging from another body of mass 12 kg. The combination is being pulled up by a string with an acceleration of 2.2 m/sec^2. The tension T_1 will be -

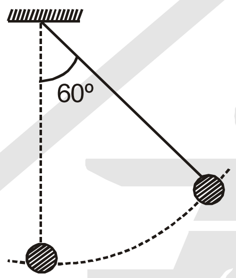
(A) 260 N (B) 240 N (C) 220 N (D) 200 N

61. Two blocks of mass 8 kg and 5 kg are connected by a heavy rope of mass 3 kg. An upward force of 180 N is applied as shown in the figure. The tension in the string at point P will be:



(A) 60 N (B) 90 N
(C) 120 N (D) 150 N

62. A pendulum of length ℓ = 1 m is released from θ_0 = 60º. The rate of change of speed of the bob at θ = 30º is: (g = 10 m/s^2)



(A) $5\sqrt{3}\,m/s^2$ (B) 5 m/s^2 (C) 10 m/s^2 (D) 2.5 m/s^2

63. A particle moves along a circle of radius R = 1 m so that its radius vector $\vec{r}$ relative to a point on its circumference rotates with the constant angular velocity ω = 2 rad/s. The linear speed of the particle is:

(A) 4m/s (B) 2 m/s (C) 1 m/s (D) 0.5 m/s

64. Starting from rest, a particle rotates in a circle of radius $R=\sqrt{2}\,m$ with an angular acceleration α = π/4 rad/s^2.The magnitude of average velocity of the particle over the time it rotates quarter circle is:

(A) 1.5 m/s (B) 2 m/s (C) 1 m/s (D) 1.25 m/s

65. A particle is moving in a circle of radius 1 m with speed varying with time as v = (2t) m/s. In first 2 sec:

(A) distance travelled by the particle is 4 m
(B) displacement of the particle is 4 sin 2
(C) average speed of the particle is 5 m/s
(D) average velocity of the particle is zero

66. A ball suspended by a thread swings in a vertical plane so that its acceleration in the extreme position and lowest position are equal. The angle θ of thread deflection in the extreme position will be -

(A) $\tan^{-1}(2)$ (B) $\tan^{-1}(\sqrt{2})$ (C) $\tan^{-1}\left(\frac{1}{2}\right)$ (D) $2\tan^{-1}\left(\frac{1}{2}\right)$

67. A particle suspended from a fixed point, by a light inextensible thread of length L is projected horizontally from its lowest position with velocity $\frac{\sqrt{7gL}}{2}$. The thread will slack after swinging through an angle θ, such that θ equal

(A) 30º (B) 135º (C) 120º (D) 150º

68. A particle is projected with a speed u at an angle θ with the horizontal. Consider a small part of its path near the highest position and take it approximately to be a circular arc. What is the radius of this circle ? This radius is called the radius of curvature of the curve at the point :

(A) $\frac{u^2 \sin^2\theta}{g}$ (B) $\frac{u^2 \cos^2\theta}{g}$ (C) $\frac{u^2 \tan^2\theta}{g}$ (D) $\frac{u^2}{g}$

69. A stone of mass m tied to the end of a string revolves in a vertical circle of radius R. The net forces at the lowest and highest points of the circle directed vertically downwards are: [Choose the correct alternative]

Lowest point Highest point

(A) $mg - T_1 mg + T_2$

(B) $mg + T_1\ mg - T_2$

(C) $mg + T_1 - (mv_1^2)/R\ mg - T_2 + (mv_1^2)/R$

(D) $mg - T_1 - (mv_1^2)/R\ mg + T_2 + (mv_1^2)/R$

T_1 and v_1 denote the tension and speed at the lowest point. T_2 and v_2 denote the corresponding values at the highest point.

70. A rubber band of length ℓ has a stone of mass m tied to its one end. It is whirled with speed v so that the stone describes a horizontal circular path. The tension T in the rubber band is -

(A) zero (B) mv^2/ℓ (C) $> (mv^2)/\ell$ (D) $< mv^2/\ell$

71. The equation of motion of a particle moving on circular path (radius 200 m) is given by $s = 18t + 3t^2 - 2t^3$ where s is the total distance covered from straight point in metres at the end of t seconds. The maximum speed of the particle will be-

(A) 15 m/sec (B) 23 m/sec

(C) 19.5 m/sec (D) 25 m/sec

72. The kinetic energy of a particle moving along a circle of radius R depends on the distance covered s as $T = KS^2$ where K is a constant. Find the force acting on the particle as a function of S -

(A) $\frac{2K}{S}\sqrt{1+\left(\frac{S}{R}\right)^2}$ (B) $2KS\sqrt{1+\left(\frac{R}{S}\right)^2}$ (C) $2KS\sqrt{1+\left(\frac{S}{R}\right)^2}$ (D) $\frac{2S}{K}\sqrt{1+\left(\frac{R}{S}\right)^2}$

73. A point moves along a circle with velocity $v = at$ where a 0.5 m/sec^2. Then the total acceleration of the point at the moment when it covered (1/10) th of the circle after beginning of motion -

(A) 0.5 m/sec^2 (B) 0.6 m/sec^2 (C) 0.7 m/sec^2 (D) 0.8 m/sec^2

74. A solid body rotates about a stationary axis so that its angular velocity depends on the rotation angle ϕ as $\omega = \omega_0 - k\phi$, where ω_0 and k are positive constants. At the moment $t = 0$, the angle $\phi = 0$. Find the time dependence of rotation angle -

(A) $K.\ \omega_0 e^{-kt}$ (B) $\frac{\omega_0}{K}\ [e^{-kt}]$ (C) $\frac{\omega_0}{K}\ [1-e^{-k.t}]$ (D) $\frac{K}{\omega_0}\ [e^{-kt} - 1]$

75. A heavy particle hanging from a fixed point by a light inextensible string of length ℓ is projected horizontally with speed $\sqrt{(gl)}$. Then the speed of the particle and the inclination of the string to the vertical at the instant of the motion when the tension in the string equal the weight of the particle-

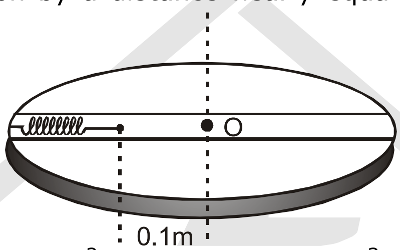
(A) $\sqrt{\frac{3l}{g}}$, $\cos^{-1}$ (3/2) (B) $\sqrt{\frac{lg}{3}}$, $\cos^{-1}$ (2/3)

(C) $\sqrt{\frac{3g}{l}}$, $\cos^{-1}$ (2/3) (D) $\sqrt{\frac{gl}{3}}$, $\sin^{-1}$ (2/3)

76. A body is allowed to slide on a frictionless track from rest position under gravity. The track ends into a circular loop of diameter D. What should be the minimum height of the body in terms of D so that it may complete successfully the loop?

(A) $\frac{4}{5}$D (B) $\frac{5}{4}$D (C) 1 D (D) 2 D

77. A circular turn table of radius 0.5 m has a smooth groove as shown in fig. A ball of mass 90 g is placed inside the groove along with a spring of spring constant 10^2 N/cm. The ball is at a distance of 0.1 m from the centre when the turn table is at rest. On rotating the turn table with a constant angular velocity of 10^2 rad-sec^{-1} the ball moves away from the initial position by a distance nearly equal to-



(A) 10^{-1} m (B) 10^{-2} m (C) 10^{-3} m (D) 2 × 10^{-1} m

78.* A gramophone record is revolving with an angular velocity ω. A coin is placed at a distance r from the centre of the record. The static coefficient of friction is μ. The coin will revolve with the record if-

(A) $r > \mu g\ \omega^2$ (B) $r = \mu g/\omega^2$ only

(C) $r < \mu g/\omega^2$ only (D) $r \le \mu g/\omega^2$

79. A mass of 2.9 kg, is suspended from a string of length 50 cm, and is at rest. Another body of mass 100 gm moving horizontally with a velocity of 150 m/sec, strikes and sticks to it. What is the tension in the string when it makes an angle of 60° with the vertical

(A) 153.3 N (B) 135.3 N (C) 513.3 N (D) 351.3 N

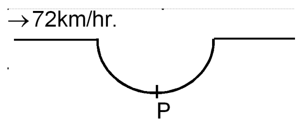
80. The vertical section of a road over a canal bridge in the direction of its length is in the form of circle of radius 8.9 metre. Then the greatest spped at which the car can cross this bridge wihout losing contact with the road at its hgihest point, the centre of gravity of the car being at a height h = 1.1 metre from the ground. Take g = 10 m/sec^2-

(A) 5 m/sec (B) 10 m/sec (C) 15 m/sec (D) 20 m/sec

81.* A car of mass 1000 kg moves on a circular path with constant speed of 16 m/s. It is turned by 90º after travelling 628 m on the road. The centripetal force acting on the car is-

(A) 160 N (B) 320 N (C) 640 N (D) 1280 N

82. A car while travelling at a speed of 72 km/hr. Passes through a curved portion of road in the form of an arc of a radius 10 m. If the mass of the car is 500 kg the reaction on the car at the lowest point P is-



(A) 25 KN (B) 50 KN (C) 75 KN (D) None of these

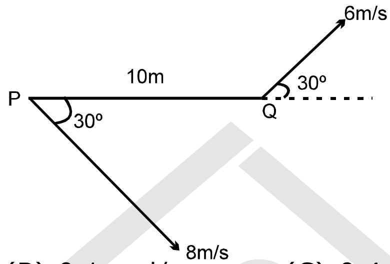
83. A stone is rotated steadily in a horizontal circle with a time period T by means of a string of length ℓ. If the tension in the string is kept constant and length ℓ increase by 1%, then percentage change in time period T is-

(A) 1 % (B) 0.5 % (C) 2 % (D) 0.25 %

84. A stone of mass 1 kg tied to a light inextensible string of length 10/3 metre is whirling in a vertical circle. If the ratio of maximum tension to minimum tension in the string is 4, then speed of stone st highest point of the circle is- [g = 10 m/s^2]

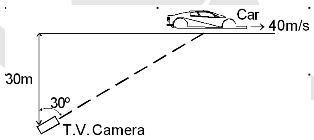
(A) 20 m/s (B) $10\sqrt{3}$ m/s (C) $5\sqrt{2}$ m/s (D) 10 m/s

85. Two moving particles P and Q are 10 m apart at a certain instant. The velocity of P is 8 m/s making 30º with the line joining P and Q and that of Q is 6 m/s making an angle 30º with PQ as shown in the firuge .Then angular velocity of P with respect to Q is-



(A) 0 rad/s (B) 0.1 rad/s (C) 0.4 rad/s (D) 0.7 rad/s

86. A racing car is travelling along a track at a constant speed of 40 m/s. A T.V. camera men is recording the event from a distance of 30 m directly away from the track as shown in figure. In order to keep the car under view in the positio shown, the angular speed with which the camera should be rotated, is-



(A) 4/3 rad/sec (B) 3/4 rad/sec (C) $8/3\sqrt{3}$ rad/sec (D) 1 rad/sec

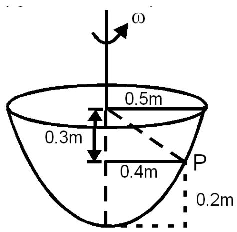
87. A partcile of mass m is moving in a circular path of constant radius r such that its centripetal acceleration a_c is varying with time t as $a_c = k^2 r t^2$, where k is a constant, the power delivered to the particle by the forces acting on it is-

(A) $2 \pi m k^2 r^2 t$ (B) $m k^2 r^2 t$ (C) $(m k^4 r^2 t^5)/3$ (D) 0

88. A partcle rests on the top of a hemisphere of radiu R. Find the smallest horizontal velocity that must be imparted to the particle if it is to leave the hemisphere without sliding down it-

(A) $\sqrt{gR}$ (B) $\sqrt{2gR}$ (C) $\sqrt{3gR}$ (D) $\sqrt{5gR}$

89. A particle P will be in equilibrium inside a hemispherical bowl of radius 0.5 m at a height 0.2 m from the bottom when the bowl is rotated at an angular speed (g = 10 m/sec^2)



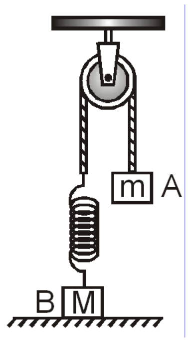
(A) $10 / \sqrt{3}$ rad/sec (B) $10\sqrt{3}$ rad/sec

(C) 10 rad/sec (D $\sqrt{20}$ rad/sec

90. Kinetic energy of a particle moving in a straight line varies with time t as $K = 4t^2$. The force acting on the particle-

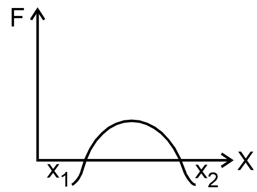
(A) is constant
(B) is increasing
(C) is decreasing
(D) first increase and then decrease

91. In the figure the block A is released from rest when the spring is at its natural length. For the block B of mass M to leave contact with the ground at some stage, the minimum mass of A must be-



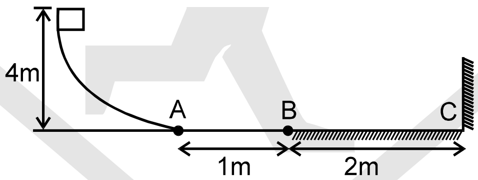
(A) 2 M
(B) M
(C) $\frac{M}{2}$
(D) a function of M and the force constant of the spring

92.* The force acting on a body moving along x-axis varies with the position of the particle as shown in the figure. The body is in stable equilibrium at -



(A) $x = x_1$
(B) $x = x_2$
(C) Both x_1 and x_2
(D) Neither x_1 nor x_2

93. A block of mass m = 0.1 kg is released from a height of 4 m on a curved smooth surface. On the horizontal surface, path AB is smooth and path BC offers coefficient of friction $\mu = 0.1$. If the impact of block with the vertical wall at C be perfectely elastic, the total distance covered by the block on the horizontal surface before coming to rest will be (take $g = 10\ ms^{-2}$) -



(A) 29 m
(B) 49 m
(C) 59 m
(D) 109 m

94. A force $\vec{F} = (2\hat{i} + 5\hat{j} + \hat{k})$ is acting on a particle. The particle is first displaced from (0, 0, 0) to (2m, 2m, 0) along the path x = y and then from (2m, 2m, 0) to (2m, 2m, 2m) along the path x = 2m, y = 2m. The total work done in the complete path is -

(A) 12 J
(B) 8 J
(C) 16 J
(D) 10 J

95. A chain of mass m and length ℓ is placed on a table with one-sixth of it hanging freely from the table edge. The amount of work. done to pull the chain on the table is

(A) $mg\ell/4$
(B) $mg\ell/6$
(C) $mg\ell/72$
(D) $mg\ell/36$

96. The force required to row a boat over the sea is proportional to the speed of the boat. It is found that it takes 24 h.p. to row a certain boat at a speed of 8km/hr, the horse power required when speed is doubled -

(A) 12 h.p.
(B) 6 h.p.
(C) 48 h.p.
(D) 96h.p.

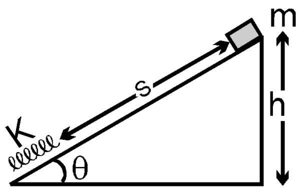
97. A 50 kg girl is swinging on a swing from rest. Then the power delivered when moving with a velocity of 2m/sec upwards in a direction making an angle 60º with the vertical is

(A) 980W
(B) 490W
(C) $490\sqrt{3}$ W
(D) 245W

98. A locomotive of mass m starts moving so that its velocity varies according to thelaw $v = k\sqrt{s}$ where k is constant and s is the distance covered. Find the total work performed by all the forces which are acting on the locomotive during the first t seconds after the beginning of motion.

(A) $W = \frac{1}{8}mk^4t^2$. (B) $W = \frac{1}{4}m^2k^4t^2$ (C) $W = \frac{1}{4}mk^4t^4$ (D) $W = \frac{1}{8}mk^4t^4$

99. A block of mass m slips down an inclined plane as shown in the figure. When it reaches the bottom it presses the spring by a length (spring length <<h and spring constant = K) -



(A) $(2mgh/K)^{1/2}$ (B) $(mgh/K)^{1/2}$
(C) $(2gh/mK)^{1/2}$ (D) $(gh/mK)^{1/2}$

100. Sand drops fall vertically at the rate of 2kg/sec on to a conveyor belt moving horizontally with the velocity of 0.2 m/sec. Then the extra force needed to keep the belt moving is
(A) 0.4 Newton (B) 0.08 Newton (C) 0.04 Newton (D) 0.2 Newton

101. An engine pumps a liquid of density 'd' continuously through a pipe of area of cross section A. If the speed with which the liquid passes through a pipe is v. then the rate at which the Kinetic energy is being imparted to the liquid is
(A) $Adv^3/2$ (B) (1/2)Adv (C) $Adv^2/2$ (D) Adv^2

102. A boy is standing at the centre of a boat which is free to move on water. If the masses of the boy and the boat are m_1 and m_2 respectively and the boy moves a distance of 1 m forward then the movement of the boat is ...... metres

(A) $\frac{m_1}{m_1+m_2}$ (B) $\frac{m_2}{m_1+m_2}$ (C) $\frac{m_1}{m_2}$ (D) $\frac{m_2}{m_1}$

103. A bullet of mass m strikes a pendulum bob of mass M with velocity u. It passes through and emerges out with a velocity u/2 from bob. The length of the pendulum is ℓ. What should be the minimum value of u if the pendulum bob will swing through a complete circle?

(A) $\frac{2M}{m} \times \sqrt{5g\ell}$ (B) $\frac{M}{2m}\sqrt{5g\ell}$ (C) $\frac{2M}{m} \times \frac{1}{\sqrt{5g\ell}}$ (D) $\frac{M}{2m} \times \frac{1}{\sqrt{5g\ell}}$

104. An open water tight railway wagon of mass 5×10^3 kg coasts at an initial velocity of 1.2 m/sec. without friction on a railway track. Rain falls vertically downwards into the wagon. What change then occurred in the velocity of the wagon, when it has collected 10^3kg of water ?
(A) 10 m/s (B) 3m/s (C) 0.2m/s (D) 9m/s

105. Two equal lumps of putty are suspended side by side from two long strings so that they are just touching. One is drawn aside so that its centre of gravity rises a vertical distance h. It is released and then collides inelastically with the other one. The vertical distance risen by the centre of gravity of the combination is -
(A) h. (B) 3h/4 (C) h/2 (D) h/4

106. A billiard ball moving at a speed 2m/s strikes an identical ball initially at rest, at a glancing blow. After the collision one ball is found to be moving at a speed of 1m/s at 60º with the original line of motion. The velocity of the other ball shall be -
(A) $(3)^{1/2}$m/s at 30º to the original direction.
(B) 1m/s at 60º to the original direction.
(C) $(3)^{1/2}$m/s at 60º to the original direction.
(D) 1 m/s at 30º to the original direction.

107. Three particles each of mass m are located at the vertices of an equilateral triangle ABC. They start moving with equal speeds υ each along the medians of the triangle and collide at its centroid G. If after collision, A comes to rest and B retraces its path along GB, then C

(A) also comes to rest (B) moves with a speed υ along CG

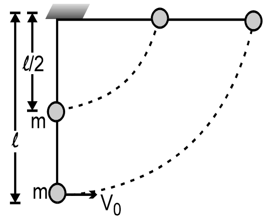
(C) moves with a speed υ along BG (D) moves with a speed along AG

108. An object of mass m slides down a hill of height h and of arbitrary shape and stops at the bottom because of friction. The coefficient of friction may be different for different segments of the path. Work required to return the object to its position along the same path by a tangential force is

(A) mgh (B) 2 mgh

(C) – mgh (D) it can not be calculated

109. A light rod of length ℓ is pivoted at the upper end. Two masses (each m), are attached to the rod, one at the middle and the other at the free end. What horizontal velocity must be imparted to the lower end mass, so that the rod may just take up the horizontal position?



(A) $\sqrt{6\ell g}/5$ (B) $\sqrt{\ell g}/5$

(C) $\sqrt{12\ell g/5}$ (D) $\sqrt{2\ell g}/5$

110. A machine, which is 72 percent efficient, uses 36 joules of energy in lifting up 1kg mass through a certain distance. The mass is the allowed to fall through that distance. The velocity at the end of its fall is

(A) 6.6 ms^{-1} (B) 7.2 ms^{-1} (C) 8.1 ms^{-1} (D) 9.2 ms^{-1}

111. A billiard ball moving at a speed of 6.6 ms^{-1} strikes an identical stationary ball a glancing blow. After the collision, one ball is found to be moving at a speed of 3.3, ms^{-1} in a direction making an angle of 60º with the original line of motion. The velocity of the other ball is

(A) 4.4 ms^{-1} (B) 6.6 ms^{-1} (C) 3.3 ms^{-1} (D) 5.7 ms^{-1}

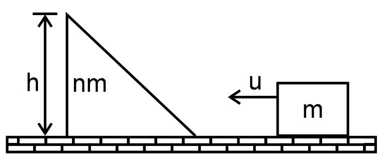
112. A projectile of mass 3m explodes at highest point of its path. It breaks into three equal parts. One part retraces its path, the second one comes to rest. The range of the projectile was 100 m if no explosion would have taken place. The distance of the third part from the point of projection when it finally lands on the ground is -

(A) 100 m (B) 150 m (C) 250 m (D) 300 m

113. A man of mass m moves with a constant speed on a plank of mass 'M' and length 'L' kept initially at rest on a frictionless horizontal surface, from one end to the other in time 't'. The speed of the plank relative to ground while man is moving, is -

(A) $\frac{L}{t}\left(\frac{M}{m}\right)$ (B) $\frac{L}{t}\left(\frac{m}{M+m}\right)$ (C) $\frac{L}{t}\left(\frac{m}{M-m}\right)$ (D) None of these

114. A block of mass m is pushed towards a movable wedge of mass nm and height h, with a velocity u. All surfaces are smooth. The minimum value of u for which the block reach the top of the wedge is -



(A) $\sqrt{2gh}$ (B) 2ngh

(C) $\sqrt{2gh\left(1+\frac{1}{n}\right)}$ (D) $\sqrt{2gh\left(1-\frac{1}{n}\right)}$

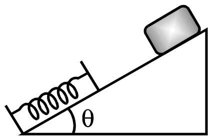
115. A uniform flexible chain of mass m and length 2ℓ hangs in equilibrium over a smooth horizontal pin of negligible diameter. One end of the chain is given a small vertical displacement so that the chain slips over the pin. The speed of chain when it leaves pin is-

(A) $\sqrt{2g\ell}$ (B) $\sqrt{g\ell}$ (C) $\sqrt{4g\ell}$ (D) $\sqrt{3g\ell}$

116. A particle of mass 0.5 kg is displaced from position $\vec{r}_1(2, 3, 1)$ to $\vec{r}_2(4, 3, 2)$ by applying of force of magnitude 30 N which is acting along $(\hat{i} + \hat{j} + \hat{k})$. The work done by the force is -

(A) $10\sqrt{3}$ J (B) $30\sqrt{3}$ J (C) 30 J (D) None of these

117. In the given figure, the inclined surface is smooth. The body releases from the top. Then-

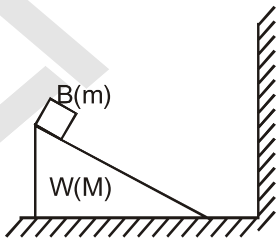


(A) the body has maximum velocity just before striking the spring
(B) The body performs periodic motion
(C) the body has maximum velocity at the compression $\frac{mg\sin\theta}{k}$ where k is spring constant
(D) both (B) and (C) are correct

118. A body of mass 2 kg is moved from a point A to a point B by an external agent in a conservative force field. It the velocity of the body at the points A and B are 5 m/s and 3 m/s respectively and the work done by the external agents is –10 J, then the change in potential energy between points A and B is-

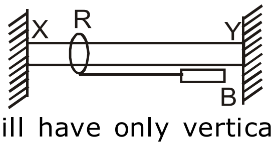
(A) 6 J (B) 36 J (C) 16 J (D) None of these

119. In the figure the block B of mass m starts from rest at the top of a wedge W of mass M. All surfaces are without friction. W can slide on the ground B slides down onto the ground, moves along it with a speed v, has an elastic collision with the wall, and climbs back onto W. then incorrect statement is



(A) B will reach the top of W again
(B) From the beginning, till the collision with the wall, the centre of mass of 'B plus W' does not move horizontally
(C) After the collision, the centre of mass of 'B plus W' moves with the velocity $\frac{2mv}{m+M}$
(D) When B reaches its highest position on W, the speed of W is $\frac{2mv}{m+M}$

120. The ring R in the arrangement shown can slide along a smooth, fixed, horizontal rod XY. It is attached to the block B by a light string. The block is released from rest, with the string horizontal.



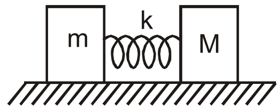
(A) One point in the string will have only vertical motion
(B) R and B will always have momenta of the same magnitude.
(C) When the string becomes vertical, the speed of R and B will be directly proportionaly to their masses
(D) R will lose contact with the rod at some point

121. A block of mass M is hanging over a smooth and light pulley through a light string. The other end of the string is pulled by a constant force F. The kinetic energy of the block increases by 20 J in 1s.
(A) The tension in the string is Mg
(B) The tension in the string is F
(C) The work done by the tension on the block is 20 J in the above 1s
(D) The work done by the force of gravity is –20 J in the above 1s

122. A smooth sphere is moving on a horizontal surface with velocity vector $2\hat{i}+2\hat{j}$ immediately before it hits a vertical wall. The wall is parallel to $\hat{j}$ vector and the coefficient of restitution between the sphere and the wall is e = $\frac{1}{2}$. The velocity vector of the sphere after it hits the wall is:
(A) $\hat{i}-\hat{j}$ (B) $-\hat{i}+2\hat{j}$ (C) $-\hat{i}-\hat{j}$ (D) $2\hat{i}-\hat{j}$

123. Two particles having position vectors $\vec{r}_1=(3\hat{i}+5\hat{j})$ metres and $\vec{r}_2=(-5\hat{i}-3\hat{j})$ metres are moving with velocities $\vec{\upsilon}_1=(4\hat{i}+3\hat{j})$ m/s and $\vec{\upsilon}_2=(a\hat{i}+7\hat{j})$ m/s. If they collide after 2 seconds the value of a is:
(A) 2 (B) 4 (C) 6 (D) 8

124. A light spring of spring constant k is kept compressed between two blocks of masses m and M on a smooth horizontal surface (figure) When released, the blocks acquire velocities in opposite directions. The spring loses contact with the blocks when it acquires natural length. If the spring was initially compressed through a distance x, find the final speed of mass m.

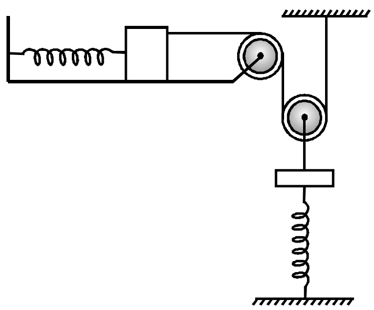


(A) $\sqrt{\frac{KM}{m(M+m)}}\,x$ (B) $\sqrt{\frac{Km}{M(m+M)}}\,x$ (C) $\sqrt{\frac{KM}{m(M-m)}}\,x$ (D) $\sqrt{\frac{Km}{M(M-m)}}\,x$

125. Force acting on a particle is $(2\hat{i}+3\hat{j})$N. Work done by this force is zero. when a particle is moved on the line 3y + kx = 5. Here value of k is:
(A) 2 (B) 4 (C) 6 (D) 8

126. A pendulum of mass 1 kg and length ℓ = 1m is released from rest at angle θ = 60º. The power delivered by all the forces acting on the bob at angle θ = 30º will be: (g = 10 m/s^2)
(A) 13.4 W (B) 20.4 W (C) 24.6 W (D) zero

127. The system is released from rest with both the springs in unstretched positions. Mass of each block is 1 kg and force constant of each spring is 10 N/m. Extension of horizontal spring in equilibrium is:



(A) 0.2 m (B) 0.4 m
(C) 0.6 m (D) 0.8 m

128. In previous question maximum speed of the block placed horizontally is:
(A) 3.21 m/s (B) 2.21 m/s (C) 1.93 m/s (D) 1.26 m/s

129. A particle undergoes uniform circular motion. About which point on the plane of the circle, will the angular momentum of the particle remain conserved?

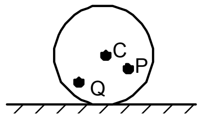
(A) centre of the circle (B) on the circumference of the circle.

(D) inside the circle (D) outside the circle

130. A horizontal circular plate is rotating about a vertical axis passing through its centre with an angular velocity 0. A man sitting at the centre having two blocks in his hands stretches out his hands so that the moment of inertia of the system doubles. If the kinetic energy of the system is K initially, its final kinetic energy will be

(A) 2K (B) K/2 (C) K (D) K/4

131. A disc is rolling without slipping with angular velocity . P and Q are two points equidistant from the centre C. The order of magnitude of velocity is



(A) $v_Q > v_C > v_P$ (B) $v_P > v_C > v_Q$

(C) $v_P = v_C$, $v_Q = v_C/2$ (D) $v_P < v_C > v_Q$

132.. A uniform thin rod of mass M and length L is standing vertically along the Y-axis on a smooth horizontal surface with its lower end at origin (0, 0). A slight disturbance at t 0 causes the lower end to slip on smooth surface along the positive X-axis and the rod starts falling. The path followed by the centre of mass of the rod during its fall is a/an.

(A) Straight line (B) Parabola (C) Ellipse (D) Circle

133. A spinning ballet dancer changes the shape of her body by spreading her arms.

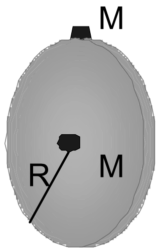
(A) The angular momentum of the system is conserved.

(B) The angular velocity of the system increases.

(C) The rotational kinetic energy of the system increases.

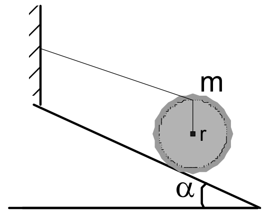
(D) The moment of inertia of the system decreases.

134. A uniform disc of mass M object of mass M is attached to the rim and raised to the highest point above the centre. The unstable system is then released. The angular speed of the system when the attached object passes directly beneath the pivot is.



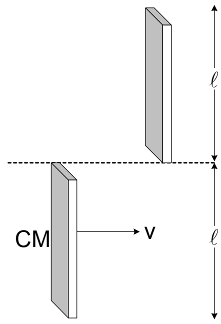
(A) $\sqrt{\frac{3R}{8g}}$ (B) $\sqrt{\frac{3g}{8R}}$ (C) $\sqrt{\frac{8R}{3g}}$ (D) $\sqrt{\frac{8g}{3R}}$

135. A spool with a thread wound on it is placed on a smooth inclined plane set at an angle of 30 to the horizontal. The free end of the thread is attached to the wall as shown. The mass of the spool is m 200g, its moment of inertia relative to its own axis is I 0.45gm2, the radius of the wound thread layer is r 3 cm. The acceleration of the spool axis is:



(A) 0.5ms - 2 (B) 5 ms - 2 (C) 1.4 ms - 2 (D) 14ms - 2

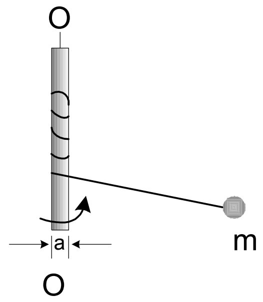
136. A bar of mass m, length is in pure translatory motion with its centre of mass velocity . It collides with and sticks to another identical bar at rest as shown in figure. Assuming that after collision it becomes one composite bar of length 2l, the angular velocity of the composite bar will be.



(A) $\frac{3v}{4\ell}$ anticlockwise (B) $\frac{4v}{3\ell}$ anticlockwise

(C) $\frac{3v}{4\ell}$ clockwise (D) $\frac{4v}{3\ell}$ clockwise

137. A small particle of mass m is given an initial high velocity in the horizontal plane and winds its cord around the fixed vertical shaft of radius a. All motion occurs essentially in horizontal plane. If the angular velocity of the cord is when the distance from the particle to the tangency point is r0, then the angular velocity of the cord after it has turned through an angle is.



(A) $\omega = \omega_0$ (B) $\omega = \frac{a}{r_0}\omega_0$

(C) $\omega = \dfrac{\omega_0}{1 - \frac{a}{r_0}\theta}$ (D) $\omega = \omega_0\theta$

138. A long horizontal rod has a bead which can slide along its length and is initially placed at a distance L from one end A of the rod. The rod is set in angular motion about A with a constant angular acceleration . If the coefficient of friction between rod and the bead is , and gravity is neglected, then the time after which the bead starts slipping is.

(A) $\sqrt{\frac{\mu}{\alpha}}$ (B) $\frac{\mu}{\sqrt{\alpha}}$ (C) $\frac{1}{\sqrt{\mu\alpha}}$ (D) infinitesimal

Statement Type Questions (139 to 157)
(a) If both Statement- I and Statement- II are true, and Statement - II is the correct explanation of Statement– I.
(b) If both Statement - I and Statement - II are true but Statement - II is not the correct explanation of Statement – I.
(c) If Statement - I is true but Statement - II is false.
(d) If Statement - I is false but Statement - II is true.

139. **Statement I :** Two balls of different masses are thrown vertically up with same speed. They will pass through their point of projection in downward direction with the same speed.
Statement II : The maximum height and downward velocity attained at the point of projection are independent of the mass of the ball.
(A) a (B) b (C) c (D) d

140. **Statement I :** For angle of projection $\tan^{-1}(4)$, the horizontal range and maximum height are equal.
Statement II : The maximum range of projectile is directly proportional to square of velocity and inversely proportional to acceleration of gravity.
(A) a (B) b (C) c (D) d

141. **Assertion :** A coin is placed on phonogram turn table. The motor is started, coin moves along the moving table.
Reason : Rotating table is providing necessary centripetal force to the coin.
(A) a (B) b (C) c (D) d

142. **Assertion :** By pressing a block against a rough wall, one can balance it.
Reason : Smooth walls can not hold the block by pressing the block against the wall, however high the force is exerted.
(A) a (B) b (C) c (D) d

143. **Assertion :** The value of dynamic friction is less than the limiting friction.
Reason : Once the motion has started, the inertia of rest has been overcome.
(A) a (B) b (C) c (D) d

144. **Statement - I :** A cyclist always bends in wards while negotiating a curve.
Statement - II : By bending, he lowers his centre of gravity
(A) a (B) b (C) c (D) d

145. **Statement I :** The maximum speed at which a car can turn on level curve of radius 40 m, is 11 m/s ; $\mu = 0.3$.

Statement II : $v = \sqrt{\mu R g} \Rightarrow \mu = \frac{v^2}{Rg} = \frac{11\times 11}{40\times 10} = 0.3.$

(A) a (B) b (C) c (D) d

146. **Statement I :** On banked curved road, vertical component of normal reaction provides the necessary centripetal force.
Statement II : Centripetal force is always required for turning.
(A) a (B) b (C) c (D) d

147. **Statement I :** The tendency to overturn of skidding/overturning is quadrupled, when a cyclist doubles his speed of turning.

Statement II : $\tan\theta = \frac{v^2}{Rg} \Rightarrow$ becomes 4 times as v doubled.

(A) a (B) b (C) c (D) d

148. **Statement - I:** In an elastic collision of two billiards balls, the kinetic energy is not conserved during the short interval of time of collision between the balls.
Statement - II: Energy spent against friction does not follow the law of conservation of energy.
(A) a (B) b (C) c (D) d

149. **Statement - I:** Work done in moving a body in non-uniform circular motion is zero.
Statement - II: The centripetal force always acts along the radius of the circle.
(A) a (B) b (C) c (D) d

150. **Statement-I:** Both stretched and compressed springs possess potential energy.
Statement - II: Work done against restoring force is stored as potential energy.
(A) a (B) b (C) c (D) d

151. **Statement I :** Work done by or against the friction in moving the body through any round trip is zero.
Statement II : This is because friction is a conservative force.
(A) a (B) b (C) c (D) d

152. **Statement I :** Work done in moving a body over a smooth inclined plane does not depend upon slope of inclined plane, provided its height is same.
Statement II : $W = mgh = mgl\sin\theta$
(A) a (B) b (C) c (D) d

153. **Statement I :** For the stable equilibrium force has to be zero and potential energy should be minimum.
Statement II : For the equilibrium it is not necessary that the force is not zero.
(A) a (B) b (C) c (D) d

154. **Statement-I :** Angular velocity is a characteristic of the rigid body as a whole.
Statement-II : Angular velocity may be different for different particles of a rigid body about the axis of rotation.
(A) a (B) b (C) c (D) d

155. **Statement I :** If bodies slide down an inclined plane without rolling, then all the bodies reach the bottom simultaneously.

Statement II : Acceleration of all bodies are equal and independent of shape.
(A) a (B) b (C) c (D) d

156. **Statement I :** A wheel moving down a perfectly frictionless inclined plane shall undergo slipping (not rolling).

Statement II : For rolling torque is required, which is provided by tangential frictional force.
(A) a (B) b (C) c (D) d

157. **Statement I :** The centre of mass of a circular disc lies always at the centre of the disc.

Statement II : Circular disc is a symmetrical body.
(A) a (B) b (C) c (D) d

2 SHM-WAVE, FLUID, GRAVITATION, HEAT

EXERCISE

158. How much energy will be needed for a body of mass 100kg to escape from the earth- ($g = 10 m/s^2$ and radius of earth = 6.4×10^6m)
(A) 6.4×10^9 joule (B) 8×10^6 joule
(C) 4×10^{16} joule (D) zero

159. The mass of planet mars is $\frac{1}{10}$th of the mass of earth and radius is $\frac{1}{2}$ of the radius of earth. If the escape velocity at the earth is 11.2km/s, then the escape velocity at Mars will be -
(A) 10km/s (B) 5 km/s (C) 20 km/s (D) 40 km/s

160. A satellite is set in a circular orbit of radius R. Another satellite is set in a circular orbit of radius 1.01R. The percentage difference of the period of the second satellite with respect to first satellite will be-
(A) 1% increased (B) 1% decreased (C) 1.5% increased (D) 1.5 decreased

161. The potential energy of a body of mass m is $U = ax + by$ the magnitude of acceleration of the body will be-
(A) $\frac{ab}{m}$ (B) $\left(\frac{a+b}{m}\right)$ (C) $\frac{\sqrt{a^2+b^2}}{m}$ (D) $\frac{a^2+b^2}{m}$

162. A number of particles each of mass 0.75kg are placed at distances 1m, 2m, 4m, 8m etc. from origin along positive X axis. the intensity of gravitational field at the origin will be -
(A) G (B) $\frac{3}{4}G$ (C) $\frac{1}{2}G$ (D) zero

163. The value of g at any point is $9.8 m/s^2$. If earth is reduced to half of its present size by shrinking without loss of mass but the point remains at the same position, then the value of g at that point will be -
(A) $4.9 \ m/s^2$ (B) $3.1 \ m/s^2$ (C) $9.8 m/s^2$ (D) $19.6 \ m/s^2$

164. One planet is orbiting around the sun, At a point P it is at minimum distance d_1 from the sun and at that time speed is v_1. If at a another point Q it is at maximum distance d_2 from the sun then at this point the speed of planet will be -
(A) $d_1^2 v_1 / d_2^2$ (B) $d_2 v_1/d_1$ (C) $d_1 v_1/d_2$ (D) $d_2^2 v_1/d_1^2$

165. The radius of a planet is 74×10^3km. A satellite of this planet completes one revolution in 16.7 days. If the radius of the orbit of satellite is 27 times the radius of planet, then the mass of planet is
(A) 2.3×10^{27}kg (B) 2.3×10^{30}kg (C) 2.3×10^{32}kg (D) 2.3×10^{42}kg

166. A body of mass M is divided into two parts of masses m and (M - m). If they are kept at a constant distance, then the relation between m and M for maximum force of attraction between them, will be -
(A) $m = \frac{M}{4}$ (B) $m = \frac{2}{3}M$ (C) $m = \frac{M}{3}$ (D) $m = \frac{M}{2}$

167. A body placed at a distance R_0 from the centre of earth, starts moving from rest. The velocity of the body on reaching at the earth's surface will be
(R_e = radius of earth and M_e = mass of earth)

(A) $GM_e\left(\frac{1}{R_e}-\frac{1}{R_0}\right)$ (B) $2GM_e\left(\frac{1}{R_e}-\frac{1}{R_e}\right)$ (C) $GMe\sqrt{\frac{1}{R_e}-\frac{1}{R_0}}$ (D) $\sqrt{2GM_e\left(\frac{1}{R_e}-\frac{1}{R_0}\right)}$

168. The masses and the radii of earth and moon are respectively M_e, R_e and M_m, R_m. The distance between the centres is r. At what minimum velocity a particle of mass m be projected from the mid point of the distance between their centres so that it may escape into space ?

(A) $\sqrt{\frac{4G}{r}(M_e+M_m)}$ (B) $\frac{4G}{r}\sqrt{(M_e+M_m)}$ (C) $\sqrt{\frac{2G}{r}(M_e+M_m)}$ (D) $\frac{2G}{r}\sqrt{(M_e+M_m)}$

169. A tunnel is dug along the diameter of the earth. If a particle of mass m is situated in the tunnel at a distance x from the centre of earth then gravitational force acting on it, will be -

(A) $\frac{GM_em}{R_e^3}x$ (B) $\frac{GM_em}{R_e^2}$ (C) $\frac{GM_em}{x^2}$ (D) $\frac{GM_em}{(R_e+x)^2}$

170. Four particles of masses m, 2m, 3m and 4m are kept in sequence at the corners of a square of side a. The magnitude of gravitational force acting on a particle of mass m placed at the centre of the square will be -

(A) $\frac{24m^2G}{a^2}$ (B) $\frac{6m^2G}{a^2}$ (C) $\frac{4\sqrt{2}Gm^2}{a^2}$ (D) zero

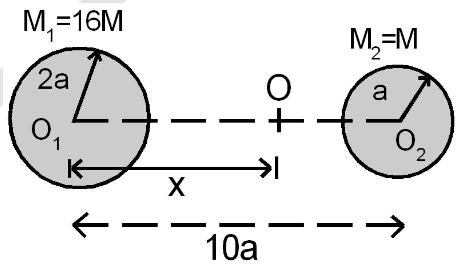
171. If the change in the value of g at a height h above the surface of the earth is the same as at a depth x below it. When both x and h are much smaller than the radius of the earth. Then

(A) x = h (B) x = 2h (C) x = h/2 (C) x = h^2

172. The gravitational force on a body inside the surface of the earth varies as r^a, where r is the distance from the center of the earth and a is some constant. If the density of the earth is assumed uniform, then -

(A) a = 1 (B) a = – 1 (C) a = 2 (D) a = – 2

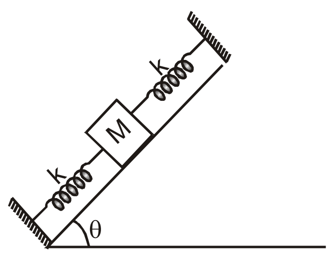
173. Distance between the centres of two stars is 10a. The masses of these stars are M and 16M and their radii a and 2a respectively. A body of mass m is fired straight from the surface of the larger star towards the smaller star. What should be its minimum initial speed to reach the surface of the smaller star? Obtain the expression in terms of G, M and a.



(A) $\upsilon_{min} = \frac{3}{2}\sqrt{\left(\frac{5GM}{a}\right)}$ (B) $\upsilon_{min} = \frac{5}{2}\sqrt{\left(\frac{5GM}{a}\right)}$

(C) $\upsilon_{min} = \frac{5}{2}\sqrt{\left(\frac{5M}{Ga}\right)}$ (D) None

174. On a smooth inclined plane a body of mass M is attached between two springs. The other ends of the spring are fixed to ffirm supports. If each spring has a force constant k, the period of oscillation of the body is: (assuming the spring as massless)

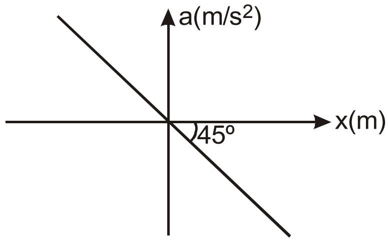


(A) $2\pi\sqrt{\frac{M}{2k}}$ (B) $2\pi\sqrt{\frac{2M}{k}}$ (C) $2\pi\sqrt{\frac{M\sin\theta}{2k}}$ (D) $2\pi\sqrt{\frac{2M\sin\theta}{k}}$

175. A unifrom disc of radius R is pivoted at point O on its circumference. The time period of small oscillations about an axis passing through O and perpendicular to plane of disc will be:

(A) $2\pi\sqrt{\frac{R}{g}}$ (B) $2\pi\sqrt{\frac{2R}{3g}}$ (C) $2\pi\sqrt{\frac{2R}{g}}$ (D) $2\pi\sqrt{\frac{3R}{2g}}$

176. Acceleration-displacement graph of a particle executing SHM Is as shown in given figure. The time period of its oscillation is: (in sec)



(A) $\frac{\pi}{2}$ (B) 2π

(C) π (D) $\frac{\pi}{4}$

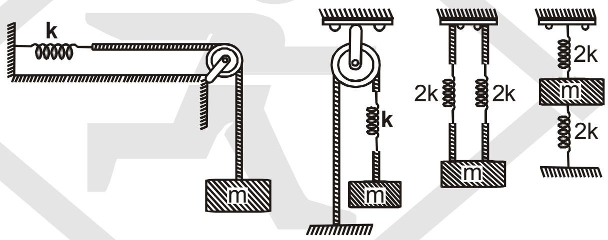
177. A particle of mass 0.1 kg executes SHM under a force F = (–10x)N. Speed of particle at mean position is 6 m/s. Then amplitude of oscillations is:
(A) 0.6 m (B) 0.2 m (C) 0.4 m (D) 0.1 m

178. Displacement-time equation of a particle executing SHM is $x = A\sin\left(\omega t + \frac{\pi}{6}\right)$.

Time taken by the particle to go directly from $x = -\frac{A}{2}$ to $x = +\frac{A}{2}$ is:

(A) $\frac{\pi}{3\omega}$ (B) $\frac{\pi}{2\omega}$ (C) $\frac{2\pi}{\omega}$ (D) $\frac{\pi}{\omega}$

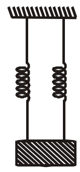
179. A block of mass m is suspended by different springs of force constant shown in figure.



(i) (ii) (iii) (iv)

Let time period of oscillation in these four positions be T_1, T_2, T_3 and T_4. Then :
(A) $T_1 = T_2 = T_4$ (B) $T_1 = T_2$ and $T_3 = T_4$
(C) $T_1 = T_2 = T_3$ (D) $T_1 = T_3$ and $T_2 = T_4$

180. An object suspended from a spring exhibits oscillations of period T. Now the spring is cut in two halves and the same object is suspsended with two halves as shown in figure. The new time period of oscillation will become:



(A) $\frac{T}{\sqrt{2}}$ (B) 2T (C) $\frac{T}{2}$ (D) $\frac{T}{2\sqrt{2}}$

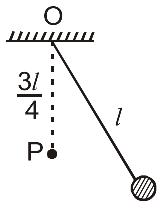
181. The potential energy of a harmonic oscillator of mass 2 kg in its mean position is 5J. If its total energy is 9J and its amplitude is 0.01 m, its time period will be :

(A) $\frac{\pi}{100}$ sec (B) $\left(\frac{\pi}{50}\right)$ sec (C) $\left(\frac{\pi}{20}\right)$ sec (D) $\left(\frac{\pi}{10}\right)$ sec

182. Let T_1 and T_2 be the time periods of two springs A and B when a mass m is suspended from them separately. Now both the springs are connected in parallel and same mass m is suspended with them. Now let T be the time period in this position. Then:

(A) $T = T_1 + T_2$ (B) $T = \frac{T_1T_2}{T_1+T_2}$ (C) $T^2 = T_1^2 + T_2^2$ (D) $\frac{1}{T^2} = \frac{1}{T_1^2} + \frac{1}{T_2^2}$

183. A pendulum has time period T for small oscillations. An obstacle P is situated below the point of suspension O at a distance $\frac{3l}{4}$. The pendulum is released from rest. Throughout the motion the moving string makes small angle with vertical. Time after which the pendulum returns back to its initial position is -



(A) T (B) $\frac{3T}{4}$ (C) $\frac{3T}{5}$ (D) $\frac{4T}{5}$

184. The displacement of a particle from its mean position (in m) varies with time according to the relation $y = 0.2 \sin(10\pi t + 1.5\pi) \cos(10\pi t + 1.5\pi)$. The motion of the particle is
(A) not simple harmonic
(B) simple harmonic with time period 0.2 s.
(C) simple harmonic with time period 0.1 sec
(D) along a circular path

185. A piece of wood has dimensions 'a', 'b' and 'c'. Its relative density is d. It is floating in water such that the side 'a' is vertical. It is now pushed down gently and relesed. The time-period of S.H.M. is

(A) $T = 2\pi\sqrt{\frac{abc}{g}}$ (B) $T = 2\pi\sqrt{\frac{bc}{dg}}$ (C) $T = 2\pi\sqrt{\frac{g}{da}}$ (D) $T = 2\pi\sqrt{\frac{da}{g}}$

186. A brass cube of height L and density σ is floating on mercury of density ρ. If cube is pressed vertically and the released, it oscillates simple harmonically with period
(A) $2\pi(\rho L/\sigma g)^{1/2}$ (B) $2\pi(\sigma L/\rho g)^{1/2}$ (C) $1/2\pi(\rho L/\sigma g)^{1/2}$ (D) $1/2\pi(\sigma L/\rho g)^{1/2}$

187. If a simple pendulum of length ℓ has maximum angular displacement θ, then the maximum K.E. of the bob of mass m is

(A) $\frac{1}{2}m\ (\ell/g)$ (B) $mg/2\ell$ (C) $mg\ell\ (1-\cos\theta)$ (D) $(mg\ell \sin\theta)/2$

188. A body of weight 30N hangs from one end of a long, vertical spring whose other end is attached to a rigid support. The spring extends by 5cm when a force of 10N is applied to it. The time period of the vertical oscillations of the body is

(A) $2\sqrt{(15\pi)}$ s (B) $(\pi/5)\sqrt{(3/2)}$ sec (C) $(\pi/10)\left(\sqrt{3/2}\right)$sec (D) $20\ \sqrt{(2/3)\pi}$ sec

189. A point performs SHM along a straight line with a period T = 0.60 s and amplitude a = 10 cm.

Starting from extreme position, in what time, the point travels a distance $\frac{a}{2}$?
(A) 10 s (B) 1.0 s (C) 0.1 s (D) 0.01 s

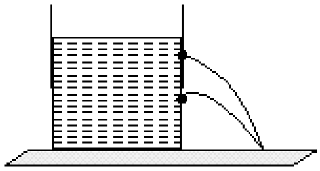
190. In above question, what is the mean velocity of the point ?
(A) 0.5 m s^{-1} (B) 1 m s^{-1} (C)1.5 m s^{-1} (D) 1.005 m s^{-1}

191. The terminal velocity of a ball in air is v, where acceleration due to gravity is g. Now the same ball is taken in a gravity free space where all other conditions are same. The ball is now pushed at a speed vv, then –
(A) The terminal velocity of the ball will be v/2
(B) The ball will move with a constant velocity
(C) The initial acceleration of the ball is 2g in opposite direction of the ball's velocity
(D) The ball will finally stop (Given that density of the ball ρ = 2 times the density of air σ)

192. A tank is filled up to a height 2H with a liquid and is placed on a platform of height H from the ground. The distance x from the ground where a small hole is punched to get the maximum range R is –

(A) H (B) 1.25 H (C) 1.5 H (D) 2H

193.* In a cylindrical vessel containing liquid of density ρ, there are two holes in the side walls at heights of h_1 and h_2 respectively such that the range of efflux at the bottom of the vessel is same. The height of a hole, for which the range of efflux would be maximum, will be –



(A) $h_2 - h_1$ (B) $h_2 + h_1$ (C) $\frac{h_2 - h_1}{2}$ (D) $\frac{h_2 + h_1}{2}$

194. Two drops of same radius are falling through air with steady speed v. If the two drops coalesce, what would be the terminal speed –

(A) 4v (B) 2v (C) 3v (D) None of these

195. A ball of relative density 0.8 falls into water from a height of 2m. The depth to which the ball will sink is (neglect viscous forces) –

(A) 8m (B) 2 m (C) 6m (D) 4 m

196. When tension in a metal wire is T_1, its length was ℓ_1 and when tension is T_2, the length is ℓ_2. Its unstretched length is –

(A) $\sqrt{l_1 l_2}$ (B) $\frac{l_1 + l_2}{2}$ (C) $\frac{(l_1T_2 - l_2T_1)}{T_2 - T_1}$ (D) $\frac{l_1T_2 + T_1l_2}{T_1 + T_2}$

197. When a sphere is taken to bottom of sea 1 km deep, it contracts by 0.01%. The bulk modulus of elasticity of the material of sphere is :

(Given Density of water = $1 g/cm^3$)

(A) 9.8×10^{10} N/m^2 (B) 10.2×10^{10} N/m^2

(C) 0.98×10^{10} N/m^2 (D) 8.4×10^{10} N/m^2

198.* When a capillary tube is immersed vertically in mercury, the level of mercury in the capillary is observed to be depressed. This is due to –

(A) Surface tension (B) Viscosity

(C) Adhesive force is more than cohesive force

(D) Cohesive force is equal to the adhesive force

199.* If a liquid neither rises nor depresses in a capillary, then it means that –

(A) Angle of contact is 0º

(B) Angle of contact may be 90º

(C) Surface tension of the liquid must be zero

(D) None of these

200. An air bubble of radius 1mm is formed inside water at a depth 10m below free surface (where air pressure is 10^5 N/m^2). The pressure inside the bubble is –

(Surface tension of water = 7×10^{-2} N/m)

(A) 2.28×10^5 N/m^2 (B) 2.0028×10^5 N/m^2

(C) 2.14×10^5 N/m^2 (D) 2.0014×10^5 N/m^2

201.* One end of a glass capillary tube with radius r = 0.05 cm is immersed into water to a depth of h = 2cm. What pressure is required to blow an air bubble out of the lower end of the tube : ($T = 7 \times 10^{-2}$ N/m and $\rho = 10^3$ kg/m^3)
(A) 480 N/m^2 (B) 680 N/m^2 (C) 120 N/m^2 (D) 820 N/m^2

202. What is the height to which a liquid rises between two long parallel plates, a distance d apart (Surface tension of liquid is T and density is ρ) ?
(A) $\frac{4T}{\rho g d}$ (B) $\frac{2T}{\rho g d}$ (C) $\frac{T}{\rho g d}$ (D) $\frac{T}{2\rho g d}$

203.* There is a horizontal film of soap solution. On it a thread is placed in the form of a loop. The film is pierced inside the loop and the thread becomes a circular loop of radius R. If the surface tension of the loop be T, then what will be the tension is the thread ?
(A) $\pi R^2/T$ (B) $\pi R^2 T$ (C) $2\pi RT$ (D) RT

204. A spherical drop of liquid having surface tension T contains 9 cm^3 of liquid. The drop is broken into 1000 identical drops The work done by the breaking agent is –
(A) $9\,(4\pi)^{1/3}$ T erg (B) $81\,(4\pi)^{1/3}$ T erg
(C) $27\,(4\pi)^{1/3}$ T erg (D) None of the these

205. In the bottom of a vessel with mercury of density ρ there is a round hole of radius r. At what maximum height of the mercury layer will the liquid still not flow out through this hole. (Surface tension = T) –
(A) $\frac{T}{r\rho g}$ (B) $\frac{T}{2r\rho g}$ (C) $\frac{2T}{r\rho g}$ (D) $\frac{4T}{r\rho g}$

206.* The equation of stationary wave along a stretched string is given by:

$$y = 5\sin\frac{\pi x}{3}\cos 40\pi t$$

where x and y are in cm and t in second. The separation between two adjacent nodes is–
(A) 1.5 cm (B) 3 cm (C) 6 cm (D) 4 cm

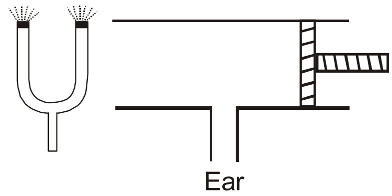
207. The tension of a stretched string is increased by 69%. In order to keep its frequency of vibration constant, its length must be increased by :
(A) 30% (B) 20% (C) 69% (D) $\sqrt{69}\,\%$

208. The equation for the vibration of a string fixed at both ends vibrating in its third harmonic is given by
$y = 2\text{ cm}\sin[(0.6\text{ cm}^{-1})x]\cos[(500\pi\text{ s}^{-1})t]$
The length of the string is –
(A) 24.6 cm (B) 12.5 cm (C) 20.6 cm (D) 15.7 cm

209. Two uniform strings A and B made of steel are made to vibrate under the same tension. If the first overtone of A is equal to the second overtone of B and if the radius of A is twice that of B, the ratio of the lengths of the strings is –
(A) 2 : 1 (B) 3 : 2 (C) 3 : 4 (D) 1 : 3

210. The amplitude of a wave disturbance propagating in the positive x-direction is given by $y = \frac{1}{1+x^2}$ at time t = 0 and $y = \frac{1}{1+(x-1)^2}$ at t = 2 seconds, where x and y are in metres. The shape of the wave disturbance does not change during the propagation. The velocity of the wave is –
(A) 1 m/s (B) 0.5 m/s (C) 1.5 m/s (D) 2 m/s

211. A vibrating tuning fork of frequency n is placed near the open end of a long cylindrical tube.



The tube has a side opening and is also fitted with a movable reflecting piston. As the piston is moved through 8.75 cm, the intensity of sound changes from a maximum to minimum. If the speed of sound is 350 metre per second, then n is –

(A) 500 Hz (B) 1000 Hz (C) 2000 Hz (D) 4000 Hz

212.* Two periodic waves of intensities I_1 and I_2 pass through a region at the same time in the same direction. The sum of the maximum and minimum intensities is –

(A) $\left(\sqrt{I_1}+\sqrt{I_2}\right)^2$ (B) $\left(\sqrt{I_1}-\sqrt{I_2}\right)^2$ (C) $I_1 + I_2$ (D) $2(I_1 + I_2)$

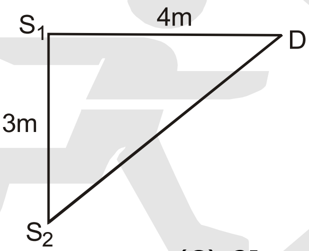
213. The vibrations of a string of length 60 cm fixed at both ends are represented by the equation

$y = 4 \sin (\pi x/15) \cos(96\pi t)$,

where x and y are in cm and t in seconds. The maximum displacement at x = 5 cm is–

(A) $2\sqrt{3}$ cm (B) $3\sqrt{2}$ cm (C) $\sqrt{2}$ cm (D) $\sqrt{3}$ cm

214. In the figure the intensity of waves arriving at D from two coherent sources S_1 and S_2 is I_0. The wavelength of the wave is λ = 4 m. Resultant intensity at D will be –



(A) $4I_0$ (B) I_0 (C) $2I_0$ (D) zero

215. $x_1 = A \sin (\omega t - 0.1x)$ and

$x_2 = A \sin \left(\omega t - 0.1x - \frac{\phi}{2}\right)$

Resultant amplitude of combined wave is–

(A) $2A \cos \frac{\phi}{4}$ (B) $A\sqrt{2\cos\phi/2}$ (C) $2A \cos \frac{\phi}{2}$ (D) $A\sqrt{2\left(1+\cos\frac{\phi}{4}\right)}$

216. When an organ pipe is open at both ends, it resonates with a fundamental frequency of 240 Hz. What is the fundamental frequency of the same pipe if it is closed at one end

(A) 64 kg (B) 120 kg (C) 360 Hz (D) 480Hz

217. An organ pipe open at one end is vibrating in first overtone and is in resonance with another pipe open at both ends and vibrating in third harmonic. The ratio of length of two pipes is–

(A) 1 : 2 (B) 4 : 1 (C) 8 : 3 (D) 3 : 8

218. In an experiment with sonometer, a tuning fork of frequency 256 Hz resonates with a length of 25 cm and another tuning fork resonates with a length of 16 cm. Tension of the string remaining constant, the frequency of the second tuning fork is –

(A) 163.84 Hz (B) 400 Hz (C) 320 Hz (D) 204.8 Hz

219. A cylindrical tube partially filled with water is in resonance with a tuning fork when height of air column is 0.1 m. When the level of water is lowered, the resonance is again observed at 0.35m. The end correction is –
(A) 0.025 m (B) 0.015 m (C) 0.001 m (D) 0.002 m

220. The end correction of a resonance column is 1.0 cm. If the shortest length resonating with a tuning fork is 15.0 cm, the next resonating length is :
(A) 31 cm (B) 45 cm (C) 46 cm (D) 47 cm

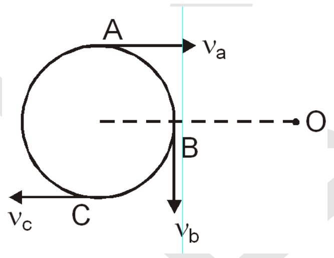
221. A standard tuning fork of frequency f is used to find the velocity of sound in air by resonance column apparatus. The difference between two resonating lengths is 1.0 m. Then the velocity of sound in air is–
(A) fm/s (B) 2fm/s (C) f/2m/s (D) 3fm/s

222. An open and a closed pipe have same length. The ratio of frequencies of their n^{th} overtone is –
(A) $\frac{n+1}{2n+1}$ (B) $\frac{2(n+1)}{2n+1}$ (C) $\frac{n}{2n+1}$ (D) $\frac{n+1}{2n}$

223. For a certain organ pipe three successive resonance frequencies are observed at 425 Hz, 595 Hz and 765 Hz respectively. If the speed of sound in air is 340m/s, then the length of the pipe is
(A) 2.0 m (B) 0.4 m (C) 1.0 m (D) 0.2 m

224. There are 26 tuning forks arranged in the decreasing order of their frequencies. Each tuning fork gives 3 beats with the next. The first one is octave of the last. What is the frequency of 18th tuning fork ?
(A) 100 (B) 99 (C) 96 (D) 103

225. If a source sounding a whistle with a constant frequency moves in a circle and frequencies observed by observer O, when the source is at points A, B, C be ν_a, ν_b, ν_c, then :



(A) $\nu_a > \nu_b > \nu_c$ (B) $\nu_a < \nu_b < \nu_c$ (C) $\nu_a = \nu_c > \nu_b$ (D) none of the above

226. A band playing music at a frequency f is moving towards a wall at a speed v_b. A motorist is following the band with a speed v_m. If v is the speed of sound, the expression for the beat frequency heard by the motorist is –
(A) $\frac{v+v_m}{v+v_b}f$ (B) $\frac{v+v_m}{v-v_b}f$ (C) $\frac{2v_b(v+v_m)}{v^2-v_b^2}f$ (D) $\frac{2v_m(v+v_b)}{v^2-v_m^2}f$

227.* An isotropic stationary source is emitting waves of frequency n and wind is blowing due north. An observer A is on north of the source while observer B is on south of the source. If both the observers are stationary, then :
(A) frequency received by A is greater than n
(B) frequency received by B is less than n
(C) frequency received by A is equal to that received by B
(D) frequencies received by A and B cannot be calculated unless velocity of waves in still air and velocity of wind are known

228. An observer moves towards a stationary source of sound with a speed (1/5)th of the speed of sound. The wavelength and frequency of the source emitted are λ and f respectively. The apparent frequency and wavelength recorded by the observer are respectively –

(A) $1.2f$ and λ (B) f and 1.2λ (C) $0.8f$ and 0.8λ (D) $1.2f$ and 1.2λ

229. The frequency changes by 10% as the source approaches a stationary observer with constant speed v_s. What should be the percentage change in frequency as the source recedes from the observer with the same speed ? Given that $v_s << v$ (v = speed of sound in air) –

(A) 14.3 % (B) 20% (C) 16.7% (D) 10%

230. Two sound sources are moving in opposite directions with velocities v_1 and v_2 ($v_1 > v_2$). Bothe are moving away from a stationary observer. The frequency of both the sources is 900 Hz. What is the value of $v_1 - v_2$ so that the beat frequency observed by the observer is 6 Hz ? Speed of sound v = 300 m/s. Given that v_1 and $v_2 << v$:

(A) 1 m/s (B) 2m/s (C) 3m/s (D) 4m/s

231. The apparent frequency of a note is 200 Hz. When a listener is moving with a velocity of 40 ms^{-1} towards a stationary source. When he moves away from the same source, the apparent frequency of the same note is 160Hz. the velocity of sound in air in m/s is:

(A) 340 (B) 330 (C) 360 (D) 320

232.* engine as heard by an observer, when the engine moves towards the observer with a speed v, is n. If the engine is stationary and the observer moves towards the engine with the same speed v, the apparent frequency of the same whistle will be :

(A) greater than n
(B) less than n
(C) equal to n
(D) less or more depending on frequency of the whistle

233.* A car moving at 20 m/s with its horn blowing (n = 1200 Hz) is chasing another car going at 15 m/s. What is the apparent frequency of the horn as heard by the driver being chased? Take the speed of the sound to be 340 m/s:

(A) 1219 Hz (B) 1183 Hz (C) 1275 Hz (D) 1083 Hz

234. A whistle emitting a sound of frequency 440Hz is tied to a string of 1.5 m length and rotated with an angular velocity of 20 rad/sec in the horizontal plane. Then the range of frequencies heard by an observer stationed at a large distance from the whistle will be:
(v = 330 m/s):

(A) 400.0 Hz to 484.0 Hz (B) 403.3 Hz to 480.0 Hz
(C) 400.0 Hz to 480.0 Hz (D) 403.3 Hz to 484.0 Hz

235. How many grams of a liquid of specific heat 0.2 at a temperature 40ºC must be mixed with 100 gm of a liquid of specific heat of 0.5 at a temperature 20ºC, so that tyhe final temperature of the mixture becomes 32ºC

(A) 175 gm (B) 300 g (C) 295 gm (D) 375 g

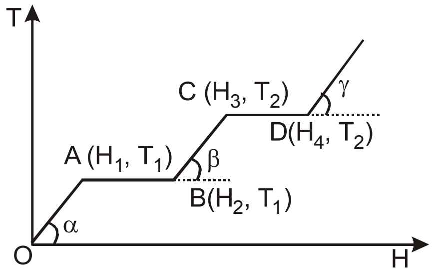
236. 300 gm of water at 25ºC is added to 100 gm of ice at 0ºC. The final temperature of the mixture is

(A) $-\frac{5}{3}$ ºC (B) $-\frac{5}{2}$ ºC (C) – 5ºC (D) 0ºC

237. If two balls of same metal weighing 5 gm and 10 gm strike with a target with the same velocity. The heat energy so developed is used for raising their temperature alone, then the temperature will be higher

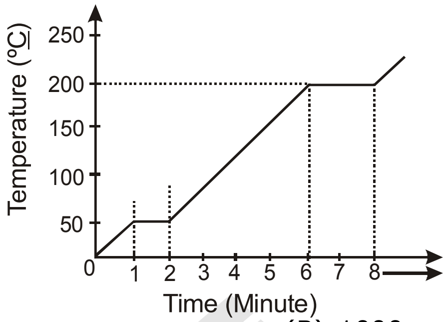
(A) For bigger ball (B) For smaller ball
(C) Equal for both the balls (D) None is correct from the above three

238.* The graph shows the variation of temperature (T) of one kilogram of a material with the heat (H) supplied to it. At O, the substance is in the solid state. From the graph, we can conclude that



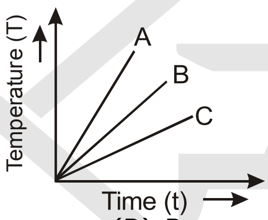
(A) T_2 is the melting point of the solid
(B) BC represents the change of state from solid to liquid
(C) $(H_2 - H_1)$ represents the latent heat of fusion of the substance
(D) $(H_3 - H_1)$ represents the latent heat of vaporization of the liquid

239. A student takes 50gm wax (specific heat = 0.6 kcal/kg°C) and heats it till it boils. The graph between temperature and time is as follows. Heat supplied to the wax per minute and boiling point are respectively



(A) 500 cal, 50°C (B) 1000 cal, 100°C
(C) 1500 cal, 200°C (D) 3000 cal, 200°C

240.* Which of the substances A, B or C has the highest specific heat ? The temperature vs time graph is shown



(A) A (B) B (C) C (D)All have equal specific heat

241.* Newton's law of cooling is used in lab for determination of –
(A) specific heat of solids (B) latent heat of solids
(C) specific heat of liquids (D) latent heat of liquids

242. A bucket full of hot water is kept in a room and it cools from 75°C to 70°C in T_1 minutes, from 70°C to 65°C in T_2 minutes and from 65°C to 60°C in T_3 minutes. Then –
(A) $T_1 = T_2 = T_3$ (B) $T_1 < T_2 < T_3$ (C) $T_1 > T_2 > T_3$ (D) $T_1 < T_2 > T_3$

243. The rectangular surface of area 8cm × 4cm of a black body at a temperature of 127°C emits energy at the rate of E per second. If the length and breadth of the surface area each are reduced to half of the initial value and the temperature is raised to 327°C, the rate of emission of energy will become–
(A) (3/8)E (B) (9/16)E (C) (81/16)E (D) (81/64)E

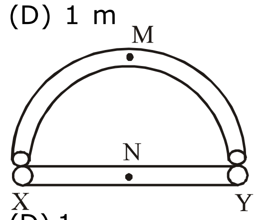
244. The temperature of a body is increased from –73°C to 327°C. Then the ratio of emissive power is –
(A) 1/9 (B) 1/27 (C) 27 (D) 1/81

245.* What will be the ratio of temperatures of sun and moon if the wavelengths of their maximum emission radiations rates are 140Å and 4200 Å respectively –
(A) 1 : 30 (B) 30 : 1 (C) 42 : 14 (D) 14 : 42

246. Liquid is filled in a vessel which is kept in a room with temperature 20°C. When the temperature of the liquid is 80°C, then it loses heat at the rate of 60 cal/sec. What will be the rate of loss of heat when the temperature of the liquid is 40°C ?
(A) 180 cal/sec (B) 40 cal/sec (C) 30 cal/sec (D) 20 cal/sec

247. The maximum wavelength of radiation emitted at 200 K is 4 μm. What will be the maximum wavelength of radiation emitted at 2400 K ?
(A) 3.33 μm (B) 0.66 μm (C) 1 μm (D) 1 m

248. Two rods of same material and thickness are joined as shown below. The ends X and Y are maintained at X°C and Y°C respectively.
The ratio of the heat flow in the two rods is –



(A) 0.36 (B) 0.64 (C) $\frac{1}{0.36}$ (D) 1

249. In previous question the ratio of heat flow at M and N are Q_1 and Q_2 respectively. Then –
(A) $Q_1 = Q_2$ (B) $Q_1 > Q_2$ (C) $Q_1 < Q_2$ (D) $Q_1 = \frac{Q_2}{2}$

250. Two rods of the same length and areas of cross-section A_1 and A_2 have their ends at the same temperature. K_1 and K_2 are the thermal conductivities of the two rods. The rate of flow of heat is same in both the rods if-
(A) $\frac{A_1}{A_2} = \frac{K_1}{K_2}$ (B) $\frac{A_1}{A_2} = \frac{K_2}{K_1}$ (C) $A_1A_2 = K_1K_2$ (D) placed in hot oil.

251. On heating one end of a rod, the temperature of whole rod will be uniform when-
(A) K = 1 (B) K = 0 (C) K = 100 (D) K = ∞.

252. A cylinder of radius R made of a material of thermal conductivity K_1 is surrounded by a cylindrical shell of inner radius R and outer radius 2R made of a material of thermal conductivity K_2. The two ends of the combined system are maintained at two different temperatures. There is no loss of heat across the cylindrical surface and the system is in steady state.
The effective thermal conductivity is-
(A) $K_1 + K_2$ (B) $\frac{K_1K_2}{K_1+K_2}$ (C) $\frac{K_1+3K_2}{4}$ (D) $\frac{3K_1+K_2}{4}$.

253. Wires A and B have have identical lengths and have circular cross-sections. The radius of A is twice the radius of B i.e. $R_A = 2R_B$. For a given temperature difference between the two ends, both wires conduct heat at the same rate. The relation between the thermal conductivities is given by-
(A) $K_A = 4K_B$ (B) $K_A = 2K_B$ (C) $K_A = K_B/2$ (D) $K_A = K_B/4$.

254. When water is heated from 0°C to 10°C, its volume –
(A) increases (B) decreases
(C) does not change (D) first decreases and then increases

Statement Type Questions (255 to 266)
(a) If both Statement- I and Statement- II are true, and Statement - II is the correct explanation of Statement– I.
(b) If both Statement - I and Statement - II are true but Statement - II is not the correct explanation of Statement – I.
(c) If Statement - I is true but Statement - II is false.
(d) If Statement - I is false but Statement - II is true.

255. **Statement I :** Escape velocity of a tennis ball from the surface of earth is the same as the escape velocity of a cricket ball from the surface of earth.
Statement II : Escape velocity of a body is independent of the mass of the body
(A) a (B) b (C) c (D) d

256. **Statement I :** The weight of a body at the centre of earth is zero
Statement II : The mass of a body decreases with increase in depth below the surface of earth.
(A) a (B) b (C) c (D) d

257. **Statement I :** Earth continuously attracts the moon towards its centre and yet the moon does not move towards the centre of earth.
Statement II : The gravitational force of atteraction between the moon and earth provides the necessary centripetal force.
(A) a (B) b (C) c (D) d

258. **Assertion :** At height h from ground and at depth h below ground, where h is approximately equal to 0.62 R, the value of g acceleration due to gravity is same.
Reason : Value of g decreases both sides, in going up and down.
(A) a (B) b (C) c (D) d

259. **Assertion :** If ice on the pole melts, length of the day will shorten.
Reason: Ice will flow towards equator and will result in the decrease in moment of inertia of earth resulting in decrease in frequency of rotation of earth.
(A) a (B) b (C) c (D) d

260. **Assertion:** An astronaut in a satellite feels weightlessness:
Reason: As observed by another ast4ronaut's in the same satellite, force of gravity and centrifugal force balance each other.
(A) a (B) b (C) c (D) d

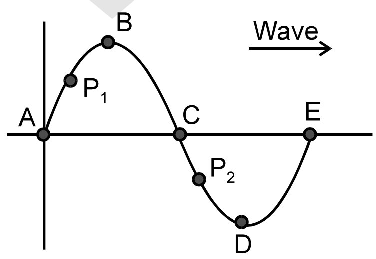
261. **Statement-I :** In simple harmonic motion A is the amplitude of oscillation. If t_1 be the time to reach the particle from mean position to $\frac{A}{\sqrt{2}}$ and t_2 the time to reach from $\frac{A}{\sqrt{2}}$ to A. Then $t_1 = \frac{t_2}{\sqrt{2}}$
Statement-II: Equation of motion for the particle starting from mean position is given by $x = \pm A \sin \omega t$ and of the particle starting from extreme position is given by $x = \pm A \cos \omega t$
(A) a (B) b (C) c (D) d

262. **Statement-I :** The graph of potential energy and kinetic energy of a particle in SHM with respect to position is a parabola.
Statement-II : Potential energy and kinetic energy do not vary linearly with position.
(A) a (B) b (C) c (D) d

263. **Statement-I :** SHM is not an example of uniformly accelerated motion.
Statement-II : Non uniform velocity cannot give uniform acceleration
(A) a (B) b (C) c (D) d

264. **Statement-I :** If Amplitude of SHM is doubled, the periodicity wall remain same.
Statement-II : Amlitude and periodicity are two independent characteristics of SHM.
(A) a (B) b (C) c (D) d

265. **Statement I :** The transverse wave is traveling along a string in the positive x-axis is shown.



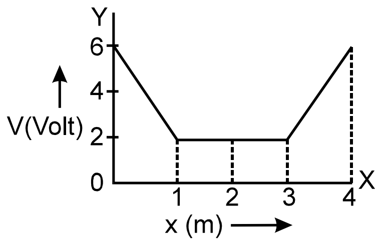
Points (A & P_1) moving downward and point (C & P_2) moving upward.
Statement II : In a wave propagating in positive x direction, the points with +ve slope move downward and vice versa.
(A) a (B) b (C) c (D) d

266. **Statement I :** Sonometer is used to determine frequency of unknown T.F.
Statement II : In sonometer riders used as indicator.
(A) a (B) b (C) c (D) d

3 Electromagnetism

EXERCISE

267. The variation of electric potential with distance from a fixed point is shown in figure. What is the value of electric field at x = 2m -



(A) Zero (B) 6/2 (C) 6/1 (D) 6/3

268. The electric flux from a cube of edge ℓ is ϕ. What will be its value if edge of cube is made 2ℓ and charge enclosed is halved -
(A) $\phi/2$ (B) 2ϕ (C) 4ϕ (D) ϕ

269. Two point charges repel each other with a force of 100 N. One of the charges is increased by 10% and other is reduced by 10%. The new force of repulsion at the same distance would be-
(A) 100 N (B) 121 N (C) 99 N (D) None of these

270. A positive point charge q is carried from a point B to a point A in the electric field of a point charge +Q at O. If the permittivity of free space is ε_0, the work done in the process is given by (where a = OA and b = OB) -

(A) $\frac{qQ}{4\pi\varepsilon_0}\left(\frac{1}{a}+\frac{1}{b}\right)$ (B) $\frac{qQ}{4\pi\varepsilon_0}\left(\frac{1}{a}-\frac{1}{b}\right)$ (C) $\frac{qQ}{4\pi\varepsilon_0}\left(\frac{1}{a^2}-\frac{1}{b^2}\right)$ (D) $\frac{qQ}{4\pi\varepsilon_0}\left(\frac{1}{a^2}+\frac{1}{b^2}\right)$

271. A spherical charged conductor has σ as the surface density of charge. The electric field on its surface is E. If the radius of the sphere is doubled keeping the surface density of charge unchanged, what will be the electric field on the surface of the new sphere -

(A) $\frac{E}{4}$ (B) $\frac{E}{2}$ (C) E (D) 2 E

272.* Three equal and similar charges are placed at (–a, 0, 0), (0, 0, 0) and (+a, 0, 0). What is the nature of equilibrium of the charge at the origin-
(A) Stable when moved along the Y-axis
(B) Stable when moved along Z-axis
(C) Stable when moved along X-axis
(D) Unstable in all of the above cases

273. Two conducting spheres each of radius R carry charge q. They are placed at a distance r from each other, where r > 2 R. The neutral point lies at a distance r/2 from either sphere. If the electric field at the neutral point due to either sphere be E, then the total electric potential at that point will be -
(A) r E/2 (B) r E (C) RE/2 (D) RE

274. Two point charges Q and –3Q are placed certain distance apart. If the electric field at the location of Q be $\vec{E}$, then that at the location of –3Q will be-

(A) $3\vec{E}$ (B) $-3\vec{E}$ (C) $\vec{E}/3$ (D) $-\vec{E}/3$

275.* If a positive charge is shifted from a low-potential region to a high-potential region, the electric potential energy -
(A) increases
(B) decreases
(C) remains the same
(D) May increase or decrease

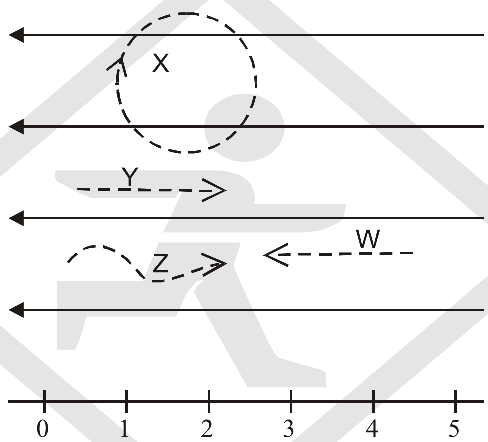
276. A particle of mass 0.002 kg and a charge $1\mu C$ is held at rest on a frictionless horizontal surface at a distance of 1m from a fixed charge of 1mC. If the particle is released, it will be repelled. The speed of the particle when it is at a distance of 10m from the fixed charge is -
(A) 60 ms^{-1} (B) 75 ms^{-1} (C) 90 ms^{-1} (D) 100 ms^{-1}

277. A charge Q is placed at each of two opposite corners of a square. A charge q is placed at each of the two opposite corners of the square. If the resultant electric field on Q is zero, then -

(A) $Q = -\frac{q}{2\sqrt{2}}$ (B) $Q = -2\sqrt{2}\, q$ (C) $Q = -2q$ (D) $Q = 2\sqrt{2}\, q$

278.* Two equal positive charges are kept at points A and B. The electric potential at the points between A and B (excluding these points) is studied while moving from A to B. The potential-
(A) Continuously increases
(B) Continuously decreases
(C) Increases then decreases
(D) Decreases then increases

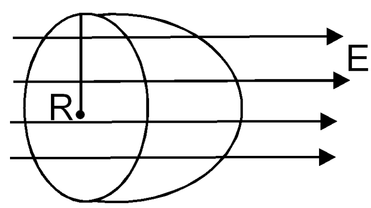
279.* In the diagram (given below) the broken lines represent the paths followed by particles W,X, Y and Z respectively through the constant field E. The numbers below the field represents meters.



If the particles begin and end at rest, and all are positively charged, the same amount of work was done on which particles.
(A) W and Z (B) W, Y and Z (C) Y and Z (D) W, X, Y and Z

280.* In previous question if the particles started from rest and all are positively charge which particles must have been acted upon by a force other than that produced by the electric field.
(A) W and Y (B) X and Z (C) X,Y and Z (D) W, X,Y and Z

281. A hemisphere (radius R) is placed in electric field as shown in fig. Total outgoing flux is -



(A) $\pi R^2 E$ (B) $2\pi R^2 E$ (C) $4\pi R^2 E$ (D) $(\pi R^2 E)/2$

282. Two small balls having equal positive charge Q on each are suspended by two insulating strings at equal length L meter, from a hook fixed to a stand. The whole set up is taken in a satellite into space where there is no gravity. Then the angle θ between two strings and tension in each string is-

(A) 0, $\frac{kq^2}{L^2}$ (B) π, $\frac{kq^2}{2L^2}$ (C) π, $\frac{kq^2}{4L^2}$ (D) $\frac{\pi}{2}$, $\frac{kq^2}{2L^2}$

283. A metal sphere A of radius R has a charge of Q on it .The field at a point B outside the sphere is E. Now another sphere of radius R having a charge -3Q is placed at point B. The total field at a point mid-way between A and B due to both sphere is-

(A) 4E (B) 8E (C) 12E (D) 16E

284. semicircle of radius R. The electric field at the centre is -

(A) $\frac{2k\lambda}{R}$ (B) $\frac{k\lambda}{2R}$ (C) Zero (D) None

285. The potential of a charged drop is v. This is divided into n smaller drops, then each drop will have the potential as ;
(A) $n^{-1}v$ (B) $n^{2/3}v$. (C) $n^{3/2}v$ (D) $n^{-2/3}$ v

286. When an electric dipole $\vec{P}$ is placed in a uniform electric field $\vec{E}$ then at what angle between $\vec{P}$ and $\vec{E}$ the value of torque will be maximum
(A) 90º (B) 0º (C) 180º (D) 45º

287. An electric dipole is placed along the x-axis at the origin O.A point P is at a distance of 20cm from this origin such that OP makes an angle $\frac{\pi}{3}$ with the x-axis. If the electric field at P makes an angle θ with the x-axis, the value of θ would be

(A) $\frac{\pi}{3}$ (B) $\frac{\pi}{3}+\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$ (C) $\frac{2\pi}{3}$ (D) $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

288. Two charged metal spheres of radii R and 2R are temporarily placed in contact and then separated. At the surface of each, the ratio of electric field will be-
(A) 1 : 1 (B) 1 : 2 (C) 2 : 1 (D) 1 : 4

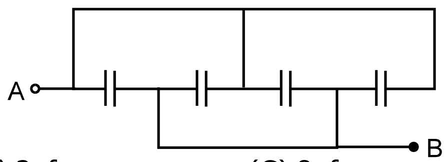
289. Two parallel plate air filled capacitors each of capacitance C, are joined in series to a battery of emf V. The space between the plates of one of the capacitors is then completely filled up with a uniform dielectric having dielectric constant K. The quantity of charge which flows through the battery is -

(A) $\frac{CV}{2}\left(\frac{K-1}{K+1}\right)$ (B) $\frac{CV}{2}\left(\frac{K+1}{K-1}\right)$ (C) CV $\left(\frac{K-1}{K+1}\right)$ (D) CV $\left(\frac{K+1}{K-1}\right)$

290. A capacitor when filled with a dielectric K = 3 has charge Q_0, voltage V_0 and Electric field E_0, If the dielectric is replaced with another one having K = 9, the new value of charge, voltage and field will be respectively-

(A) 3 Q_0, $3V_0$, $3E_0$ (B) Q_0, $3V_0$, $3E_0$ (C) Q_0, $\frac{V_0}{3}$, $3E_0$ (D) Q_0, $\frac{V_0}{3}$, $\frac{E_0}{3}$

291. Four condensers are joined as shown in fig. the capacity of each is 8μf. the equivalent capacity between points A and B will be -

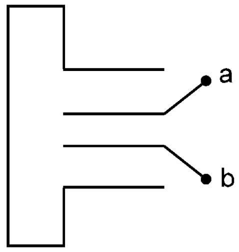


(A) 32 μf (B) 2μf (C) 8μf (D) 16 μf

292. In a parallel plate capacitor, the separation between the plates is 3mm with air between them. Now a 1mm thick layer of a material of dielectric constant 2 is introduced between the plates due to which the capacity increases. In order to bring its capacity of the original value, the separation between the plates must be made-

(A) 1.5 mm (B) 2.5 mm (C) 3.5 mm (D) 4.5 mm

293. Four metallic plates each with a surface area A of one side and placed at a distance d from each other. the plates are connected as shown in the fig. Then the capacitance of the system between a and b is -



(A) $\frac{3 \epsilon_0 A}{d}$ (B) $\frac{2 \epsilon_0 A}{d}$

(C) $\frac{2 \epsilon_0 A}{3d}$ (D) $\frac{3 \epsilon_0 A}{2d}$

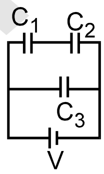
294. Two identical parallel plate capacitors are placed in series and connected to a constant voltage source of V_0 volt. If one of the capacitors is completely immersed in a liquid with dielectric constant K, the potential difference between the plates of the other capacitor will change to -

(A) $\frac{K+1}{K}V_0$ (B) $\frac{K}{K+1}V_0$ (C) $\frac{K+1}{2K}V_0$ (D) $\frac{2K}{K+1}V_0$

295. A number of capacitors each of capacitance 1 μF and each one of which get punctured if a potential difference just exceeding 500 volt is applied, are provided. Then an arrangement suitable for giving a capacitor of 2 μF across which 3000 volt may be applied requires at least-

(A) 18 component capacitors (B) 36 component capacitors
(C) 72 component capacitors (D) 144 component capacitors

296. In the given circuit $C_1 = C$, $C_2 = 2C$, $C_3 = 3C$. If charge at the capacitor C_2 is Q. Then the charge at the capacitor C_3 will be -



(A) $\frac{3Q}{2}$ (B) $\frac{9Q}{2}$

(C) $\frac{Q}{3}$ (D) $\frac{Q}{6}$

297. A capacitor of 2 μF is charged to its maximum emf of 2V and is discharged through a resistance of $10^4\Omega$. Current in the circuit after 0.02 s will be-

(A) 10^{-4}A (B) 1.4×10^5 A
(C) 7.4×10^{-5}A (D) 3.7×10^{-5}A

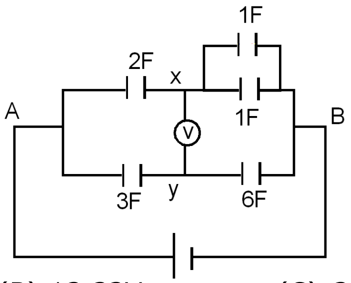
298. A battery charges a parallel plate capacitor of thickness (d) so that an energy [U_0] is stored in the system. A slab of dielectric constant (K) and thickness (d) is then introduced between the plates of the capacitor. The new energy of the system is given by -

(A) KU_0 (B) $K^2 U_0$ (C) $\frac{U_0}{K}$ (D) U_0/K^2

299. Two spheres of radii R_1 and R_2 have equal charge are joint together with a copper wire. If the potential on each sphere after they are separated to each other is V, then initial charge on any sphere was ($k = \frac{1}{4\pi \epsilon_0}$) -

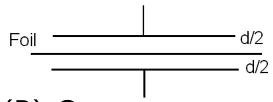
(A) $\frac{V}{k}(R_1 + R_2)$ (B) $\frac{V}{2k}(R_1 + R_2)$ (C) $\frac{V}{3k}(R_1 + R_2)$ (D) $\frac{V}{k}\frac{(R_1R_2)}{(R_1+R_2)}$

300. Calculate the reading of voltmeter between X and Y then $(V_x - V_y)$ is equal to -



(A) 10 V (B) 13.33V (C) 3.33 V (D) 10.33 V

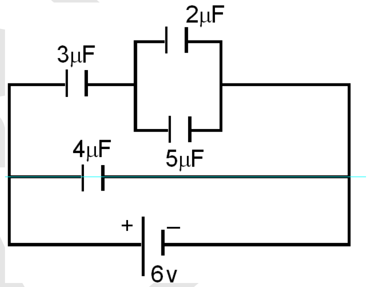
301.* A sheet of aluminium foil of negligible thickness is placed between the plates of a capacitor of capacitance C as shown in the figure then capacitance of capacitor becomes



(A) 2C (B) C (C) C/2 (D) zero

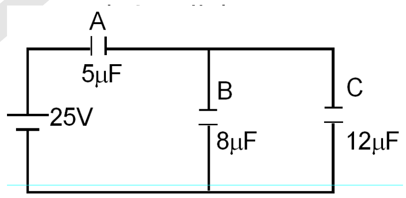
302. In above problem if foil is connected to any one plate of capacitor by means of conducting wire then capacitance of capacitor becomes -
(A) 2C (B) C (C) C/2 (D) zero

303. A circuit is shown in the figure below. Find out the charge of the condenser having capacity $5\mu F$



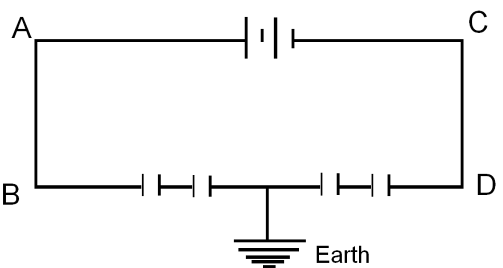
(A) 4.5 micro coulomb
(B) 6.0 micro coulomb
(C) 9.0 micro coulomb
(D) 30 micro coulomb

304. Three capacitors A , B and C are connected to a battery of 25volt as shown in the figure. The ratio of charges on capacitors A



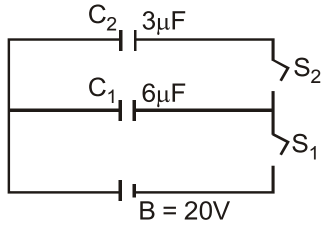
(A) 5 : 2 : 3 (B) 5 : 3 : 2
(C) 2 : 5: 3 (D) 2 : 3 : 5

305. Four equal capacitors , each with a capacitance (C) are connected to a battery of E.M.F 10volts as shown in the adjoining figure. The mid point of the capacitor system is connected to earth. Then the potentials of B and D are respectively -



(A) +10volts , zero volts (B) +5volts , –5 volts
(C) –5 volts, +5volts (D) zero volts, 10 volts

306. In the circuit shown here $C_1 = 6\mu F$, $C_2 = 3\mu F$ and battery B = 20V. The Switch S_1 is first closed. It is then opened and afterwards S_2 is closed. What is the charge finally on C_2

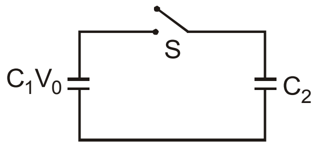


(A) $120\mu C$ (B) $80\mu C$ (C) $40\mu C$ (D) $20\mu C$

307. A capacitor of capacity C_1 is charged to the potential of V_0. On disconnecting with the battery, it is connected with a capacitor of capacity C_2 as shown in the adjoining figure. The ratio of energies before and after the connection of switch S will be

(A) $(C_1 + C_2)/C_1$ (B) $C_1/(C_1 + C_2)$

(C) C_1C_2 (D) C_1/C_2



308. A charge of 2×10^{-2} C moves at 30 revolution per second in a circle of diameter 0.80 m. The current linked with the circuit will be -

(A) 0.1 A (B) 0.2 A (C) 0.4 A (D) 0.6 A

309 The current in a copper wire is increased by increasing the potential difference between its end. Which one of the following statements regarding n, the number of charge carriers per unit volume in the wire and v the drift velocity of the charge carriers is correct -

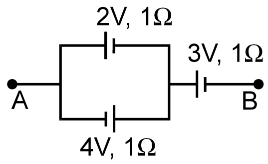
(A) n is unaltered but v is decreased (B) n is unaltered but v is increased
(C) n is increased but v is decreased (D) n is increased but v is unaltered

310. Consider two conducting wires of same length and material, one wire is solid with radius r. The other is a hollow tube of outer radius 2r while inner r. The ratio of resistance of the two wires will be -

(A) 1 : 1 (B) 1 : 2 (C) 1 : 3 (D) 1 : 4

311. The potential difference between points A and B is -

(A) 2 V (B) 6 V
(C) 4 V (D) 3 V



312. If a copper wire is stretched to make its radius decrease by 0.1%, then the percentage increase in resistance is approximately -

(A) 0.1% (B) 0.2% (C) 0.4% (D) 0.8%

313. The number of dry cells, each of e.m.f. 1.5 volt and internal resistance 0.5 Ω that must be joined in series with a resistance of 20 ohm so as to send a current of 0.6 ampere through the circuit is -

(A) 2 (B) 8 (C) 10 (D) 12

314. The sides of a rectangular block are 2cm, 3cm and 4 cm. The ratio of maximum to minimum resistance between its parallel faces is -

(A) 4 (B) 3 (C) 2 (D) 1

315. A long resistance wire is divided into 2n parts. Then n parts are connected in series and the other n parts in parallel separately. Both combinations are connected to identical supplies. Then the ratio of heat produced in series to parallel combinations will be -

(A) 1 : 1 (B) $1 : n^2$ (C) $1 : n^4$ (D) $n^2 : 1$

316. Two bulbs 100 W, 250 V and 200 W, 250 V are connected in parallel across a 500 V line. Then-

(A) 100 W bulb will fused
(B) 200 W bulb will fused
(C) Both bulbs will be fused
(D) No bulb will fused

317.* Two tungston lamps with resistance R_1 and R_2 respectively at full incandescence are connected first in parallel and then in series, in a lighting circuit of negligible internal resistance. It is given that $R_1 > R_2$.

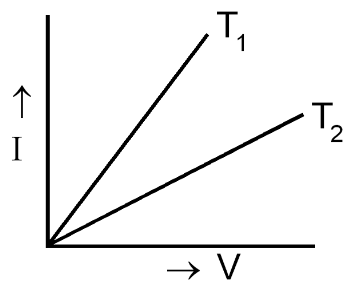
Which lamp will glow more brightly when they are connected in parallel ?

(A) Lamp having lower resistance
(B) Lamp having higher resistance
(C) Both the lamps
(D) None of the two lamps

318.* In the previous question which lamp will glow more brightly when they are in connected in series ?

(A) Lamp having lower resistance
(B) Lamp having higher resistance
(C) Both the lamps
(D) None of the two lamps

319. The current (I) and voltage (V) graphs for a given metallic wire at two different temperature (T_1) and (T_2) are shown in fig. It is concluded that

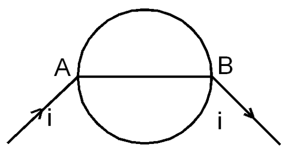


(A) $T_1 > T_2$
(B) $T_1 < T_2$
(C) $T_1 = T_2$
(D) $T_1 = 2T_2$

320. A 3^0C rise in temperature is observed in a conductor by passing a certain current. When the current is doubled, the rise in temp -

(A) 15^0C
(B) 12^0C
(C) 9^0C
(D) 3^0C

321. A wire of resistance $0.5\Omega\ m^{-1}$ is bent into a circle of radius 1m. The same wire is connected across a diameter AB as shown in fig. The equivalent resistance is -

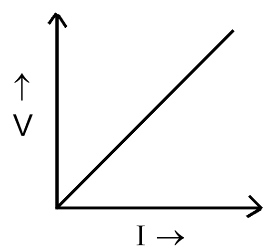


(A) π ohm
(B) $\frac{\pi}{(\pi+2)}$ ohm
(C) $\frac{\pi}{(\pi+4)}$ ohm
(D) $(\pi + 1)$ ohm

322. In Wheat stone's bridge P = 9 ohm , Q = 11 ohms, R = 4 ohm and S = 6 ohms. How much resistance must be put in parallel to the resistance (S) to balance the bridge

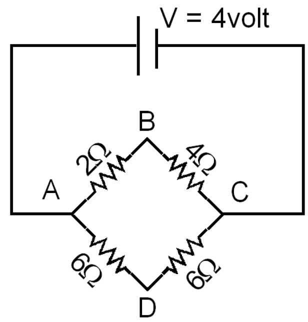
(A) 24 ohms
(B) (44/9) ohm
(C) 26.4 ohms
(D) 18.7 ohms

323. The current -voltage - variation for a wire of copper of length (L) and area (A) is shown in fig. The slope of the line will be



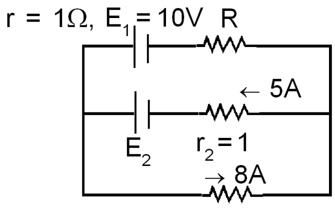
(A) less if experiment is done at a heigher temperature
(B) more if a wire of silver of same dimensions is used
(C) will be doubled if the lengths of the wire is doubled
(D) will be halved if the length is doubled

324 If fig. the difference of potential between (B) and (D) is -



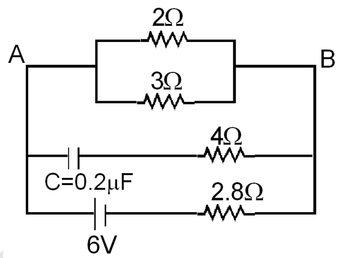
(A) + 0.67V (B) −0.67V
(C) 2V (D) 1.33V

325. In fig the current through resistance (R) is



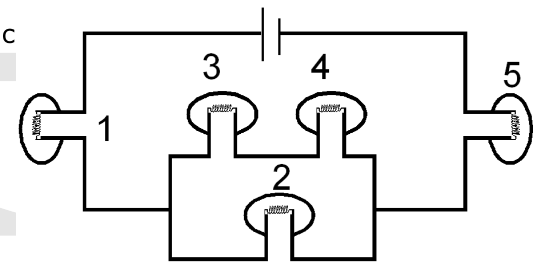
(A) 3A (B) 13A
(C) 6.5 A (D) 9A

326 In fig the steady state current in 2Ω resistance is



(A) 0.3 A (B) 0.9 A (C) 0.6 A (D) zero

327. All bulbs in figure below are identical whic bulbs light most brightly

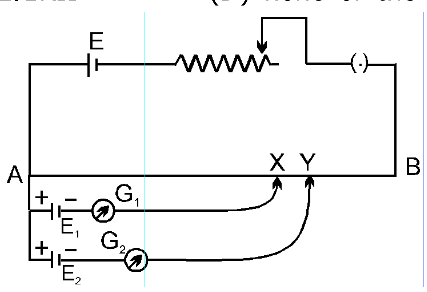


(A) 1 only (B) 2 only (C) 3 and 4 only (D) 1 and 5

328. A resistance coil of 60 Ω is immersed in 42 kg of water. A current of 7 A is passed through it. The rise in temperature of water per minutes is :
(A) 4ºC (B) 8ºC (C) 1ºC (D) 12ºC

329. The resistance of a galvanometer coil is 100Ω. The value of current for full scale deflection in it is 1mA. What should be the value of series resistance to be used to convert it into a voltmeter of 12volt range
(A) 11.9KΩ (B) 12KΩ (C) 12.1KΩ (D) none of the above

330. A potentiometer experiment is setup as shown in fig. If both the galvanometer shows null deflections for the sliding contacts at x and y as shown then-



(A) $E_1 = E_2$ (B) $E_1 > E_2$ (C) $E_1 < E_2$ (D) none of the above

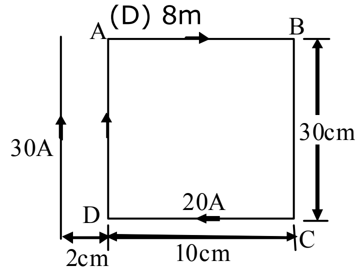
331. A potentiometer, wire of length 10m and resistance 21.8ohm is connected in series with a cell of emf 22 volt internal resistance 0.2Ω and a Rheostate with maximum resistance of 22 ohm , then the minimum & maximum Potential gradient that can be obtained (V/m) are -
(A) 1.09, 2.18 (B) 0.109, 0.218 (C) 0.109, 0.220 (D) 0.218 , 0.220

332. To send 10% of the main current through a moving coil galvanometer of resistance 99Ω, the shunt required is –
(A) 9.9Ω (B) 10Ω (C) 11Ω (D) 9Ω

333. A cell of two volt and 1.5 ohm internal resistance is connected to two ends of a 100metre wire. The resistance of wire is 0.005 ohm/m. The potential gradient of the wire is
(A) 5 v/m (B) 5×10^{-2} v/m (C) 5×10^{-3} v/m (D) 5×10^{-4} v/m

334. A ten meter long potentiometer wire is connected to accumulator of emf 2volts and negligible internal resistance. A lechlanche cell gives null point at 4 meter. If the diameter of the wire is doubled keeping the length same. The position of new null point will be
(A) 2m (B) 4m (C) 6m (D) 8m

335. The resultant force due to a current carrying long wire on a current loop ABCD in Newton will be: (Direction of current is clockwise)



(A) 1.8×10^{-3} (B) 0.36×10^{-3}
(C) 1.5×10^{-3} (D) zero

336. Out of two identical straight conducting wires of length 20 cm and mass 1.2 gm each, one wire is horizontally clamped below the other wire and in series with both the wires a current source is connected. The second wire can be in equilibrium in air at a height of 0.75 cm from first wire if the current flowing in the wires is-
(A) 47 A (B) 4.7 A
(C) 0.47 A (D) 0.047 A

337. Current I is flowing through a circular coil of radius r. It is placed in a magnetic field B_0 in such a way that the plane of the circular coil is perpendicular to B_0. The force acting in it will be -
(A) $\pi I r B_0$ (B) $I r B_0$
(C) zero (D) $2\pi I r B_0$

338. A direct current is sent through a helical spring. The spring -
(A) tends to get shorter (B) tends to get longer
(C) tends to rotate about the axis (D) tends to move northward

339. Two long, thin wires distant a apart exert a force F on one another when current through each wire is i. The distance between the wires is doubled and the current is decreased to i/3. The force they exert on one another now-
(A) F/6 (B) F/9 (C) 2F/3 (D) F/18

340. A current of 2 ampere is flowing through a coil of radius 0.1 m and having 10 turns. The magnetic moment of the coil will be :
(A) 20 A-m^2 (B) 2A-m^2 (C) 0.314 A-m^2 (D) 0.628 A-m^2

341. The radius of a circular ring of wire is R and it carries a current of I ampere. At its centre a smaller ring of radius r with current i and N turns is placed. Assuming that the planes of two rings are perpendicular to each other and the magnetic induction produced at the centre of bigger ring is constant, then the torque acting on smaller ring will be -

(A) $Ni\pi r^2 \times \left\{\frac{\mu_0 I}{2R}\right\}$ (B) zero (C) $Nir^2 \times \left\{\frac{\mu_0 I}{2R}\right\}$ (D) $Nir^2 \left\{\frac{I^2}{2R}\right\}$

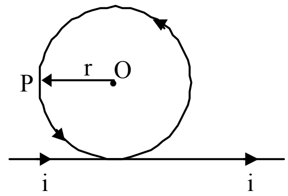
342. The effective radius of a circular coil is R and number of turns is N. The current through it is i ampere. The work done is rotating the coil from angle $\theta = 0^o$ to $\theta = 180^o$ in an external magnetic field B will be -

(A) πNiR^2B (B) $2\pi NiR^2B$ (C) $(2NiB)/(\pi R^2)$ (D) $4\pi NiR^2B$

343. A current carrying wire of length ℓ is bent to from a circular coil. If this coil is placed in any other magnetic field, then for the maximum torque on the coil, the number of turns will be

(A) 1 (B) 2 (C) 4 (D) 8

344. An electric current of i ampere is flowing in a long conductor as shown in the figure. The magnitude and direction of magnetic induction at the centre of circular part will be-



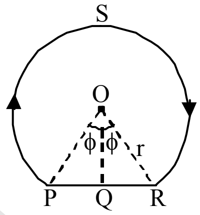
(A) $\frac{\mu_0 i}{2r}\left(1+\frac{1}{\pi}\right)$, $\odot$ (B) 0

(C) $\frac{\mu_0 i}{2r}\left(1-\frac{1}{\pi}\right)$, $\otimes$ (D) $\frac{\mu_0 i}{2r}$, $\odot$

345. A circular arc of wire of radius of curvature r subtends an angle of $\frac{\pi}{4}$ radian at its centre. If i current is flowing in it then the magnetic induction at its centre will be-

(A) $\frac{\mu_0 i}{8r}$ (B) $\frac{\mu_0 i}{4r}$ (C) $\frac{\mu_0 i}{16r}$ (D) 0

346. The total magnetic induction at point O due to curve portion and straight portion in the following figure, will be-



(A) $\frac{\mu_0 i}{2\pi r}$ $[\pi - \phi + \tan\phi]$ (B) $\frac{\mu_0 i}{2\pi r}$

(C) 0 (D) $\frac{\mu_0 i}{2\pi r}$ $[\pi - \phi + \tan\phi]$

347. A 6.28m long wire is turned into a coil of diameter 0.2m and a current of 1 amp. is passed in it. The magnetic induction at its centre will be-

(A) 6.28×10^{-5} Tesla (B) 0

(C) 6.28 Tesla (D) 6.28×10^{-3} Tesla

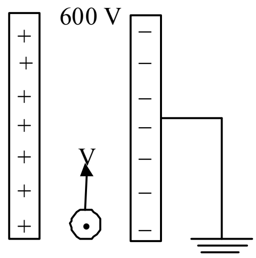
348. A proton, a deutron and an α-particle are accelerated through same potential difference and then they enter a normal uniform magnetic field. The ratio of their kinetic energies will be-

(A) 2 : 1 : 3 (B) 1 : 1 : 2

(C) 1 : 1 : 1 (D) 1 : 2 : 4

349. A potential difference of 600 volt is applied across the plates of a parallel plate condenser placed in a magnetic field. The separation between the plates is 3 mm. An electron projected vertically upward parallel to the plates with a velocity of 2×10^6 m/s moves undeflected between the plates. The magnitude and direction of the magnetic field in the region between the condenser plates will be (in Wb/m^2)

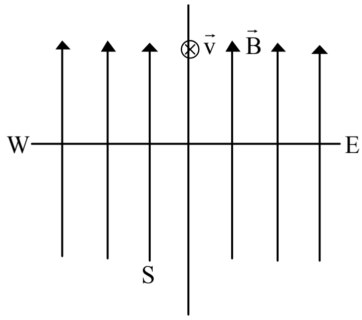
(Given charge of electron = -1.6×10^{-19} coulomb).



(A) 0.1, vertically downward (B) 0.2 vertically downward

(C) 0.3 vertically upward (D) 0.4 vertically downward.

350. A 5 MeV proton moves vertically downward through a magnetic field of induction 1.5 weber/m^2 pointing horizontally from south to north. The force acting on the proton, mass of proton = 1.6×10^{-27} kg. will be-

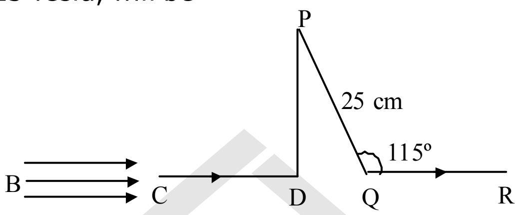


(A) 7.44×10^{-12} N
(B) 3.1×10^{-12} N
(C) 5×10^{-12} N
(D) 6×10^{-12} N

351. An α-particle is describing a circle of radius 0.45 m in a field of magnetic induction 1.2 weber/m^2. The potential difference required to accelerate the particle, so as to give this much energy to it (The mass of α-particle is 6.8×10^{-27} kg and its charge is 3.2×10^{-19} coulomb.) will be-

(A) 6×10^{6} V
(B) 2.3×10^{-12} V
(C) 7×10^{6} V
(D) 3.2×10^{-12} V

352. The magnetic force on segment PQ, due to a current of 5 amp. flowing in it, if it is placed in a magnetic field of 0.25 Tesla, will be-

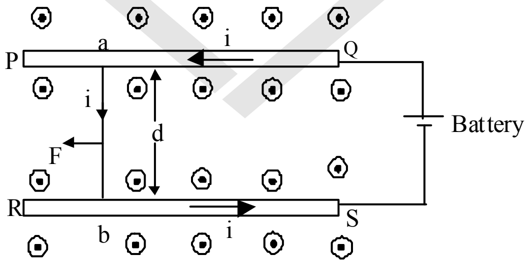


(A) 0.3125 sin 65° N
(B) 0
(C) 31.25 sin 65° N
(D) 3.125 sin 65° N

353. A loop of flexible conducting wire of length 0.5 m lies in a magnetic field of 1.0 tesla perpendicular to the plane of the loop. The tension developed in the wire if the current is of 1.57 amp. will be-

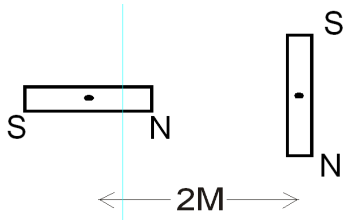
(A) 0.15 N
(B) 0.25 N
(C) 0.125 N
(D) 0.138 N

354. A metal wire of mass m slides without friction on two rails spaced at a distance d apart. The track lies in a vertical uniform field of induction B, a constant current i flows along one rail, across the wire and back down the other rail. The velocity (speed and direction) of the wire as a function of time, assuming it to be at rest initially will be-



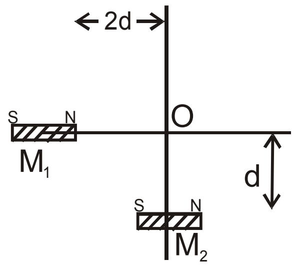
(A) $\frac{Bid}{m}t$
(B) 0
(C) Bidmt
(D) none

355. Two identical magnetic dipoles of magnetic moment 1.0 A-m^2 each, placed at a separation of 2m with their axis perpendicular to each other. The resultant magnetic field at a point midway between dipoles is



(A) $\sqrt{5}\times10^{-7}$T
(B) 3×10^{-7}T
(C) 2×10^{-7}T
(D) zero

356. Two short barmagnet of magnetic moments M_1 and M_2 are kept on X and Y axis as shown is figure. If resultant magnetic field at origin is zero, Then $\frac{M_1}{M_2}$ will be



(A) 1 : 4 (B) 4 : 1
(C) 2 : 1 (D) 8 : 1

357. A magnet of length 14 cm and magnetic moment μ is broken into two parts of length 6 cm and 8 cm. They are put at right angles to each other with opposite poles together. The magnetic dipole moment of the combination is-

(A) $\frac{\mu}{1.4}$ (B) μ (C) $1.4\ \mu$ (D) $2.8\ \mu$

358. Torques τ_1 and τ_2 are required for a magnetic needle to remain perpendicular to the magnetic fields at two different places. The magnetic field at those places are B_1 and B_2 respectively, then $\frac{B_1}{B_2}$ is

(A) $\frac{\tau_1}{\tau_2}$ (B) $\frac{\tau_2}{\tau_1}$ (C) $\frac{\tau_1+\tau_2}{\tau_1-\tau_2}$ (D) $\frac{\tau_1-\tau_2}{\tau_1+\tau_2}$

359. A magnetised wire of moment M is bent into an arc of a circle subtending an angle of 60° at the centre; then the new magnetic moment is –

(A) $(2M/\pi)$ (B) (M/π) (C) $(3\sqrt{3}M/\pi)$ (D) $(3M/\pi)$

360. Magnetic field produced by electrons in aotms and molecules is due to their -
(A) spin motion only (B) orbital motion only
(C) spin and orbital motion both (D) neither spin nor orbital motion.

361. When a magnet is heated, its strength –
(A) always decreases (B) always increases
(C) may increase or decrease (D) remains unaffected

362.* The lines of force due to earth's horizontal magnetic field are –
(A) parallel and straight (B) concentric circle
(C) elliptical (D) curved lines

363. A deflection magnetometer can be used for measuring –
(A) declination (B) dip (C) horizontal component (D) all these

364. Lines passing through points of zero declination are –
(A) isogonic lines (B) isoclinic lines (C) agonic lines (D) aclinic lines

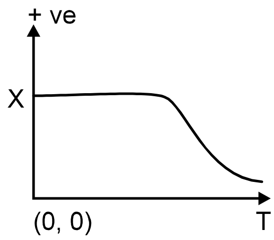
365. A hydrogen atom is a paramagnetic. A hydrogen molecule is –
(A) Diamagnetic (B) Paramagnetic (C) Ferromagnetic (D) None of these

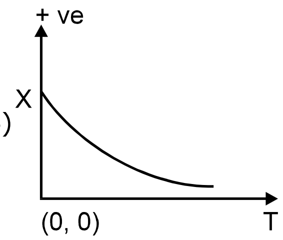
366. The core of an electromagnet is made of soft iron, because –
(A) the susceptibility of soft iron is very high
(B) coercivity of soft iron is very low
(C) both of these
(D) none of these

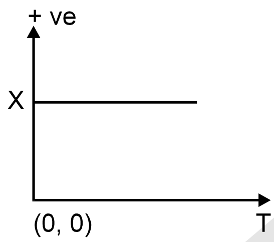
367. A permanent magnet –
(A) attracts all substances
(B) attracts only ferromagnetic substances
(C) attacts ferromagnetic substances and repels all others
(D) attracts some substances and repels others

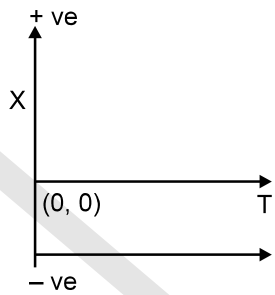
368.* The relative permeability of a substance X is slightly less than unity and that of substance Y is slightly more than unity then –
(A) X is paramagnetic and Y is ferromagnetic
(B) X is diamagnetic and Y is ferromagnetic
(C) X and Y both are paramagnetic
(D) X is diamagnetic and Y is paramagnetic

369. The variation of magnetic susceptibility (x) with absolute temperature T for a diamagnetic material is given by –

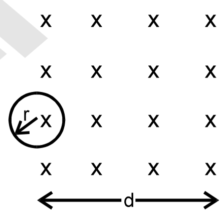
(A) 

(B) 

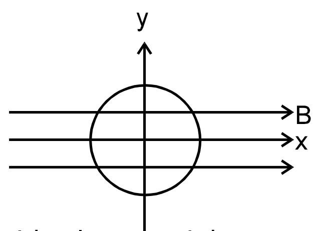
(C) 

(D) 

370. A conducting loop is pulled with a constant velocity towards a region of uniform magnetic field as shown in the figure then the current involved in the loop is (d > r) -
(A) Clockwise while entering
(B) Anticlockwise while entering
(C) Zero when partially outside
(D) Anticlockwise while leaving.

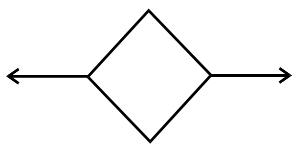


371. A conducting loop of resistance R and radius r has its centre at the origin of the coordinate system in a magnetic field B, When it is rotated about y-axis through 90°, net charge flown in the loop is directly proportional to -
(A) B^{-1} (B) R
(C) r^2 (D) r

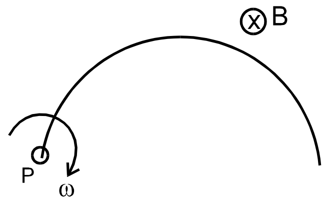


372. A small conducting circular ring of area 2 mm^2 is placed coplanerly with a long straight current carrying wire at a distance of 10 cm from it. It current through the wire decreases from 4 A to zero in 0.1s, the average value of emf induced in the ring.
(A) 1.6×10^{-10} V (B) 2.0×10^{-10} V (C) 3.2×10^{-10} V (D) Zero.

373. A conducting square loop edge length a and resistance R is in a uniform magnetic field B, perpendicularly. Two opposite corners of the loop are pulled apart as shown in fig., till it becomes straight, the charge flown through the loop will be -
(A) $\frac{Ba^2}{R}$ (B) $\frac{2Ba^2}{R}$
(C) $\frac{Ba^2}{2R}$ (D) Zero



374. A wire is bent to form a semicircle of radius a. The wire rotales about its one end with angular velocity ω. Axis of rotation being perpendicular to the plane of the semicircle. In the region, a uniform magnetic field B exist along the axis of rotation as shown in fig.The emf induced in the wire.



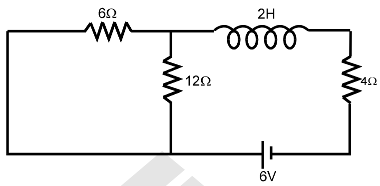
(A) $\frac{B\omega a^2}{2}$ (B) $B\omega a^2$

(C) $2B\omega a^2$ (D) $\frac{B\omega a^2}{4}$

375. A circular coil of radius a and having N turns is placed at centre of a long solenoid, coaxially. The solenoid has radius b (b >> a) and number of turns per unit length is n. Their coefficient of mutual inductance will be -

(A) $\mu_0 n N^2 \pi a^2$ (B) $\mu_0 n N \pi a^2$ (C) $\mu_0 n^2 N \pi a^2$ (D) $\mu_0 n^2 N^2 \pi a^2$

376. In the circuit shown in fig.. Time constant and steady state current will be -



(A) 0.25 s, 0.75 A (B) 0.75 s, 0.25 A (C) 0.25 s, 0.25 A (D) 0.5 s, 0.5 A

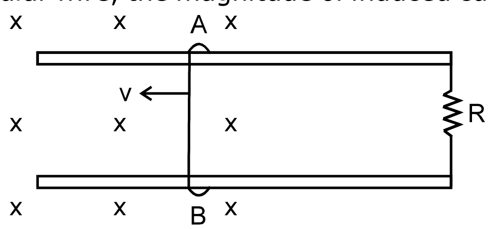
377. Through an induction coil of L = 0.2 H, an a.c. current of 2A is passed first with frequency f_1 and then with frequency f_2. The ratio of the maximum value of induced emf $\frac{e_1}{e_2}$ in the coil in the two cose is -

(A) $\frac{f_2}{f_1}$ (B) $\frac{f_2^2}{f_1^2}$ (C) $\frac{f_1^2}{f_2^2}$ (D) $\frac{f_1}{f_2}$

378. When the current in a coil charges from 2A to 4A in 0.05 s, emf of 8 volt is induced in the coil. The coefficient of self induction of the coil is -

(A) 0.1 H (B) 0.2 H (C) 0.4 H (D) 0.8 H

379. Consider the situation shown in fig. the wire AB is slide on the fixed rails with a constant velocity. If the wire AB is replaced by a semicircular wire, the magnitude of induced current will be -



(A) Increase
(B) decrease
(C) remain the same
(D) May increase or decrease depending on whether the semicircle bulges towards the resistance or away from it.

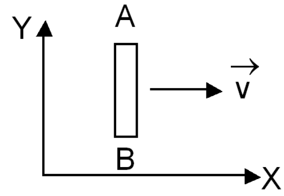
380. A coil having inductance and L and resistance R is connected to a battery of emf $\in$ at t = 0. If t_1 and t_2 are time for 90% and 99% completion of current growth in the circuit, then $\frac{t_1}{t_2}$ will be-

(A) 1 : 2 (B) 2 : 1 (C) $\frac{\log_e 10}{2}$ (D) $2\log_e 10$

381. Two circular, similar, coaxial loops carry equal currents in the same direction. If the loops are brought nearer, what will happen -
(A) Current will increase in each loop.
(B) Current will decrease in each loop.
(C) Current will remain same in each loop.
(D) Current will increase in one and decrease in the other.

382. A solenoid of inductance 50 mH and resistance 10 Ω is connected to a battery of 6 V. The time elapsed before the current acquires half of its steady-state value will be-
(A) 3.01 s (B) 3.02 s
(C) 3.03 s (D) 3.5 ms

383. A conductor rod AB moves parallel to X-axis in a uniform magnetic field, pointing in the positive Z-direction. The end A of the rod gets-



(A) positively charged
(B) negatively charged
(C) neutral
(D) first positively charged and then negatively charged.

384. 5.5×10^{-4} magnetic flux lines are passing through a coil of resistance 10 ohm and number of turns 1000. If the number of flux lines reduces to 5×10^{-5} in 0.1 sec. The electromotive force and the current induced in the coil will be respectively-
(A) 5V, 0.5 A (B) 5×10^{-4} V, 5×10^{-4} A
(C) 50 V, 5 A (D) none of the above.

385. The electric current in a circuit is given by $i = \frac{i_0 t}{\tau}$ for some time. The rms current for the period $t = 0$ to $t = \tau$ will be-

(A) $\frac{i_0}{\sqrt{2}}$ (B) $\frac{i_0}{\sqrt{3}}$ (C) $\frac{i_0}{2}$ (D) $\frac{i_0}{3}$

386. A series AC circuit has a resistance of 4Ω and an inductor of reactance 3Ω. The impedance of the circuit is z_1. Now a capacitor of reactance 6Ω is connected in the series of above combination, the impedance becomes z_2 , Then $\frac{z_1}{z_2}$ will be-
(A) 1 : 1 (B) 5 : 4 (C) 4 : 5 (D) 2 : 1

387. An inductor (L) and resistance (R) are connected in series with an AC source. The phase difference between voltage (V) and current (i) is 45°. Now a capacitor (C) is connected in series with L-R, If the phase difference between V and i remain same, then capacitive reactance and impedance of L-C-R circuit will be-

(A) $R, R\sqrt{2}$ (B) $2R, R\sqrt{2}$ (C) R, R (D) $2R, R\sqrt{3}$

388. In an LR circuit, the inductive reactance is equal to resistance R of the circuit. An e.m.f. $E = E_0 \cos \omega t$ is applied to the circuit. The power consumed in the circuit is-
(A) E_0^2/R (B) $E_0^2/2R$ (C) $E_0^2/4R$ (D) $E_0^2/8R$

389. The voltage of an AC supply varies with time (t) as $V = 120 \sin 100 \pi t \cos 100\pi t$. The maximum voltage and frequency respectively are -

(A) 60 volt, 100 Hz (B) $\frac{120}{\sqrt{2}}$ volt, 100 Hz (C) 120 volt, 100 Hz (D) 60 volt, 200 Hz

390. A generator of 100 V (rms) is connected in an ac circuit and 1 A (rms) current is flowing in the circuit. If the phase difference between the voltage and the current is $\pi/3$. then the average power consumption and the power factor of the circuit will be –
(A) 50 W, 0.86 (B) 100 W, 0.86
(C) 100 W, 0.5 (D) 50 W, 0.5

391. In ac circuit contains a pure capacitor, across which an ac emf

$$e = 100 \sin (1000t), \text{ volt}$$

is applied. If the peak value of the current is 200 mA, then the value of the capacitor is

(A) 2 μF (B) 20 μF (C) 5 μF (D) 500μF

392. An ac circuit contains a resistance R and a reactance X. If the impedace of the circuit is given by

$$Z = 50 \angle \pi/6$$

Then the resistance and the reactance are, respectively (in ohms) –

(A) Zero ; 50 (B) $25\sqrt{3}$; 25 (C) 25 ; $25\sqrt{3}$ (D) 25 ; 25

393. A d.c. voltage with appreciable riple expressed as $V = V_1 + V_2 \cos \omega t$ is applied to a resistor R. The amount of heat generated per second is given by -

(A) $\frac{V_1^2 + V_2^2}{2R}$ (B) $\frac{2V_1^2 + V_2^2}{2R}$ (C) $\frac{V_1^2 + 2V_2^2}{2R}$ (D) None of these

Statement Type Question (394 to 402)

Each of the questions given below consist of Statement – I and Statement – II. Use the following Key to choose the appropriate answer.

(A) If both Statement- I and Statement- II are true, and Statement - II is the correct explanation of Statement– I.

(B) If both Statement - I and Statement - II are true but Statement - II is not the correct explanation of Statement – I.

(C) If Statement - I is true but Statement - II is false.

(D) If Statement - I is false but Statement - II is true.

394. **Statement I :** Electrons move away from a region of lower potential to a region of higher potential.
Statement II : Since an e^- has negative charge.

(A) a (B) b (C) c (D) d

395. **Statement I :** If a point charge q is placed in front of an infinite grounded conducting plane surface, the point charge will experience a force.
Statement II : The force is due to the induced charge on the conducting surface which is at zero potential.

(A) a (B) b (C) c (D) d

396 **Statement I :** Work done in moving a charge between any two points in an electric field is independent of the path followed by the charge, between these points.
Statement II : Electrostatic forces are non conservative.

(A) a (B) b (C) c (D) d

397 **Statement I :** Force between two charges decreases when air separating the charges is replaced by water.
Statement II : Medium intervening the charges has no effect on force.

(A) a (B) b (C) c (D) d

398. **Statement I :** Capacity of a parallel plate condenser increases on introducing a conducting or insulating slab between the plates.
Statement II : In both the cases, electric field intensity between the plates reduces.

(A) a (B) b (C) c (D) d

399. **Statement I :** The resistance of a copper wire varies directly as the length and diameter.
Statement II : Because the resistance varies inversely the area of cross-section.

(A) a (B) b (C) c (D) d

400. **Statement I :** In series combination of electrical bulbs of lower power emits more light than that of higher power bulb.
Statement II : The lower power bulb in series gets more current than the higher power bulb.

(A) a (B) b (C) c (D) d

401. **Statement I :** In series LCR circuit , the resonance occurs at one frequency only.
Statement II : At this frequency, inductive reactance is equal to capacitative reactance.

(A) a (B) b (C) c (D) d

402. **Statement I :** A capacitor blocks d.c.
Statement II : This is because capacitative reactance of condenser is $X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$ and for d.c. f = 0.

(A) a (B) b (C) c (D) d

4 Optics

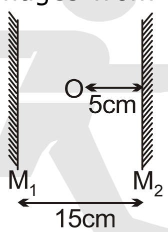
EXERCISE

403. An object is placed between two plane mirrors inclined at an angle to each other. If the number of images formed is 7 then the angle of inclination is -
(A) 15º (B) 30º (C) 45º (D) 60º

404. A plane mirror rotating at an angular velocity of 3 radian/s reflects a light beam. The angular velocity of the reflected beam is -
(A) 3 rad/s (B) 6 rad/s (C) 9 rad/s (D) 12 rad/s

405. In case of image formation by plane mirrors -
(A) Object can be real and image virtual (B) Both object and image can be virtual
(C) Both object and image can be real (D) None of these

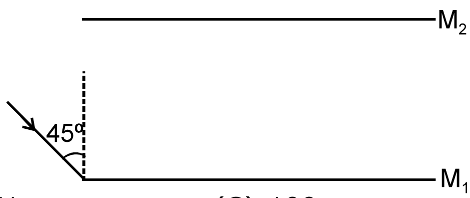
406. Two plane mirrors parallel to each other and an object O placed between them. Then the distance of the first three images from the mirror M_2 will be (in cm) –



(A) 5, 10, 15 (B) 5, 15, 30 (C) 5, 25, 35 (D) 5, 15, 25

407. A man moves towards a plane mirror with a velocity v in a direction making an angle θ with the normal to the mirror. The magnitude of velocity of the image relative to man normal to mirror will be
(A) 2v (B) $2v \cos\theta$ (C) $2v \sin\theta$ (D) $2v/\cos\theta$

408. Two plane mirrors M_1 and M_2 each have length 1m and are separated by 1cm. A ray of light is incident on one end of mirror M_1 at angle 45º. How many reflections the ray will have before going from the other end ?



(A) 50 (B) 51 (C) 100 (D) 101

409. A convex mirror of focal length f (in air) is immersed in water $\left(\mu = \frac{4}{3}\right)$. The focal length of the mirror in water will be -
(A) f (B) $\left(\frac{4}{3}\right)f$ (C) $\left(\frac{3}{4}\right)f$ (D) $\left(\frac{7}{3}\right)f$

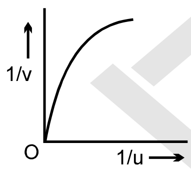
410. Image formed by a concave mirror radius of curvature 40 cm is half the size of the object. Then distance of object and its image from the mirror will be -
(A) 30 cm and 60 cm (B) 60 cm and 120 cm
(C) 60 cm and 30 cm (D) 120 cm and 60 cm

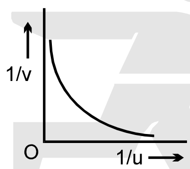
411. A small piece of wire bent into on L shape with upright and horizontal portions of equal lengths, is placed with the horizontal portion along the axis of the concave mirror whose radius of curvature is
10 cm. If the bend is 20 cm from the pole of the mirror, then the ratio of the lengths of the images of the upright and horizontal portions of the wire is
(A) 1 : 2 (B) 3 : 1 (C) 1 : 3 (D) 2 : 1

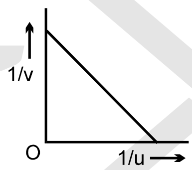
412. A point object is placed on the principal axis of a concave mirror quite far away from the pole and moved at a constant speed 0.5 cm/sec towards the pole. Its image also moves. It is found that the object and the image cross each other at a point which is at a distance 50 cm from the pole. Focal length of the mirror is -
(A) 50 cm (B) 35 cm (C) 25 cm (D) 15 cm

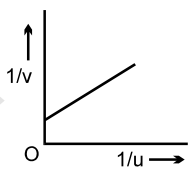
413.* Position of the image when the object is at a distance 30 cm from the pole is -
(A) 150 cm from the pole in front of the reflecting surface
(B) 120 cm from the pole behind the mirror
(C) 150 cm from the pole behind the mirror
(D) 120 cm from the pole in front of the reflecting surface

414.* An object is placed at a distance u cm from a concave mirror of focal length f cm. The real image of the object is received on a screen placed at a distance of v cm from the mirror. The values of u are changed and the corresponding values of v are measured. Which one of the graphs shown in the figure represents the variation of $\frac{1}{v}$ with $\frac{1}{u}$?

(A) 

(B) 

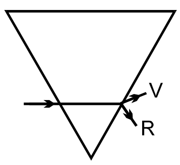
(C) 

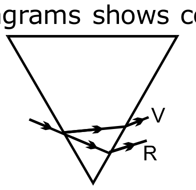
(D) 

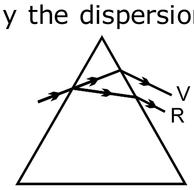
415. A man standing in a swimming pool looks at a stone lying at the bottom. The depth of the swimming pool is h. At what distance from the surface of water is the image of the stone formed -
(A) h/μ (B) $h\mu$ (C) μ/h (D) h

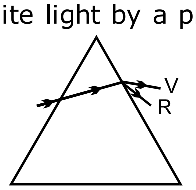
416. A ray of light enters a rectangular glass slab of refractive index $\sqrt{3}$ at angle of incidence 60º. It travels a distance of 5 cm inside the slab and emerges out of the slab. The perpendicular distance between the incident and the emergent rays is
(A) $5\sqrt{3}$ cm (B) $\frac{5}{2}$ cm (C) $5\sqrt{\frac{3}{2}}$ cm (D) 5 cm

417. Which of the following diagrams shows correctly the dispersion of white light by a prism ?

(A) 

(B) 

(C) 

(D) 

418. An equilateral prism is placed on the prism table of a spectrometer in the position of minimum deviation. If the angle of incidence is 60º, the angle of deviation of the ray is :
(A) 90º (B) 60º (C) 45º (D) 30º

419. The refractive index of the material of the prism for a monochromatic beam of light is $\sqrt{2}$ and its refracting angle is 60º . The angle of incidence corresponding to which this beam of light suffers minimum deviation is :
(A) 30º (B) 45º (C) 60º (D) 75º

420. A lense behaves as a converging lens is air and diverging lens in water. The refractive index of the lens material is -
(A) equal to 1.33 (B) equal to unity
(C) greater than 1.33 (D) between unity and 1.33

421. A convergent lens is placed inside a cell filled with a liquid. The lens has a focal length +20 cm when in air and its material has a refractive index 1.50. If the liquid has a refractive index 1.60, the focal length of the system -
(A) –160 cm (B) –24 cm (C) –80 cm (D) + 80 cm

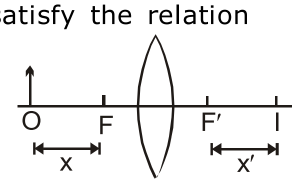
422. The radius of curvature of a thin plane-convex lens is 10 cm (of curved surface) and the refractive index is 15. If the plane surface is silvered, then the focal length will be -
(A) 15 cm (B) 20 cm (C) 5 cm (D) 10 cm

423. An object is placed at a distance of 15 cm from a convex lens of focal length 10 cm. On the other side of the lens, a convex mirror is placed at its focus such that the image formed by the combination coincides with the object itself. The focal length of the convex mirror is
(A) 20 cm (B) 10 cm (C) 15 cm (D) 30 cm

424. A thin equiconvex lens has focal length 10 cm and refractive index 1.5 . One of its faces is now silvered and for an object placed at a distance u in front of it, the image coincides with the object. The value of u is
(A) 10 cm (B) 5 cm (C) 20 cm (D) 15 cm

425.* A convex lens of focal length f produces a virtual image n times the size of the ojbect, then the distance of the object from the lens, is
(A) (n– 1) f (B) (n + 1) f (C) $\left(\frac{n-1}{n}\right)f$ (D) $\left(\frac{n+1}{n}\right)f$

426.* An object is placed at a point distant x from the focus of a convex lens and its imge is formed at I as shown in the figure. The distance x, x′ satisfy the relation



(A) $\frac{x+x'}{2} = f$ (B) f = x x
(C) x + x′ ≤ 2f (D) x + x′ ≥ 2f

427.* A convex lens froms a real image of a point object placed on its principal axis. If the upper half of the lens is painted black, the image will :
(A) be shifted downwards (B) be shifted upwards
(C) not be shifted (D) shift on the principal axis

428.* Phase difference between two waves having same frequency (ν) and same amplitude (A) is $2\pi/3$. If these waves superimpose each other, then resultant amplitude will be–
(A) 2A (B) 0 (C) A (D) A^2

429.* Ratio of amplitudes of the waves coming from two slits having widths in the ratio 4 : 1 will be–
(A) 1 : 2 (B) 2 : 1 (C) 1 : 4 (D) 4 : 1

430. Two coherent waves are represented by $y_1 = a_1$ cost ωt and $y_2 = a_2 \cos\left(\frac{\pi}{2}-\omega t\right)$.Their resultant intensity after interference will be –
(A) $a_1 - a_2$ (B) $a_1 + a_2$ (C) $a_1^2 - a_2^2$ (D) $a_1^2 + a_2^2$

431. In young's double slit experiment, if wavelength of light changes from λ_1 to λ_2 and distance of seventh maxima changes from d_1 to d_2. Then

(A) $\frac{d_1}{d_2} = \frac{\lambda_1}{\lambda_2}$ (B) $\frac{d_1}{d_2} = \frac{\lambda_2}{\lambda_1}$ (C) $\frac{d_1}{d_2} = \frac{\lambda_1^2}{\lambda_2^2}$ (D) $\frac{d_1}{d_2} = \left(\frac{\lambda_2}{\lambda_1}\right)^2$

432. If the frequency of the source is doubled in Young's double slit experiment, then fringe width (β) will be –

(A) unchanged (B) $\beta/2$ (C) 2β (D) 3β

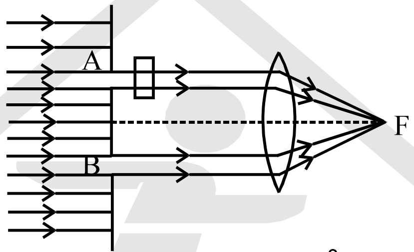
433.* If two waves of same frequency and same amplitude superimpose and produce third wave of same amplitude, then waves differ in phase by –

(A) $\pi/3$ (B) $2\pi/3$ (C) $\pi/2$ (D) π

434. In Young's double slit experiment, fringe width is found to be 0.4 mm. If the whole apparatus is immersed in water of refractive index 4/3 without disturbing the geometrical arrangement, new fringe width will be –

(A) 0.30 mm (B) 0.40 mm (C) 0.50 mm (D) 0.45 mm

435. In the modified Young's double-slit experiment, a monochromatic, uniform and parallel beam of light of wavelength 6000 Å and intensity $\left(\frac{10}{\pi}\right)$ W/m^2 is incident normally on two circular apertures A and B of radii 0.01 m and 0.002 m respectively.



A perfect transparent film of thickness 2000 Å and refractive index 1.5 for the wavelength of 6000 Å is placed in front of aperture A. The lens is symmetrically placed with respect to the apertures. Assume that 10% of the power received by each aperture goes in the original direction and is brought to the focal spot.

Path difference introduced when a film is placed in front of aperture A, is given by -

(A) 600 Å (B) 800 Å (C) 1000 Å (D) 1200 Å

436. Powers received at focal spot F from A and B are -

(A) 10^{-6} watt and 4×10^{-6} watt
(B) 10^{-7} watt and 4×10^{-7} watt
(C) 10^{-5} watt and 4×10^{-5} watt
(D) 10^{-4} watt and 4×10^{-4} watt

437. In Young's experiment, if a slab of mica of refractive index μ and thickness of t is introduced in the path of light from one of the slits, then number of fringes formed on the screen will –

(A) Decrease
(B) Increases
(C) Remain unchanged
(D) Move to one side

438. Distance between the sources is one meter. An observer observes minimum intensity at some point outside the line joining the sources, then the wavelength of the wave should be –

(A) 1 m (B) 2m (C) 0.5 m (D) 0.25 m

439. If two coherent light waves produce minima of fifth order, the path difference between the waves is-

(A) 5λ (B) $5\lambda/2$ (C) $7\lambda/2$ (D) $9\lambda/2$

440. Laser beam is considered to be coherent because it consists of –

(A) Many wavelengths (B) Uncoordinated wavelength

(C) Coordinated waves of exactly the same wavelength

(D) Divergent beam

441. Light of wavelength λ is incident on a slit of width d and distance between screen and slit is D. Then width of maxima and width of slit will be equal if D is ––

(A) $\frac{d^2}{\lambda}$ (B) $\frac{2d}{\lambda}$ (C) $\frac{2d^2}{\lambda}$ (D) $\frac{d^2}{2\lambda}$

442. Fraunhoffer diffraction pattern of a single slit is obtained in the focal plane of lens of focal length 1m. If third maximum is formed at a distance of 5mm from the central maximum and wavelength of light used is 5000Å, then width of the slit will be –

(A) 0.02 cm (B) 0.03 cm (C) 0.04 cm (D) 1 cm

Statement type questions (443 to 447)

Each of the questions given below consist of Statement – I and Statement – II. Use the following Key to choose the appropriate answer.

(A) If both Statement- I and Statement- II are true, and Statement - II is the correct explanation of Statement– I.

(B) If both Statement - I and Statement - II are true but Statement - II is not the correct explanation of Statement – I.

(C) If Statement - I is true but Statement - II is false.

(D) If Statement - I is false but Statement - II is true.

443. **Statement-1** : A ray incident along normal to the mirror retraces its path.

Statement-2 : In reflection, angle of incidence is always equal to angle of reflection

(A) a (B) b (C) c (D) d

444. **Statement I :** A concave mirror is preferred to a plane mirror for shaving.

Statement II: When a man keeps his face between pole and focus of a mirror an erect and magnified virtual image is formed.

(A) a (B) b (C) c (D) d

445. **Statement I :** Magnification of a convex mirror is always positive .

Statement II: $m = \frac{-v}{u}$ and convex mirror always forms virtual image.

(A) a (B) b (C) c (D) d

446. **Statement I :** Light reflected from any surface obeys the law of reflection.

Statement II: Distance measured in the direction of light are taken as positive.

(A) a (B) b (C) c (D) d

447. **Statement I :** Convex mirror is used as a rear view mirror.

Statement II: Convex mirror always forms virtual, erect and diminished image for all positions of the object.

(A) a (B) b (C) c (D) d

5 Modern Physics

EXERCISE

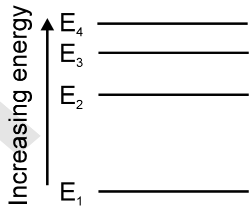
448.* The electron in a hydrogen atom makes a transition from an excited state to the ground state. Which of the following statements is true -
(A) Its kinetic energy increases and its potential and total energies decrease.
(B) Its kinetic energy decreases, potential energy increases and its total energy remains the same.
(C) Its kinetic and total energies decrease and its potential energy increases
(D) Its kinetic, potential and total energies decrease

449. If the radius of first orbit of hydrogen atom is 0.5Å and the velocity of electron in this orbit is 2×10^6 m/s, then the electric current due to electron motion will be nearly
(A) 1 mA (B) 1 μA (C) 1 A (D) None of these

450.* The ionization potential of H-atom is 13.6 V. The H-atoms in ground state are excited by mono chromatic radiations of photon energy 12.09 ev. Then the number of spectral lines emitted by the excited atoms, will be
(A) 1 (B) 2 (C) 3 (D) 4

451.* Consider the spectral line resulting from the transition $n = 2 \rightarrow n = 1$ in the atoms and ions given below, the shortest wavelength is produced by
(A) hydrogen atom (B) deuterium atom
(C) singly ionized helium (D) doubly ionized lithium

452.* Figure represents in simplified form some of the energy levels of the hydrogen atom. The energy axis has a linear scaleIf the transition of an electron from E_4 to E_2 were associated with the emission of blue light, which transition could be associated with the absorption of red light ?



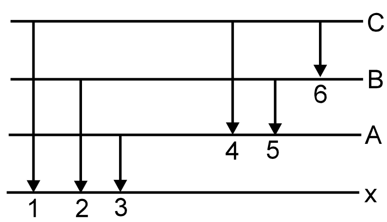
(A) E_4 to E_1 (B) E_3 to E_2 (C) E_2 to E_3 (D) E_1 to E_4

453. If the wavelength of photon emitted due to transition of electron from third orbit to first orbit in a hydrogen atom is λ, then the wavelength of photon emitted due to of electron from fourth orbit to second orbit will be -
(A) $\frac{128}{27}\lambda$ (B) $\frac{25}{9}\lambda$ (C) $\frac{36}{7}\lambda$ (D) None of these

454.* Electrons accelerated from rest by a potential difference of 12.75V, are bombarded on a mono-atomic hydrogen gas. Possible emission of spectral lines are -
(A) first three Lyman lines, first two Balmer lines and first Paschen line
(B) first three Lyman lines only
(C) First two Balmer lines only (D) none of the above

455. Three photons coming from excited atomic-hydrogen sample are picked up. Their energies are12.1 eV, 10.2 eV and 1.9 eV. These photons must come from
(A) a single atom (B) two atoms
(C) three atoms (D) either two atoms or three atoms

456. The figure indicates the energy level diagram of an atom and the origin of six spectral lines in emission (e.g. line no.5 arises from the transition from level B to A). Which of the following spectral lines will also occur in the absorption spectrum?



(A) 4, 5, 6 (B) 1, 2, 3, 4, 5, 6
(C) 1, 4, 6 (D) 1, 2, 3

457. When a potential drop of V volt is applied on a stationary neutron. then de broglie wavelength-

(A) 0 (B) ∞ (C) $\frac{12.27}{\sqrt{V}}$ A^0 (D) $\frac{0.101}{\sqrt{V}}$ A^0

458.* When an electron moving with constant speed enters in a magnetic field at 60° then its de-broglie wave length.

(A) Increase (B) Decreases (C) Remains constant (D) None

459.* The De Broglie wave present in the fifth Bohr orbit is -

(A)  (B) 

(C)  (D) 

460. A nucleus at rest undergoes a decay emitting an α-particle of de-broglie wavelength $\lambda = 5.76 \times 10^{-15}$m. The mass of daughter nucleus is 223.40 amu and that of α-particle is 4.002 amu - The linear momentum of α-particle and that of daughter nucleous is -

(A) 1.15×10^{-19}N × s & 2.25×10^{-19} N × s

(B) 2.25×10^{-19}N × s & 1.15×10^{-19} N × s

(C) both 1.15×10^{-19} N × s

(D) both 2.25×10^{-19} N × s

461. In previous question KE of daughter nucleous is -

(A) 3.16 Mev (B) 4.16 Mev (C) 5.16 Mev (D) 6.16 Mev

462.* An electron is confined to a tube of length L. The electron's potential energy in one half of the tube is zero, while the potential energy in the other half is 10eV. If the electron has a total energy E = 15 eV, then the ratio of the deBroglie wavelength of the electron in the 10eV region of the tube to that in the other half is -

(A) $1/\sqrt{3}$ (B) $\sqrt{3}$ (C) 3 (D) $\frac{1}{3}$

463.* An electron moving with a velocity of 10^6 m/s in the X-direction enters a region of uniform magnetic field of strength 0.2T in Y-direction. Then its de-Broblie wavelength (in the magnetic field region in comparison to outside)-

(A) increases (B) decreases

(C) remains the same (D) nothing can be predicted.

464. If the thermal energy of a monoatomic gas molecules of mass m at temperature T kelvin is of the order of f /2 kT, then the deBroglie wavelength of the matter waves is of the order of

(A) h/kT (B) h/2mkT (C) $h/\sqrt{fmkT}$ (D) $\sqrt{h}$ /2mkT

465.* The collector plate in an experiment of photoelectric effect is kept vertical above the emitter plate. Light source is put on, and a saturation photocurrent is recorded. An electric field is switched on which has a vertically downward direction-

(A) Photocurrent will increase. (B) Kinetic energy of electrons will increase

(C) Stopping potential will decrease (D) threshold wavelength increase.

466. A surface does not eject electrons when illuminated with blue light. Then photo electrons will be ejected when the surface is illuminated by-

(A) Red (B) Infrared (C) Yellow (D) None.

467. If work function of a metal is 2 eV and light of 1 eV is incident on that surface while 1 eV energy is given by heat to that surface electron will-

(A) Come out (B) Not come out (C) Depends on intensity (D) None of these

468. A cesium photocell with a steady potential difference of 60 V across it, is illuminated by a small bright light placed 1 m away. When the same light is placed 2 m away, the electrons crossing the photocell-

(A) Each carry one quarter of their previous momentum

(B) Each carry one quarter of their previous energy

(C) Are one quarter as numerous

(D) Are half as numerous

469. Light corresponding to the transition n = 4 to n = 2 in hydrogen atoms falls on cesium metal having work function 1.9 eV. The maximum kinetic energy of the photoelectrons emitted will be-

(A) 2.55 eV (B) 1.9 eV (C) 1.65 eV (D) 0.65 eV.

470. When light of sufficiently high frequency is incident on metallic surface, electrons are emitted. Kinetic energy of emitted photoelectron depends on the wavelength of incident light and is independent of the intensity of light. Number of emitted photoelectrons depends on intensity. $(h\nu - \phi)$ is the maximum kinetic energy of emitted photoelectrons (where ϕ is work function of metallic surface). Reverse effect of photo emission produces X-ray, X ray is not deflected by electric and magnetic field. Wavelength of continuous X ray depends on potential difference across the tube. Wavelength of characteristic X ray depends on atomic number.
If frequency $(\nu > \nu_0)$ of incident light becomes n times the initial frequency (ν) then K.E. of emitted photoelectrons becomes (ν_0 threshold frequency) -
(A) n times to the initial kinetic energy
(B) more than n times to the initial K.E.
(C) less than n times to initial K.E.
(D) K.E. of emitted photoelectrons remain unchanged

471. A monochromatic light is used in an photoelectric experiment on photoelectric effect. The stopping potential -
(A) is related to mean wavelength
(B) is not related to shortest wavelength
(C) is related to the maximum K.E. of emitted photoelectron
(D) intensity of incident light

472. A freshly cleaned zinc plate is connected to the top of a positively charged gold leaf electroscope. If the plate is now illuminated with ultraviolet radiation, then
(A)the separation between gold leaves increase
(B)the separation between gold leaves decreases
(C) nothing happens
(D) sparking between leaves occur

473. The frequency and intensity of a light source are both doubled. consider the following statements
(i) The saturation photocurrent remains almost the same
(ii)The maximum kinetic energy of the photoelectrons is doubled
(A) both (i) and (ii) are true (B) (i) is true but (ii) is false
(C) (i) is false but (ii) is true (D) Both (i) and (ii) are false

474. When stopping potential is applied in an experiment on photoelectric effect, no photocurrent is observed. This means that
(A) the emission of photoelectrons is stopped
(B) the photoelectrons are emitted but are reabsorbed by the emitter metal
(C) the photoelectrons are accumulated near the collector plate
(D) the photoelectrons are dispersed from the sides of the apparatus

475. When the intensity of a light source is increased
(a) the number of photons emitted by the source in unit time increases
(b) the total energy of the photons emitted per unit time increases
(c) more energetic photons are emitted
(d) faster photons are emitted
(A) a,b (B) a,c (C) a,d (D) b,d

476. A photon of energy $h\nu$ is absorbed by a free electron of a metal having work function $\phi < h\nu$
(A) The electron is sure to come out
(B) The electron is sure to come out with a kinetic energy $h\nu - \phi$
(C) Either the electron does not come out or it comes out with a kinetic energy $h\nu - \phi$
(D) It may come out with a kinetic energy less than $h\nu - \phi$

477. In a photoelectron experiment , the stopping potential for the photoelectrons is 2V for the incident light of wavlength 400 nm. If the incident light is changed to 300 nm , the cut off potential is

(A) 2V
(B) greater than $\frac{8}{3}$V
(C) $\frac{8}{3}$V
(D) zero

478. If 5% of the energy supplied to a bulb is radiated as visible light, how many quanta are emitted per sec by a 100 watt lamp? Assume wavelenght of visible light as 5.6×10^{-5} cm
(A) 1.4×10^{19}
(B) 2.0×10^{-4}
(C) 1.4×10^{-19}
(D) 2.0×10^{4}

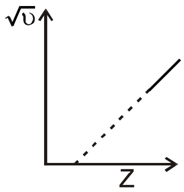
479. The work function of Na metal is 2.3 eV, then the threshold wavelength lies in the following region of EM spectrum -
(A) Ultraviolet (B) X-ray (C) Violet (D) Yellow

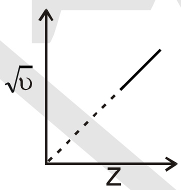
480. The patient is asked to drink $BaSO_4$ for examining the stomach by X-rays because X-rays are-
(A) Reflected by heavy atoms
(B) Refracted by heavy atoms
(C) Less absorbed by heavy atoms
(D) More absorbed by heavy atoms

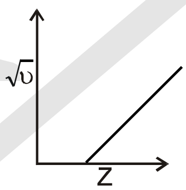
481. If I_0 and I_a denote intensities of incident and absorbed X-rays, then-
(A) $I_a = I_0 e^{-\mu d}$
(B) $I_a = I_0(1 - e^{-\mu d})$
(C) $I_a = I_0(1 - e^{\mu d})$
(D) $I_a = I_0 e^{\mu d}$

482. Generation of X-rays is a-
(A) Phenomenon of conversion of KE into radiant energy
(B) Principle of conservation of momentum
(C) Phenomenon of conversion of mass into energy
(D) Principle of conservation of electric charge

483. Which one curve is correct-

(A) 

(B) 

(C) 

(D) None of these.

484. In an X-ray tube if the electrons are accelerated through 140KV then anode current obtained is 30mA. If the whole energy of electrons is converted into heat then the rate of production of heat at anode will be
(A) 968 calorie (B) 892 calorie (C) 1000 calorie (D) 286 calorie

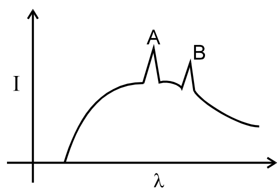
485. If the frequency of K_α, K_β and L_α , X-ray lines of a substance are ν_{K_α} , ν_{K_β} and ν_{L_β}

(A) $\nu_{K_\alpha} + \nu_{K_\beta} = \nu_{L_\alpha}$ (B) $\nu_{K_\alpha} - \nu_{K_\beta} = \nu_{L_\alpha}$ (C) $\nu_{K_\alpha} + \nu_{L_\alpha} = \nu_{K_\beta}$ (D) none of these

486. If λ_{K_α}, λ_{K_β} and λ_{L_α} are the wavelengths of K_α, K_β and L_α, lines respectively , then

(A) $\lambda_{K_\beta} = \frac{\lambda_{K_\alpha}\lambda_{L_\alpha}}{\lambda_{K_\alpha} + \lambda_{L_\alpha}}$ (B) $\lambda_{L_\alpha} = \frac{\lambda_{K_\alpha}\lambda_{K_\beta}}{\lambda_{K_\alpha} + \lambda_{K_\beta}}$ (C) $\lambda_{L_\alpha} = \frac{\lambda_{K_\alpha}\lambda_{K_\beta}}{\lambda_{K_\beta} + \lambda_{K_\alpha}}$ (D) none of these

487.* Following diagram shows relation between emitted X-rays intensity and wavelength obtained X-ray tube its sharp peaks A and B shows



(A) band spectrum
(B) continuous spectrum
(C) characteristics radiations
(D) white radiations

488.* If λ_α , λ_β and λ_γ are respectively the wavelength of k_α, k_β and k_γ lines of tungsten then

(A) $\lambda_\alpha = \lambda_\beta = \lambda_\gamma$ (B) $\lambda_\alpha > \lambda_\beta > \lambda_\gamma$
(C) $\lambda_\alpha < \lambda_\beta < \lambda_\gamma$ (D) $\lambda_\beta > \lambda_\alpha > \lambda_\gamma$

489. 50% of X-rays obtained from a Coolidge tube pass through 0.3 mm thick aluminium foil. If the potential difference between the target and the cathode is increased, then the fraction of X-rays passing through the same foil will be

(A) 50% (B) >50% (C) < 50% (D) 0%

490. The ionisation energies of K-shell for cobalt, copper, and molebdenum are 7.8, 9.0 and 20.1 KeV respectively. If any metal out of these is used as target in an X-ray tube operated at 15KV, then

(a) the K-series of characteristic X-rays will be emitted only by cobalt
(b) the K-series of characteristic X-rays will be emitted only by cobalt & Cu
(c) the K-series of characteristic X-rays will be emitted only by cobalt, Cu , Co and Mo
(d) the minimum wavelength of continuous X-rays emitted by the three metals will be same

(A) a,c (B) b,d (C) a,d (D) none

491.* Electrons with energy 80 keV are incident on the tungsten target of an X-ray tube. K shell electrons of tungsten have –72.5 keV energy. X-rays emitted by the tube contains only

(A) a continuous X-ray spectrum with a minimum wavelength of 0.155 Å
(B) a continuous X-ray spectrum with all wavelengths
(C) a characteristic X-ray spectrum of tungsten
(D) a continuous X-ray spectrum with a minimum wavelength of 0.155 Å and a characteristic X-ray spectrum of tungsten

492. Energies required to knock the electrons out of the various shells of Ni atom are

K - shell 1.36×10^{-15} J
L - shell 0.16×10^{-15} J
M - Shell 0.08×10^{-15} J

The minimum accelerating potential for emission of K-radiation from an X-ray tube with Ni as target will be

(A) 8.5 KV (B) 7.5 KV (C) 6.5 KV (D) 5.5 KV

493. The atom of a heavy fissionable element hit by a neutron of sufficient energy breaks into two or more lighter elements with the release of two or additional neutrons because-

(A) Neutron is an uncharged particle
(B) Momentum of neutron is very large
(C) It is easier for protons than neutrons to be in the nucleus
(D) Neutron-proton ratio increases as mass number of the element increases

494. The binding energies of the atoms of elements A and B are E_a and E_b respectively. three atoms of the elements B fuse to give one atom of element A. This fusion process is accompanied by release of energy e. Then E_a , E_b and e are related to each other as-

(A) $E_a + e = 3E_b$ (B) $E_a = 3E_b$ (C) $E_a - e = 3E_b$ (D) $E_a + 3E_b + e = 0$

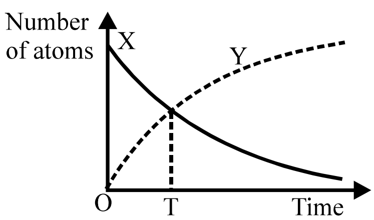
495. A radioactive isotope has a decay constant λ and a molar mass M. Taking the Avogadro constant to be L, what is the activity of a sample of mass m of this isotope ?

(A) λmML (B) $\frac{\lambda mL}{M}$ (C) $\frac{\lambda ML}{m}$ (D) $\frac{mL}{\lambda M}$

496. The passage of γ-rays photons through materials sometimes results in pair production, i.e., the transformation of a γ-rays photon into a positron and an electron (eachof mass m). What is the maximum wavelength of $\gamma-\text{ray}$ photons for which pair production is possible?
(c = speed of light, h = plank constant)

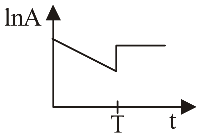
(A) $\frac{1}{2mch}$ (B) $\frac{1}{2mc^2h}$ (C) $\frac{h}{2mc}$ (D) $\frac{h}{2mc^2}$

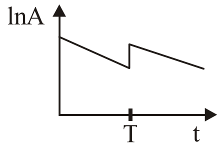
497. The graph represents the decay of a newly-prepared sample of radioactive nuclide X to a stable nuclide Y. The half-life of X is t. The growth curve for Y intersects the decay curve for X after time T. What is the time T ?

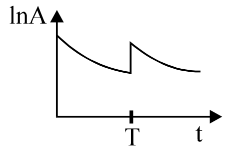


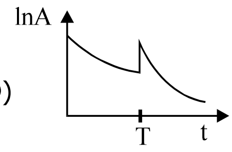
(A) t/2 (B) $\ell n(t/2)$
(C) t (D) $\ell n(2t)$

498. At time t = 0, some radioactive gas is injected into a sealed vessel. At time T, some more of the same gas is injected into the same vessel. Which one of the following graphs best represents the variation of the logarithm of the activity A of the gas with time t ?

(A) 

(B) 

(C) 

(D) 

499. The equations $\frac{dN}{dt} = -\lambda N$ and $N = N_0 e^{-\lambda t}$

describes how the number N of undecayed atoms in a sample of radioactive material, which initially (at t = 0) contained N_0 undecayed atoms, varies with time t. Which one of the following statements about λ is correct ? (A) $\lambda\delta t$ gives the fraction of atoms present which will decay in the next small time interval δt

(B) λ is the time needed for N to fall from N_0 to the value N_0/e.

(C) λ is the number of atoms left after a time equal to e second.

(D) λ is the chance that any one atom will still be undecayed after one second.

500. If the half lives of a radioactive element for α and β decay are 4 year and 12 years respectively, then the percentage of the element that remains after 12 year will be
(A) 6.25% (B) 5.25% (C) 4.25% (D) 3.50%

501. The radioactive carbon gets produced by the process of :
(A) reaction of radium rays on simple carbon
(B) reaction of cosmic rays on simple carbon
(C)reaction of high energy neutrons on nitrogen
(D) reaction of cosmic rays on oxygen.

502. A nucleus $_ZX^A$ emits 2 α - particles and 3 β-particles. The ratio of total protons and neutrons in the final nucleus is :

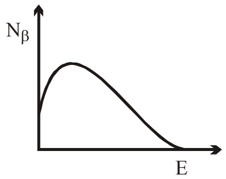
(A) $\frac{Z-7}{A-Z+7}$ (B) $\frac{Z-1}{A-Z-8}$ (C) $\frac{Z-1}{A-Z-7}$ (D) $\frac{Z-3}{A-Z+3}$

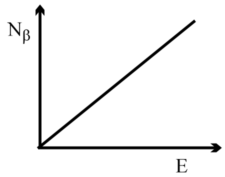
503. The decay constants of a radioactive substance for a and b emission are λ_a and λ_b respectively. If the substance emits α and β simultaneously, the average half life of the material will be -

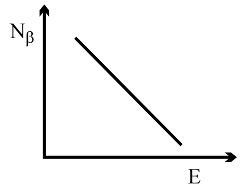
(A) $\lambda_\alpha - \lambda_\beta$ (B) $\lambda_\alpha + \lambda_\beta$

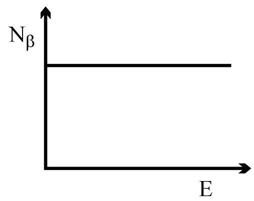
(C) $\frac{\lambda_\alpha \lambda_\beta}{\lambda_\alpha + \lambda_\beta}$ (D) None of these

504. The curve representing the energy spectrum of β-particles is

(A) 

(B) 

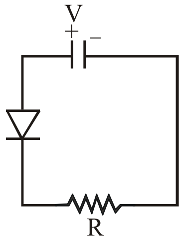
(C) 

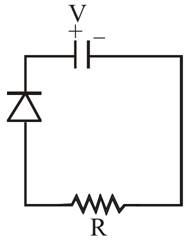
(D) 

505. The particles emitted in the nuclear reaction are respectively -
$_ZX^A \rightarrow {}_{Z+1}Y^A \rightarrow {}_{Z-1}R^{A-4} \rightarrow {}_{Z-1}R^{A-4}$
(A) β, γ, α (B) α, β, γ (C) β, α, γ (D) γ, α, β

SEMICONDUCTOR

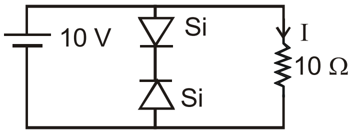
506. Two identical capacitors A and B are charged to the same potential V and are connected in two circuits at t = 0 as shown in figure. The charge of the capacitors at a time t = CR are respectively-





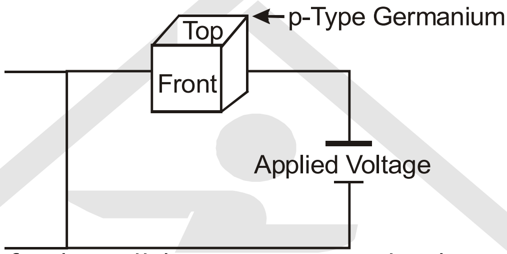
(A) VC, VC (B) VC/e, VC (C) VC, VC/e (D) VC/e, VC/e

507. Determine current I in the configuration-



(A) 1 amp (B) 0 amp (C) less than 1 amp (D) None

508. A cube of germanium is placed between the poles of a magnet and a voltage is applied across opposite faces of the cube as shown in Figure. Magnetic field is directed vertical downward in the plane of the paper :
What effect will occur at the surface of the cube ?



(A) The top surface of cube will become negatively charged
(B) The front surface of the cube will become positively charged
(C) The front surface of the cube will become negatively charged
(D) Both top and front surface of cube will become positively charged

509. In a p-n junction–
(A) new holes and conduction electrons are produced continuously throughout the material
(B)new holes and conduction electrons are produced continuously throughout the material except in the depletion region
(C)holes and conduction electrons recombine continuously throughout the material
(D) holes and conduction electrons recombine continuously throughout the material except in the depletion region

510. The diffusion current in a p-n junction is from
(A) p-side to n-side (B) n-side to p-side
(C) p-side to n-side if the junction is forward biased and in the opposite direction if it is reverse biased
(D) n-side to p-side if the junction is forward biased and in the opposite direction if it is reverse based

511. The mean free path of a conduction electron in a metal is 5×10^{-8} m. The electric field, required to be applied across the conductor so as to impart 1eV energy to the conduction electron , will be
(A) 1×10^{-7} V/m (B) 2×10^{7} V/m (C) 3×10^{7} V/m (D) 4×10^{7} V/m

512. Which of the following statements is correct ?
(A) when forward bias is applied on a p-n junction then current does not flow in the circuit
(B) rectification of alternating current can not be achieved by p-n junction
(C) when reverse bias is applied on a p-n junction then it acts as a conductor
(D) some potential gap developed across the p-n junction when it is formed

COMMUNICATION

513. The distance between consecutive maxima and minima is given by -
(A) $\lambda / 2$ (B) 2λ (C) λ (D) $\lambda / 4$

514. The frequencies of electromagnetic waves employed in space communication vary over a range of -
(A) 10^4 Hz to 10^7 Hz (B) 10^4 Hz to 10^{11} Hz
(C) 1 Hz to 10^4 Hz (D) 1 Hz to 10^{11} Hz

515. The maximum range of ground or surface wave propagation depends on -
(A) the frequency of the radiowaves only
(B) power of the transmitter only
(C) both of them
(D) none of them

Statement Type Questions (516 to 520)
(A) If both Statement- I and Statement- II are true, and Statement - II is the correct explanation of Statement– I.
(B) If both Statement - I and Statement - II are true but Statement - II is not the correct explanation of Statement – I.
(C) If Statement - I is true but Statement - II is false.
(D) If Statement - I is false but Statement - II is true.

516. **Statement I :** Penetration power of hard X-ray is more than that of soft X-ray.
Statement II : Hard X-ray is used for engineering purpose while soft X-ray is used for medical purpose.
(A) a (B) b (C) c (D) d

517. **Statement I :** Wavelength of continuous X-ray varies from a minimum value to infinity.
Statement II : Continuous X-rays are emitted due to transition of electron from higher to lower energy level.
(A) a (B) b (C) c (D) d

518. **Statement I :** Photo-electric effect demonstrates particle nature of light.
Statement II : Number of photons is proportional to frequency of photons.
(A) a (B) b (C) c (D) d

519. **Statement I :** K.E. of all photo-electrons are same, when monochromatic light is incident on a metal.
Statement II : $K_{max} = h\nu - \phi$, where all symbols have their usual meaning.
(A) a (B) b (C) c (D) d

520. **Statement I :** Threshold frequency supports wave nature of light.
Statement II : Photo electrons are not emitted when incident light has frequency lesser than threshold frequency.
(A) a (B) b (C) c (D) d

ANSWER KEY

1. A	2. C	3. A	4. D	5. B	6. B
7. B	8. A	9. A	10. B	11. D	12. C
13. B	14. B	15. C	16. D	17. A	18. C
19. D	20. A	21.D	22.B	23. C	24. A
25. A	26. D	27. A	28. A	29. A	30. A
31. A	32. A	33. C	34. B	35. B	36. A
37. A	38. A	39. A	40. A	41. A	42. B
43. D	44. C	45. B	46. D	47. D	48. B
49. B	50. B	51. C	52. C	53. C	54. C
55. B	56. B	57. B	58. D	59. B	60. B
61. B	62. B	63. A	64. C	65. A	66. D
67. C	68. B	69. A	70. D	71. C	72. C
73. D	74. C	75. B	76. B	77. B	78. D
79. B	80. B	81. C	82. A	83. B	84. D
85. D	86. D	87. B	88. A	89. A	90. A
91. C	92. D	93. C	94. C	95. C	96. D
97. B	98. A	99. A	100. A	101. A	102. A
103. A	104. C	105. D	106. A	107. C	108. B
109. C	110. B	111. D	112. C	113. B	114. C
115. B	116. B	117. D	118. A	119. A	120. A
121. B	122. B	123. D	124. A	125. A	126. A
127. B	128. D	129. A	130. B	131. C	132. D
133. A	134. D	135. C	136. A	137. C	138. A
139. A	140. B	141. A	142. B	143. A	144. B
145. A	146. D	147. A	148. C	149. D	150. A
151. D	152. A	153. C	154. C	155. A	156. A
157. A	158. A	159. B	160. C	161. C	162. A
163. C	164. C	165. A	166. D	167. D	168. A
169. A	170. C	171. B	172. A	173. A	174. A
175. D	176. B	177. A	178. A	179. B	180. C
181. A	182. B	183. B	184. C	185. D	186. B
187. C	188. B	189. C	190. A	191. D	192. C
193. D	194. D	195. A	196. C	197. A	198. A
199. B	200. D	201. A	202. B	203. D	204. B
205. C	206. B	207. A	208. D	209. D	210. B
211. B	212. D	213. A	214. C	215. A	216. B
217. A	218. B	219. A	220. D	221. B	222. B
223. C	224. D	225. A	226. C	227. C	228. A
229. D	230. B	231. C	232. B	233. A	234. D
235. D	236. D	237. C	238. C	239. C	240. C
241. B	242. B	243. D	244. D	245. B	246. D
247. A	248. B	249. C	250. B	251. D	252. C

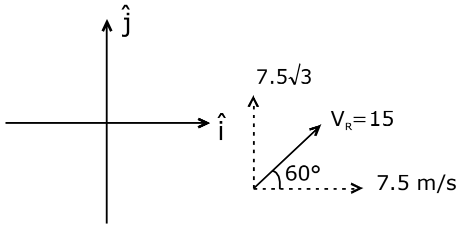
ANSWER KEY

253. D	254. D	255. A	256. C	257. D	258. B
259. C	260. B	261. D	262. B	263. C	264. A
265. A	266. B	267. A	268. A	269. C	270. B
271. C	272. C	273. B	274. C	275. A	276. C
277. B	278. D	279. C	280. C	281. A	282. C
283. D	284. A	285. D	286. A	287. B	288. C
289. A	290. D	291. A	292. C	293. D	294. B
295. C	296. B	297. C	298. A	299. B	300. C
301. B	302. A	303. C	304. A	305. B	306. C
307. A	308. D	309. B	310. C	311. A	312. C
313. C	314. A	315. B	316. C	317. A	318. B
319. B	320. B	321. C	322. C	323. C	324.A
325. A	326. B	327. D	328. C	329. A	330.C
331. A	332. C	333. C	334. B	335. C	336. A
337. C	338. A	339. D	340. D	341. A	342. B
343. A	344. A	345. C	346. A	347. A	348. B
349. A	350. A	351. C	352. A	353. C	354. A
355. A	356. B	357.A	358. A	359. D	360. C
361. A	362. A	363. C	364. C	365. A	366. C
367. D	368. D	369. D	370. B	371. C	372. A
373. A	374. C	375. B	376. A	377. D	378. B
379. C	380. A	381. B	382. D	383. B	384. A
385. B	386. A	387. B	388. C	389. A	390. D
391. A	392. B	393. B	394. A	395. A	396. C
397. C	398. A	399. D	400. C	401. A	402. A
403. C	404. B	405. A	406. C	407. B	408. D
409. A	410. C	411. B	412. C	413. A	414. C
415. A	416. B	417. B	418.B	419. A	420. D
421. A	422. D	423. B	424. B	425. C	426. D
427. C	428. C	429. D	430. D	431. A	432. B
433. B	434. A	435. C	436. A	437. D	438. B
439. D	440. C	441. D	442. B	443. A	444. A
445. A	446. B	447. A	448. A	449. A	450. C
451. D	452. C	453. A	454. A	455. D	456. D
457. B	458. C	459. D	460. C	461. D	462. B
463. C	464. C	465. B	466. D	467. B	468. C
469. D	470.B	471. C	472. A	473. B	474. B
475. A	476. D	477. B	478. A	479. A	480. D
481. B	482. A	483. A	484. C	485. C	486. A
487. C	488. B	489. B	490. B	491. D	492. A
493. D	494. C	495. B	496. C	497. C	498. B
499. A	500. A	501. C	502. C	503. C	504. A
505. C	506. B	507. A	508. B	509. A	510. A
511. B	512. D	513. D	514. B	515. C	516. B
517. C	518. C	519. D	520. D		

HINTS & SOLUTIONS

Mechanics

1. **A**



$\vec{V}_c = 20 m/s\,\hat{i} \quad \vec{V}_R = 7.5\hat{i} + 7.5\sqrt{3}\hat{i}$

$\vec{V}_{RC} = 7.5\hat{i} + 7.5\sqrt{3}\hat{i} - 20\hat{i}$

$|\vec{V}_{RC}| = \sqrt{(12.5)^2 + \left(7.5\sqrt{3}\right)^2}$

= 18.027 m/sec

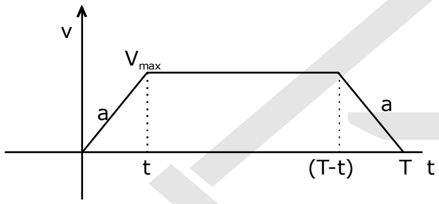
2. **C**

$a_{av} = \dfrac{\vec{v}_f - \vec{v}_i}{\Delta t} = \dfrac{0}{\Delta t} = 0$

w = F.ds = o × ds = 0

$v_{av} = \dfrac{\text{area of (v.t curve)}}{\Delta t}$

3. **A**



$v_{av} = \dfrac{v_{max}t + v_{vax}(T-2t)}{T} = \dfrac{7}{8}v_{max}$

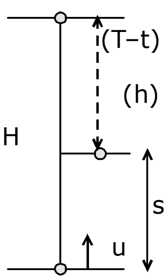
$t + T - 2t = \dfrac{7}{8}T$

Time when particle move with constant velocity = $T-2t = \dfrac{3}{4}T$

4. **D**

$\left(\dfrac{ds}{dt}\right)_{at(A)} = 0$ means velocity is $v_A = 0$

5. **B**



$u = \sqrt{2gh}$

u = gT

at any time t

$s = ut - \dfrac{1}{2}gt^2$

$s = H - \dfrac{1}{2}gT - t$

$s = H - \dfrac{1}{2}g(T-t)^2$

6. **B**

S = $7 \times (1.5) + 7 \times (1.5) + 1/2 \times 10 \times (1.5)^2$

7. **B**

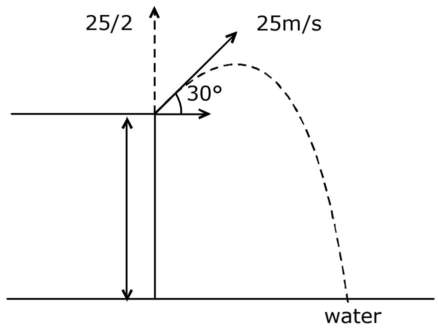
$t = \dfrac{d}{v} = \dfrac{58.8}{14.7} = 4s$

$t = \dfrac{2u}{g}$

$2\mu = 4^2 \times 9.8$

$\mu = 19.6 m/s$

8. **A**



$-H = \dfrac{25}{2} \times 2.5 - \dfrac{1}{2} \times 10 \times 2.5 \times 2.5$

$H = \dfrac{625}{20} + \dfrac{625}{20} = \dfrac{625}{10} = 62.5m$

9. **A**

$h = \dfrac{u^2 \sin^2\theta}{2g}$

$h' = \dfrac{u^2 \sin^2(90-\theta)}{2g}$

$hh' = \dfrac{u^2 \sin^2\theta \cos^2\theta}{2g \times 2g}$

$hh' = \left(\dfrac{u^2 \times \sin\theta\cos\theta}{2 \times 2g}\right)^2 = \left(\dfrac{u^2 \sin 2\theta}{g}\right)^2$

$hh' = \dfrac{R^2}{16} \Rightarrow \ R = \sqrt{16hh'}$

$R = 4\sqrt{hh'}$

10. **B**

$T = \dfrac{u\sin\theta}{g}, \quad T' = \dfrac{u\sin\theta}{\left(\dfrac{11g}{10}\right)} = \dfrac{10T}{11}$

$\Delta T \dfrac{T-T'}{T} = \dfrac{T - \dfrac{10T}{11}}{T} = \dfrac{T}{11} \times 100^{-1} = 9\%$

11. **D**

$y = \frac{1}{2}\alpha t^2$

$x = ut$

$t = \frac{x}{u}$

$y = \frac{1}{2}\alpha\frac{x^2}{u^2}$

$y = \frac{1\alpha}{2-u^2}x^2$

$u = \sqrt{\frac{\alpha}{2B}}$

12. **C**

$\theta_2 = 90 - \theta_1$

$\theta_1 + \theta_2 = 90$

$t_1 = \frac{2u\sin\theta_1}{g}$

$t_2 = \frac{2u\sin\theta_2}{g}$

$\frac{t_1}{t_2} = \frac{\sin\theta_1}{\sin\theta_2}$

13. **B**

$y = \frac{x^2}{2}$ where $x = \frac{t^2}{2}$

$y = \frac{\left(\frac{t^2}{2}\right)^2}{2}, \; y - \frac{t^4}{8}$

$v_y \frac{t^3}{2}$

at t = 2 sec, $v_x = 2\hat{i}$

$v_y = \frac{8}{2}\hat{j} = 4\hat{j}$

$\vec{v} = (2\hat{i} + 4\hat{i})m/s$

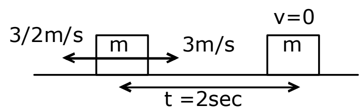
14. **B**

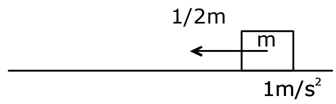
15. **C**

$v = u + at$

$0 = 3 - \frac{3}{2}t$

t = 2 s



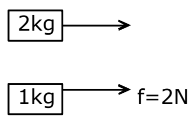


$s = ut - \frac{1}{2}at^2$

$= 3\times 2 - \frac{1}{2}\times\frac{3}{2}\times 4$

= 6–3 = 3m

16. **D**



$a_{max} = 2m/s^2$

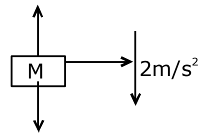
$\rightarrow 2m/sh2$

3kg → T T = 6N

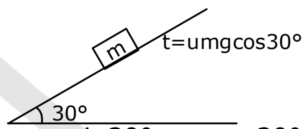
10M–6 = 2m

8 m = 6

M=6/8 = 3/4 kg



17. **A**



a = gsin30° – ugcos30°

$a = \left(\frac{g}{2} - \frac{ug\sqrt{3}}{2}\right)$

$v8 = \frac{1}{2}\times\left(\frac{g}{2} - \frac{ug}{2}\sqrt{3}\right)$

$4 = \frac{g}{2}\left(1 - u\sqrt{3}\right)$

$8 = 1 - u\sqrt{3}$

$u\sqrt{3} = 1 - 0.8 = 0.2$

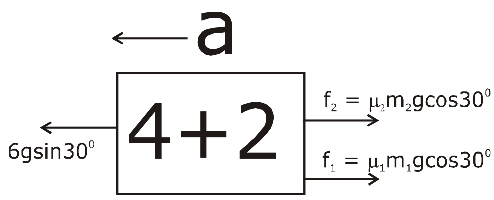
$u = \frac{0.2}{1.73} = 0.11$

18. **C**

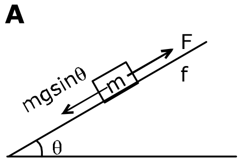
For upward

$f = mg\sin\theta + \mu mg\cos\theta$

19. **D**



20. **A**



$F + f = Mgsing\theta$

$2F = f + Mg\sin\theta \quad ....(1)$

$2F = 2Mg\sin\theta - 2f \quad ...(2)$

(1) - (2)

$\sin\theta = 3\mu g\cos\theta$

$\frac{1}{3}\tan\theta = \mu$

21. **D**

$f = \mu mg = 30N$

$a_B = 1.5\ m/s^2$

$a_T = 2m/s^2$

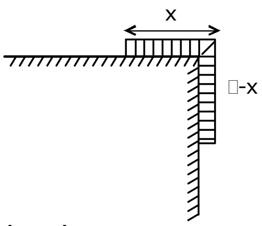
$a_{BT} = -0.5\ m/s^2$

$4 = \frac{1}{2} \times 0.5t^2$

$t = 4\ s$

$s = \frac{1}{2}at^2 = 16m$

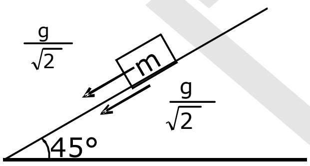
22. **B**



$(\ell - x)\lambda g = \mu x\lambda g$

$x = \frac{\ell}{1+\mu}$

23. **C**

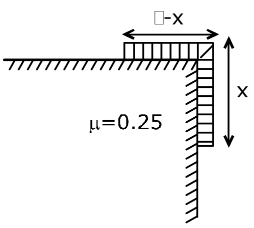


$a = \frac{g}{\sqrt{2}}\left(1 + \frac{1}{2}\right)$

24. **A**

$f_{min} = \mu(m_1 + m_2)g$

25. **A**



$(\ell - x)\lambda g\frac{1}{4} = x\lambda g$

$x = \frac{\ell}{5} \times 100 = 20\%$

26. **D**

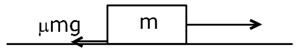
$a = g\sin\theta - \mu g\cos\theta$

$\because mg\sin\theta = \mu\cos\theta$

$\tan\theta = \mu = 3/4 \Rightarrow \theta = 37°$

$4 = \frac{1}{2}10\left(\frac{3}{5} - \frac{1}{2} \times \frac{4}{5}\right)t^2$, $t = 2s$

27. **A**



$a = \frac{F - \mu mg}{m}$

28. **A**

$F = \frac{F\sqrt{3}}{2} = mg\sin 30 + 80$

$F = 206N$

29. **A**

$\frac{mv^2}{R} = N \qquad f = mg = \mu N$

$v = \sqrt{\frac{Rg}{\mu}} \qquad N = mg/\mu$

30. **A**

$a = \frac{10 \times 1}{2} - 0.5 \times 10 \times \frac{\sqrt{3}}{2} = g\left(\frac{2 - \sqrt{3}}{4}\right)$

31. **A**

$s = \frac{1}{2}g\sin\theta t^2$

$s = \frac{1}{2}(g\sin\theta - mg\cos\theta)n^2t^2$

$\frac{1}{2}g\sin\theta t^2 = \frac{1}{2}g(\sin\theta - \mu\cos\theta)n^2t^2$

$\mu = \tan\theta\left(1 - \frac{1}{n^2}\right)$

32. **A**

same as Q. no 31 ($\theta = 45°$)

33. **C**

$a_{in} = \frac{100 - 25}{15} = \frac{75}{15} = 5m/s^2$

$\frac{5}{2} = \frac{100 - (25 + \frac{v}{2})}{15}$

$v = 75m/s^2$

34. **B**

$a = \frac{F - f}{(m+M)}$

$a = 0.6\ m/s^2$

35. **B**

$T - mg' = \frac{mg}{2} - \frac{1}{3\sqrt{3}}mg\frac{\sqrt{3}}{2}$

$M' = \frac{M}{2} - \frac{M}{6} = \frac{M}{3}$

36. **A**

$$6a = 6 \times 10 \times \frac{3}{5} - \left(\frac{3}{4} 10 \times 4 \times \frac{4}{5} + \frac{1}{4} \times 10 \times 2 \times \frac{4}{5}\right)$$

$a = 1.3\ m/s^2$

37. **A**

Free fall N = 0

$a_m = a_L = g\downarrow$

38. **A**

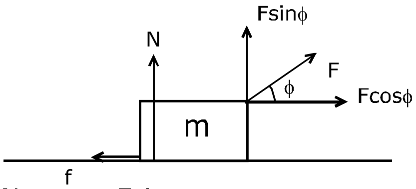
Relative slipping present

$\mu = .4$

$f = \mu mg = 28$

$35a = 28 \Rightarrow a = 0.8\ m/s^2$

39. **A**



$N = mg - F\sin\phi$

$Ma = F\cos\phi - f$

$$a = \frac{F}{m}(\cos\phi + \mu\sin\phi) - \mu g$$

40. **A**

$$a_{system} = \frac{Mg}{mn + M}$$

$$T = \frac{mMg}{mn + M}$$

41. **A**

$$T = \frac{mg}{2}$$

$$2T\cos\theta = \frac{mg}{2} \Rightarrow \cos\alpha = \frac{1}{2}$$

$\alpha = 60°$

42. **B**

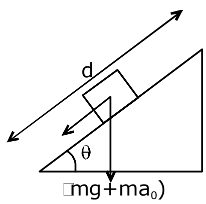
$$a_1 = \frac{2mg - mg}{m} = g$$

$$a_2 = \frac{2mg - mg}{3m} = g/3$$

$a_3 = 2mg - mg/2m$

$= g\ /\ 2$

43. **D**



$$d\cos\theta = L \Rightarrow d = \frac{L}{\cos\theta}$$

$$L = \frac{1}{2}(g + a_0)\sin\theta\cos\theta t^2$$

44. **C**

N = mg + ma

N = 0.3 (10 + 2.5) = 3.69

45. **B**

$$a = \frac{m_2 - m_1}{(m_1 + m_2)} \text{x}\, g$$

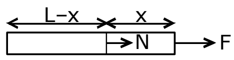
$v = \sqrt{2ad}$

46. **D**

$$F = \frac{dp}{dt} = 2yt$$

$F \propto t$

47. **D**



$$N = \frac{M}{L}(L - x)\frac{F}{M} \qquad \left(a = \frac{F}{m}\right)$$

$$N = \left(\frac{L - x}{L}\right)F$$

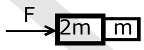
48. **B**

$T - mg = ma$

1000 – 600 = ma

$a = 4\ m/s^2$

49. **B**



$$a = \frac{F}{3m} \qquad a = \frac{F}{3m}$$

$$N_1 = m\frac{F}{3m} = \frac{F}{3} \qquad N_2 = \frac{2F}{3}$$

$$N_1 : N_2 = \frac{1}{3} : \frac{2}{3} = 1 : 2$$

50. **B**

2F = 180

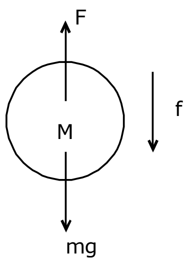
51. **C**

$$\frac{32 - 20}{3} = a$$

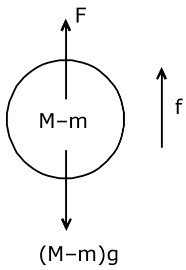
52. **C**

$T - 20 = 4$

53. **C**



Mg – F = Mf



F –(M-m)g = (M–m)f

m(g + f) = Mg + mf – Mg + Mf

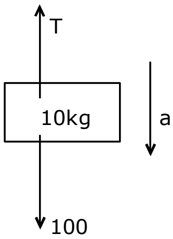
$$m = \frac{2mf}{(g + f)}$$

54. **C**

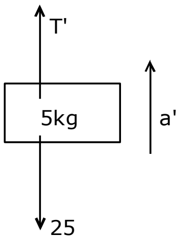
$P = F.V \qquad F = \frac{vdm}{dt} = 10\ N$

$P = 10 \times 2 = 20$ watts

55. **B**



$100 - T = 10a$ ....(1)



$T' - 25 = 5a'$

$T = 2T'$

$a' = 2a$

by eq. (1), (2) & (3)

$a' = \frac{50}{15} = 3.33 m/s^2$

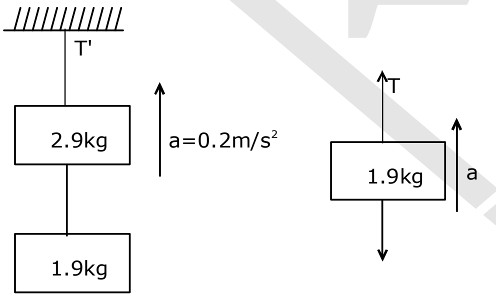
56. **B**

$m_1 g - m_2 g \sin 30^0 = a_1(m_1 + m_2)$

$m_2 g - m_1 g \sin 30^0 = a_2(m_1 + m_2)$

$4a_1 = a_2$

57. **B**



$T - 2 \times 9.8 = 2 \times 0.2$

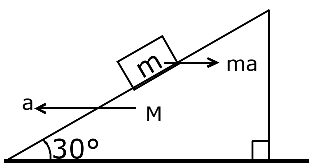
$T = 19.6 + 0.4 = 20N$

58. **D**

$ma \sin\theta = mg \cos\theta$

$a = g \cot\theta$

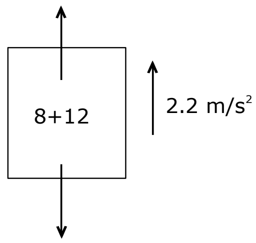
59. **B**



$ma \cos 30 = mg \sin 30$

$a = 5.6 m/s^2$

60. **B**



$T_1 - 200 = 20 \times 2.2$

$T_1 = 240\ N$

61. **B**

62. **B**

$a_T = g\sin 30 = 10 \times 1/2 = 5 m/s^2$

63. **A**

$v = wR$

$= 4 \times 1 = 4\ m/s$

64. **C**

$v_{avg} = \frac{\text{displacement}}{\text{time}} = \frac{\sqrt{2}R}{t}$

$\theta = \frac{1}{2}\alpha t^2$

$t = 2\ s$

$v_{av} = \frac{\sqrt{2} \times \sqrt{2}}{2} = 1 m/s$

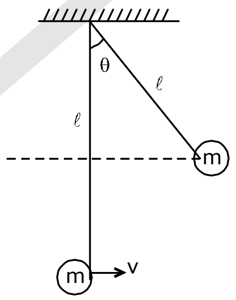
65. **A**

$R = m, \qquad v = 2t$

$a_T = 2$

$s = \frac{1}{2} a_T t^2 = \frac{1}{2} \times 2 \times 4 = 4m$

66. **D**



$mg(\ell - \ell\cos\theta) = \frac{1}{2}mv^2$

$\frac{v^2}{\ell} = 2g(1 - \cos\theta)$

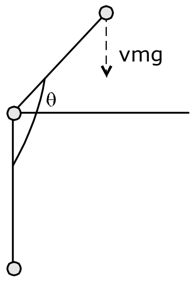
$a_T = g\sin\theta$

$2g(1 - \cos\theta) = g\sin\theta$

$\tan\left(\frac{\theta}{2}\right) = \frac{1}{2}$

$\frac{\theta}{2} = \tan^{-1}\frac{1}{2}$

67. **C**



$$Mg\sin\theta = \frac{mv^2}{\ell}$$

$$v^2 = \ell g \sin\theta$$

$$\frac{1}{2}m\frac{7g\ell}{2} = \frac{1}{2}mv^2 + mg(\ell + \ell\sin\theta)$$

$$\sin\theta = \frac{1}{2},\ \theta = 30°$$

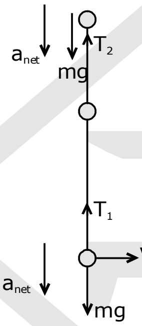
Total angle = 90 + 30 = 120°

68. **B**

$$mg = \frac{mv^2\cos^2\theta}{R}$$

69. **A**

$F_H = mg + T_2$



$F_L = mg - T_1$

70. **D**

$$T = \frac{mv^2}{(\ell + x)}$$

$$T < \frac{mv^2}{\ell}$$

71. **C**

$s = 18t + 3t^2 - 2t^3$

$v = 18 + 6t - 6t^2$

$$\frac{dv}{dt} = 6 - 12t = 0, \qquad t = \frac{1}{2}s$$

$$v_{max} = 19.5 m/s$$

72. **C**

$KE = Ks^2$

$$\frac{1}{2}mv^2 = ks^2$$

$$F_c = \frac{mv^2}{R} = \frac{2ks^2}{R}$$

$$v^2 = \frac{2ks^2}{m}$$

$$v = \sqrt{\frac{2k}{m}}s$$

$$a_T = \frac{dv}{dt} = \sqrt{\frac{2k}{m}}v$$

$$a_T = \sqrt{\frac{2k}{m}} \times \sqrt{\frac{2k}{m}} \times s$$

$$a_T = 2k \times s$$

$F_T = ma_t = 2ks$

$$F_{net} = \sqrt{(2ks)^2 + \left(\frac{2ks^2}{R}\right)^2}$$

$$= 2ks\sqrt{1 + \left(\frac{s}{R}\right)^2}$$

73. **D**

$v = at \qquad a = 0.5\ m/s^2$

$v = 0.5t$

$a_T = \alpha R \qquad \theta = \left(\frac{\pi}{5}\right)$

$a_T = 0.5\ m/s^2$

$$a_c = \frac{0.5 \times 0.5}{R}t^2$$

$$\frac{\pi}{5} = \frac{1}{2} \times \frac{0.5}{R}t^2$$

$$a_r = \sqrt{0.25 + 0.4} = 0.8 m/s^2$$

74. **C**

$\omega = \omega_0 - k\phi \qquad t = 0 \qquad \phi_0 = 0$

$\omega_t = \omega_0$

$$\frac{d\theta}{dt} = \omega_0 = k\phi$$

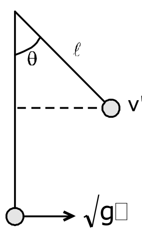
$$\int_0^{\phi}\frac{1d\theta}{(\omega_0 - k\phi)} = \int_0^t dt$$

$$\left(\frac{-1}{k}\right)\log\left(\frac{\omega_0 - k\phi}{\omega_0}\right) = t$$

$$\omega_0 - k\phi = \omega_0 e^{-kt}$$

$$\phi = \frac{\omega_0}{k}(1 - e^{-k}t)$$

75. **B**



$$T - mg\cos gq = \frac{mv^2}{\ell}$$

$$mg(1-\cos\theta) = \frac{mv^2}{\ell}$$

$$v'^2 = 2g\ell(1-\cos\theta)$$

$$\frac{1}{2}mgl = \frac{1}{2}mv'^2 + mg(l - s\cos\theta)$$

$$\frac{1}{2}mg\ell = \frac{1}{2}mg\ell(1-\cos\theta) + mg\ell(1-\cos\theta)$$

$$\frac{1}{2} = \frac{3}{2}(1-\cos\theta) \qquad \frac{1}{3} = 1-\cos\theta$$

$$\cos\theta = 1 - \frac{1}{3} = \frac{2}{3}$$

$$0 = \cos^{-1}\left(\frac{2}{3}\right)$$

$$v'^2 = gl\left(1-\frac{2}{3}\right) \qquad v'^2 = g\ell\left(\frac{1}{2}\right) = \frac{g\ell}{3}$$

$$v' = \sqrt{\frac{g\ell}{3}}$$

76. **B**

$$mgh = \frac{1}{2}m\left(\sqrt{5gD/2}\right)^2$$

$$mgh = \frac{1}{2}m\frac{5gD}{2}$$

$$h = \frac{5D}{4}$$

77. **B**

$$kx = k\omega^2(\ell + x)$$

$$10^4x = 90\times10^{-3}\times10^4(0.1+x)$$

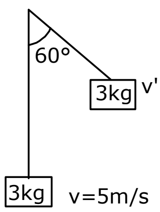
$x = 0.09(0.1 + x)$
$x = 0.09 \times 0.1 + 0.09x$
$x(1-0.09) = 0.09\times0.1$
$x(0.91) = 0.09\times0.1$
$x = 9.89\times10^{-3}$
$x = 10^{-2}$ m

78. **D**

$f = 4mg = m\omega^2 r$

$$r = \frac{\mu g}{\omega^2} \qquad r \le \frac{\mu g}{\omega^2}$$

79. **B**



$0.1\times150 = 3v'$
$v' = 5$m/s

$$\frac{1}{2}\times3\times25 = 3\times10\times\frac{1}{2}\left(\frac{1}{2}\right) + \frac{1}{2}\times3v'^2$$

$$\frac{25}{2} = \frac{5}{2} + \frac{v'^2}{2}$$

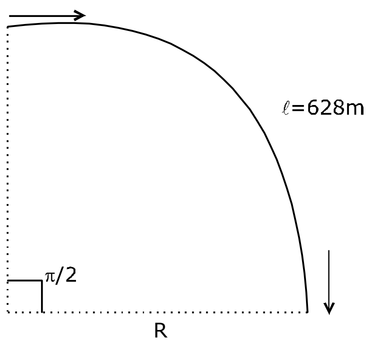
$v'^2=20$
$T = mg\cos60° + mv'^2/\ell = 135$N

80. **B**

$$\frac{mv^2}{r} = Mg$$

$v = \sqrt{rg} = 10$ m/s

81. **C**



$$\theta = \frac{\ell}{R}$$

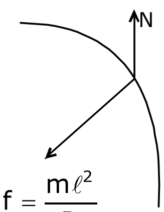
$$R = \frac{\ell}{\theta} = \frac{628}{314}\times2\times100$$

$$F = \frac{mv^2}{R}$$

$$= \frac{1000\times16\times16}{400} = 640\text{ N}$$

82. **A**

$$v = 72\times\frac{5}{18} = 20\text{m/s}$$



$$f = \frac{m\ell^2}{R}$$

$$R = \sqrt{N^2 + f^2}$$

$$= \sqrt{(5000)^2 + (20000)^2}$$

$= 25$ K

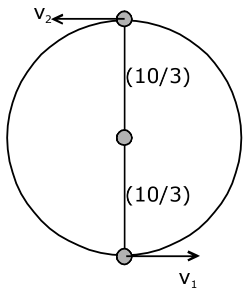
83. **B**

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$$\frac{\Delta T}{T} = \frac{1}{2}\frac{\Delta\ell}{\ell}$$

$=0.5\%$

84. **D**



$$\frac{T_{max}}{T_{min}} = \frac{\ell mg + mv_1^2}{mv_2^2 - mg\ell}$$

$$\frac{4}{1} = \frac{v_1^2 + g\ell}{v_2^2 - g\ell}, \qquad \frac{1}{2}mv_1^2 = mg2\ell + \frac{1}{2}mv_2^2$$

$$4v_2^2 - v_1^2 = 5g\ell \qquad v_1^2 = 4g\ell + v_2^2$$

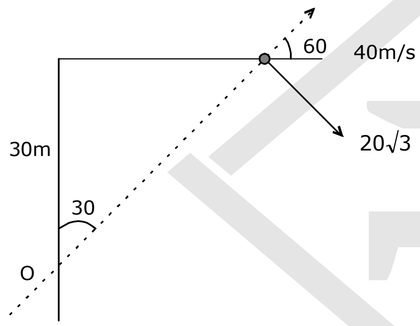
$$4v_2^2 - (4g\ell + v_2^2)5g\ell$$

$$3v_2^2 = 9g\ell \qquad v_2 = \sqrt{3 \times 10 \times 10} = 10m/s$$

85. **D**

$$\omega_{PQ} = \frac{v_{\perp Relative}}{R} = \frac{7}{10} = 0.7 rad/s$$

86. **D**



$$\cos 30 = \frac{30}{d}$$

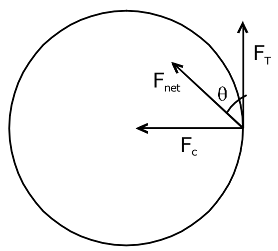
$$\omega = \frac{v}{R} = \frac{20\sqrt{3} \times \sqrt{3}}{60} = 1 rad/s$$

87. **B**

$$a_c = k^2rt^2 \qquad P = Fv$$

$$\frac{v^2}{r} = k^2rt^2 \qquad v = krt \qquad Ft = mkr$$

$$F_{net} = \sqrt{(mk^2rt^2)^2 + \left(2mk^2r^2t^2\right)^2}$$



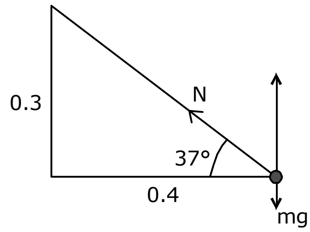
$P = Fv \cos\theta \quad = mk^2r^2 t$

88. **A**

$$Mg - N = \frac{mv^2}{R}, N = 0$$

$$V = \sqrt{Rg}$$

89. **A**



$$\frac{3}{4} = \frac{g}{R\omega^2}$$

$$\omega^2 = \frac{4g}{3R}$$

$$\omega = \frac{10}{\sqrt{3}} rad/s$$

90. **A**

$$\frac{1}{2}mv^2 = 4t^2$$

$$v = \sqrt{\frac{8}{m}}t$$

$$m\frac{dv}{dt} = m\sqrt{\frac{8}{m}}$$

$$F = \sqrt{8m} = \text{costant}$$

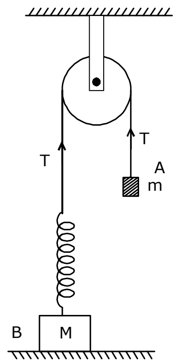
91. **C**

$$kx = mg$$

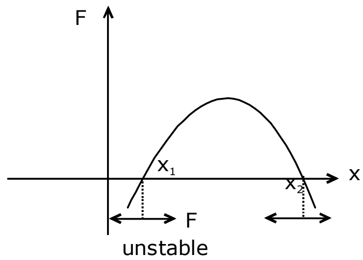
$$x = \frac{mg}{k}$$

$$\frac{1}{2}kx^2 = mgx$$

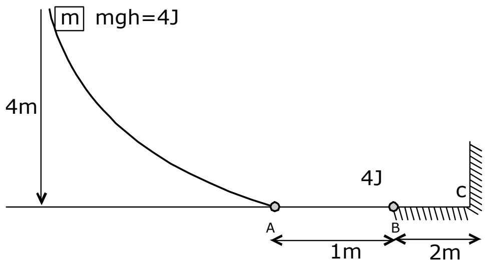
$$m = \frac{M}{2}$$



92. **D**



93. **C**



$$mgh = \frac{1}{2}mv^2$$

$$v = \sqrt{2hg} = \sqrt{2\times10\times4} = \sqrt{80}m/s$$

$a=\mu g$, $= 0.1 \times 10$, $= 1\ m/s^2$

$0=80 - 2\times1\times s$

$s = 40m$

Distance covered = 59m

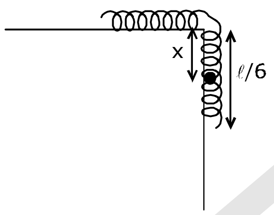
94. **C**

$$\Delta\vec{r} = 2\hat{i} + 2\hat{j} + 2\hat{k}$$

$$\vec{F} = 2\hat{i} + 5\hat{j} + \hat{k}$$

$$\vec{w} = \vec{F}.\Delta\vec{r} = 4 + 10 + 2 = 16J$$

95. **C**



$$w = \int_0^{L/6} \frac{M}{L}.\left(\frac{L}{6} - x\right)gdx = \frac{Mg\ell}{72}$$

96. **D**

$F \propto v$

$$F_1 = \frac{k.d_1}{t_1}, \qquad F_2 = \frac{k.d_2}{t_2}$$

$$\text{Power} = \frac{w}{t} = \frac{F.d}{t} = F.v$$

$P \propto v^2$

$P_2 = kv_2^2$

$$\frac{P_1}{P_2} = \frac{v_1^2}{v_2^2}$$

$$P_2 = \frac{v_2^2}{v_1^2}.P_1$$

$P_2 = 96$ h.p

97. **B**

$P = \vec{F}.\vec{V}$

$= mg.v\cos\theta$

$= 50 \times 9.8 \times 2\cos60° = 490$ w

98. **A**

$v = k\sqrt{s}$

$$\frac{dv}{dt} = \frac{k}{2\sqrt{s}}.\frac{ds}{dt}$$

$$a = \frac{k^2}{2}$$

$$F = ma = \frac{mk^2}{2}$$

(Distanced covered in t seconds)

$$\frac{ds}{dt} = v, \int_0^x \frac{1}{v}.ds = \int_0^t dt \Rightarrow x = \frac{t^2k^2}{4}$$

$$dw = \int_0^x F.ds = \int_0^{t^2k^2/4} \frac{mk^2}{2}.ds = \frac{mk^4t^2}{8}$$

99. **A**

$$mgh = \frac{1}{2}kx^2$$

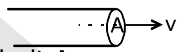
$$x = \left(\frac{2mgh}{k}\right)^{1/2}$$

100. **A**

$$F = v\frac{dm}{dt}$$

$F = 0.2 \times 2 = 0.4$ newton

101. **A**



dm = dvdt A

$$\frac{dm}{dt} = dvA$$

$$K = \frac{1}{2}mv^2$$

$$\frac{dk}{dt} = \frac{1}{2}\frac{dm}{dt}v^2 = \frac{1}{2}DUV^2A$$

$$\frac{dk}{dt} = \frac{1}{2}dAv^3$$

102. **A**

$xm_2 = (1-x)m_1$

$xm_2 = m_1 - xm_1$

$x(x_1 + mx) = m_1$

$$x = \frac{m_1}{m_1 + m_2}$$

103. **A**

$mu = mv' + mu/2$

$$mv' = \frac{mu}{2}$$

$$v' = \frac{m}{M}\frac{u}{2}$$

$$\sqrt{5g\ell} = \frac{m}{M}\frac{u}{2} \Rightarrow M = \frac{2M\sqrt{5g\ell}}{m}$$

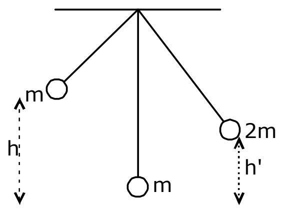
104. C

$5\times10^{3}\times1.2=6\times10^{3}v$

$v = 1m/s$

$v_{rel} = 0.2$ m/sec.

105. D



$$\frac{1}{2}mv^{2}=mgh$$

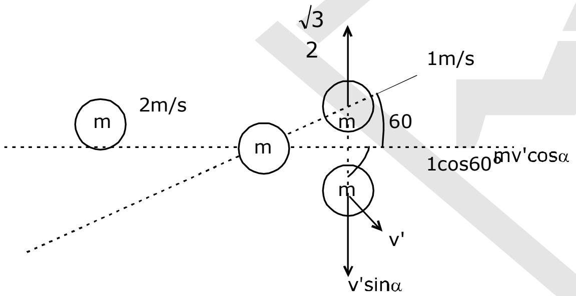
$$v=\sqrt{2gh}$$

$$v'=\sqrt{\frac{gh}{2}}$$

$$\frac{1}{2}2mv'^{2}=2mgh'$$

$$h'=\frac{h}{4}$$

106. A



$$2m=\frac{m}{2}+mv'\cos\alpha$$

$$\Rightarrow\frac{3}{2}=v'\cos\alpha \;....(1)$$

$$\frac{\sqrt{3}}{2}=v'\sin\alpha \quad ....(2)$$

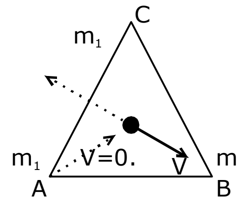
by Eq (2) /(1) $\tan\alpha=\frac{1}{\sqrt{3}}$, $\alpha=30^{\circ}$

$(1)^2 + (2)^2$

$$\Rightarrow v'^{2}\cos^{2}\alpha+v'^{2}\sin^{2}\alpha=\frac{9}{4}+\frac{3}{4}$$

$$v'=\sqrt{3}m/s$$

107. C



$p_i = 0$

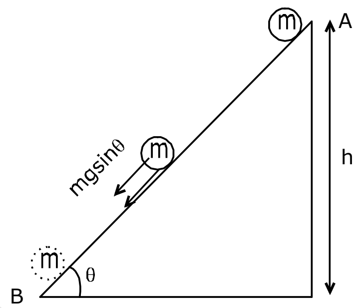
p_f must be zero

$$\vec{P}_A+\vec{P}_B+\vec{P}_C=0$$

$$\vec{P}_A=0$$

$$\vec{P}_B=-\vec{P}_C$$

108. B



$f_{AB}=mgh$

$F = f_{BA}+mgh \qquad = 2mgh$

109. C

$$\frac{1}{2}M\frac{v_0^2}{4}+\frac{1}{2}Mv_0^2=Mgl+Mg\frac{\ell}{2}$$

$$v_0=\sqrt{\frac{12g\ell}{5}}$$

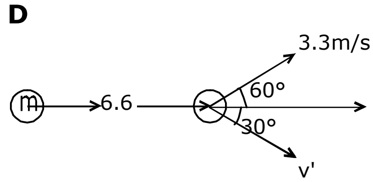
110. B

$$Mgl=36\times\frac{72}{100}$$

$$h=\frac{324}{125}$$

$$v=\sqrt{2gh}=7.2m/s$$

111. D



$v'\sin 30 = 3.3\,\frac{\sqrt{3}}{2}$

$v'=5.7m/s$

112. C

Linear momentum conservation in x-axis at highest point.

$d=\frac{R}{2}+2R \qquad (R=100)$

$d = 250$

113. B

$$\frac{Mx}{t}=\frac{m(L-x)}{t}$$

114. C

$mu=(m+\eta m)v'$

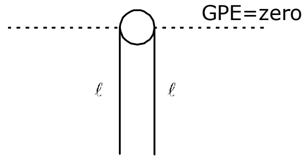
$$v'=\frac{u}{1+\eta}$$

Energy conservation

$$\frac{1}{2}mu^2=mgh+\frac{1}{2}(m+\eta m)v'^2$$

$$u=\sqrt{2gh\left(1+\frac{1}{\eta}\right)}$$

115. B



$$\frac{-mg\ell}{2}=\frac{1}{2}mv^2-mg\ell \quad v=\sqrt{g\ell}$$

116. B

$w=\vec{F}.\vec{d}$

$$=\frac{30(\hat{i}+\hat{j}+\hat{k})}{\sqrt{3}}.\left(2\hat{i}+\hat{k}\right)=30\sqrt{3}\ \text{J}$$

117. D

It will not perform SHM

$kx=mg\sin\theta$, maximum velocity

118. A

$\Delta U=w_F-\Delta k=-10+16=6\ \text{J}$

119. A

When slide

$$Mgh=\frac{1}{2}Mv_1^2+\frac{1}{2}mv_2^2 \qquad ....(1)$$

$$MV_1=mv_2 \qquad ....(2)$$

when climb

$$\frac{1}{2}mv_2^2+\frac{1}{2}Mv_1^2=mgh+\frac{1}{2}(M+m)v'^2$$

From (1), (2) & (3)

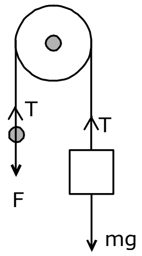
h' < h

120. A

COM will remain constant in x direction

COM will move in y direction

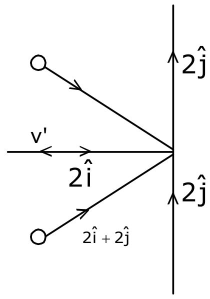
121. B



$w_T+v_{mg}=k=205$

$w_T=20-wmg$

122. B



$$v'=ev=\frac{1}{2}\times 2=1$$

$=-1\hat{i}$

So velocity $=-\hat{i}+2\hat{j}$

123. D

$\vec{r}_{12}=\vec{v}_{12}x\,t$

124. A

125. A

$F=\left(2\hat{i}+3\hat{j}\right)N$

$\Rightarrow m=3/2$

F.x = 0

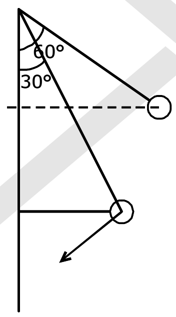
$\theta=90°$

$3y+kx=5$

$$m=\frac{-k}{3}\times\frac{3}{2}=-1$$

K=2

126. A



$$(1\cos 30-1\cos 60)mg=\frac{1}{2}mv^2$$

$$\left(\frac{\sqrt{3}}{2}-\frac{1}{2}\right)\times 1\times 10=\frac{1}{2}\times v^2$$

P = mg sin30v

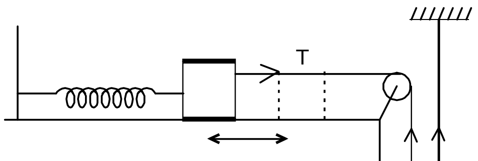
$v^2=\left(\sqrt{3}-1\right)10$

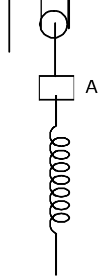
$v=\sqrt{10(\sqrt{3}-1)}$

$=1\times 10\times\frac{1}{2}\times\sqrt{7.32}$ $\qquad v=\sqrt{7.32}$

$=5\times\sqrt{7.32}=13.4$

127. B





$kx = T$

$2T + k\dfrac{x}{2} = Mg$

$2kx + \dfrac{kx}{2} = mg$

$x = 0.4m$

$T = 0.4 \times 10 = 4N$

128. D

$w_T + w_{sp} = \Delta k$

$4 \times 0.4 + \left(-\dfrac{1}{2}k(0.4)^2\right) = \dfrac{1}{2} \times mv^2$

$1.6 - 5 \times 0.16 = 0.5v^2$

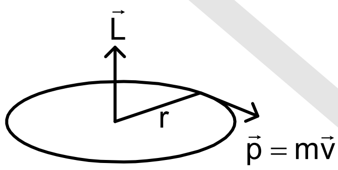
$1.6\left[1 - \dfrac{1}{2}\right] = 0.5v^2$

$1.6 \times \dfrac{1}{2} = 0.5v^2$

$\Rightarrow\ v^2 = \dfrac{8}{5} = 1.6$

$v = \sqrt{1.6} = 1.26 m/s$

129. A



The direction of $\vec{L}$ (about the center) is perpendicular to the plane containing the circular path. Both magnitude and direction of the angular momentum of the particle moving in a circular path about its center O is constant.

130. B

The linear momentum (L) is conserved, since τ_{ext} is zero.
Let

$\therefore I_o\omega_o = 2I_o\omega \Rightarrow \omega = \dfrac{\omega_o}{2}$

$K = \dfrac{1}{2}I\omega_o^{\,2};$

$K_f = \dfrac{1}{2}(2I_o) x \left(\dfrac{\omega_o}{2}\right)^2 = \dfrac{1}{2} x\, 2I_o x \dfrac{\omega_0^2}{4}$

$= \left\{\dfrac{1}{2}\left(\dfrac{I_o\omega_0^2}{2}\right)\right\} x \dfrac{1}{2} = \dfrac{K}{2}$

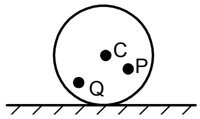
131. C

Here $V_C = V_C$

$V_P = \sqrt{V_C^2 + \omega^2 r^2}$

$V_Q = \sqrt{V_C^2 + \omega^2 r^2 + 2V_C \omega r \cos\theta}$

132. D



$x = \dfrac{L}{2}\cos\theta; y = \dfrac{L}{2}\sin\theta$

$\left(\dfrac{2x}{L}\right)^2 + \left(\dfrac{2y}{L}\right)^2 = 1$

$\Rightarrow x^2 + y^2 = \dfrac{L^2}{4} = \text{circle}$

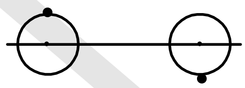
133. A

Iw = constant
When ballet dancer then I will increase

$\Rightarrow \omega$ will$\downarrow$

$\dfrac{1}{2}I\omega^2 = \dfrac{1}{2}Ix\left(\dfrac{C}{I}\right) = \dfrac{C^2}{2I}$

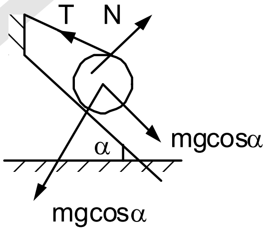
134. D



$mgR = -mgR + \left(\dfrac{mR^2}{2} + mR^2\right)\dfrac{1}{2}\omega^2$

$2mR = \dfrac{3mR^2}{4}\omega^2 \qquad \omega = \sqrt{\dfrac{8g}{3R}}$

135. C



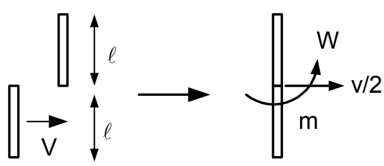
$mg\sin\alpha - T = mA$

$TR = I\alpha, A = R\alpha \qquad T = \dfrac{I\alpha}{R}$

$mg\sin\alpha - \dfrac{Ia}{R^2} = ma$

So a = 1.4 m/s²

136. A

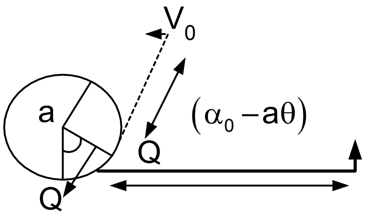


by conservator angular momentum about joint

$$\frac{mvl}{2} = \frac{4 \times 2Ml^2}{12}\omega$$

$$\omega = \frac{3V}{4l} \text{ anti clock wise}$$

137. C



$$V_o = (r_o - a\theta)\omega$$

$$\omega = \frac{v_o}{r_o - a\theta} \;\&\; V_o = r_o\omega_o$$

$$\Rightarrow \omega = \frac{r_o\omega_o}{r_o - a\theta} = \frac{\omega_o}{1 - \frac{a}{r_o}\theta}$$

138. A

$N = mL\alpha$

$f_{max} = \mu N = m\mu L\alpha$

$\omega = \alpha t$

$m\omega^2 L = f_{max}$

$$\Rightarrow mx\alpha^2 t^2 L = \mu mL\alpha$$

$$\Rightarrow t = \sqrt{\frac{\mu}{\alpha}}$$

SHM, Wave, Gravitation, Fluid, Heat

158. A

$$E = \frac{1}{2}mv_{es}^2$$

159. B

$$v_e = \sqrt{\frac{Gm}{R}}$$

$$\frac{v_1}{v_2} = \sqrt{\frac{m_1}{m_2} \times \frac{R_2}{R_1}}$$

$v_1 = 11.2$

$$v_2 = \frac{11.2}{55} = 5.023 \approx 5 \text{ km/sec}$$

160. C

$T^2 \propto R^3$

$T \propto R^{3/2}$

$$\frac{dT}{T} \times 100 = \frac{3}{2}\frac{dR}{R} \times 100$$

$dR = 1.01\,R - R = .01R$

$$= \frac{3}{2} \times \frac{.01R}{R} \times 100 = 1.5\%$$

161. C

$$F = \frac{-\partial u}{\partial x}\hat{i} - \frac{\partial v}{\partial y}\hat{j}$$

$$\frac{\partial u}{\partial x} = a, \quad \frac{\partial u}{\partial x} = b,$$

$$F = -a\hat{i} - b\hat{j}$$

$$\therefore\ a_{cc} = \sqrt{\frac{a^2 + h^2}{m}}$$

162. A

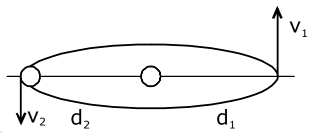
$$E = -\left[\frac{am}{1} + \frac{Gm}{2^2} + \frac{Gm}{4^2} + \frac{Gm}{8^3}\right]$$

$$= G\left(\frac{255}{256}\right) \approx G$$

163. C

$$g = \frac{GMe}{R_e^2} \text{ no change}$$

164. C

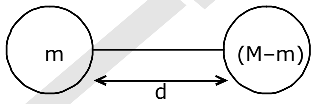


$v_1 d_1 = v_2 d_2$

$$\therefore\ v_2 = \frac{v_1 d_1}{d_2}$$

165. A

166. D



$$F = \frac{G(M-m)m}{d^2}$$

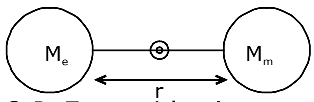
$$\therefore \frac{dF}{dm} = 0, \ \frac{m}{M} = \frac{1}{2} \quad m = \frac{M}{2}$$

167. D

using D.A

$$\frac{GM_e m}{R_e} + \frac{1}{2}mv^2 = \frac{GM_e m}{R_e}$$

168. A



G.P. E. at mid point

$$= \frac{-GM_e}{r/2} - \frac{GM_m}{r/2}$$

$$= \frac{-2G}{r}\left(M_e + M_m\right)$$

G.P.E at mid point

$\therefore U = m \times v$

$$= m\left(\frac{-2G}{r}\right)(M_e + M_m)$$

To escape $U = \frac{1}{2}mv_e^2$

$$\frac{-2Gm}{r}(M_e + M_m) = \frac{1}{2}mv_e^2$$

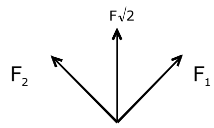
$$\therefore \ v_e = \sqrt{\frac{4G(M_e + M_m)}{r}}$$

169. A

$$E_G = \frac{-Gmx}{R_e^3}$$

$$\therefore \ -F = \frac{-GM_e mX}{R_e^3}$$

170. C



$$F_1 = F_2 = \frac{2Gmm}{\frac{a^2}{2}} = \frac{4Gmm}{a^2}$$

$$F_{net} = \frac{4\sqrt{2}Gmm}{a^2}$$

171. B

$$g' = g\left(1 - \frac{2h}{R_e}\right)$$

$$g' = g\left(1 - \frac{x}{R_e}\right)$$

$x = 2h$

172. A

$$F = \frac{Gmmx'}{R_e^3}$$

$a = 1$

173. A

Sheet solution

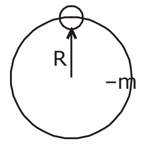
174. A

$$T = 2\pi\sqrt{\frac{m}{k_{eq}}}$$

$$k_{eq} = k_1 + k_2$$

$$T = 2\pi\sqrt{\frac{m}{2k}}$$

175. D



$$I_H = \frac{3mR^2}{2}$$

$$T = 2\pi\sqrt{\frac{I_H}{mgh}}$$

$$= 2\pi\sqrt{\frac{3R}{2g}}$$

176. B

177. A

$F = -10x \because K = 10$

$u^2 = \frac{K}{m} = \frac{100}{1} = 100$ w=10,

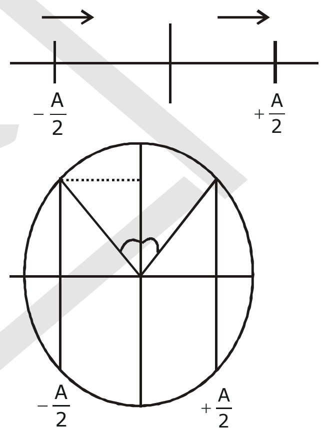
v = aw

6 = A x 10

A = .6 m

178. A

$$x = A\sin(\omega t + \frac{\pi}{6})$$



$\therefore$ On Rotated on Rhandir

$\therefore 60^0 \Rightarrow \pi/3$

$Q = \omega t$

$\pi/3 = \omega t \therefore t = \frac{\pi}{3\omega}$

179. B

(i) $T_1 = 2\pi\sqrt{\frac{m}{R}}$, $T_2 = 2\pi\sqrt{\frac{m}{2R}}$

$$T_3 = 2\pi\sqrt{\frac{m}{2R + 2R}} = 2\pi\sqrt{\frac{m}{4K}}$$

$$T_4 = 2\pi\sqrt{\frac{m}{2K + 2R}}$$

$\therefore T_1 = T_2, T_3 = T_4$

B is count

180. C

$$T = 2\pi\sqrt{\frac{m}{k}}$$

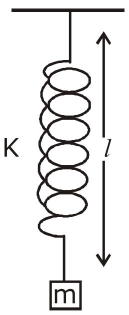
$$\therefore K_1 l_1 = K_2 l_2$$

$$K_1 l_1 = Kl$$

$$K_2 l_2 = Kl$$

$$Kl_2 = 2K + 2K = 4K$$

$$K_1 = 2K$$



$$T^1 = 2\pi\sqrt{\frac{m}{4K}}$$

$$= \frac{2\pi}{2}\sqrt{\frac{m}{K}} = \frac{T}{2}$$

181. A

A = 0.01m , m = 2kg

$\therefore$ TE = ME + 0.E

$\therefore$ $(OE)_{MP}$=

$$4S = \frac{1}{2}mv^2A^2 = \frac{1}{2}\times 2\times w^2\times(0.01)^2$$

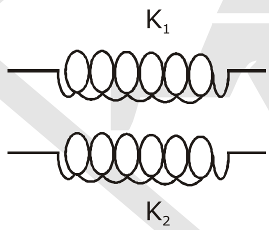
Ans. (A)

$$T = \frac{\pi}{100}$$

182. B

$$T_1 = 2\pi\sqrt{\frac{m}{K_1}}, T_2 = 2\pi\sqrt{\frac{m}{K_2}},$$

$$\therefore K_l = K_1 + K_2$$



$$T = 2\pi\sqrt{\frac{m}{K_1 + K_2}}$$

On solving we get

$$T = \frac{T_1 + T_2}{T_1 + T_2}$$

183. B

$$T = T_1 + T_2 \qquad T \to l \quad T_1 = 2\pi\sqrt{\frac{l}{g}}$$

$$= \frac{T_1}{2} + \frac{T_2}{2} \quad T_2 \to l/4 \quad T_2 = 2\pi\sqrt{\frac{l}{4g}}$$

$$T = \pi\sqrt{\frac{l}{g}} + \pi\sqrt{\frac{l}{4g}}$$

$$T = \pi\sqrt{\frac{l}{g}} + \frac{\pi}{2}\sqrt{\frac{l}{g}}$$

$$= \frac{3\pi}{2}\sqrt{\frac{l}{g}} = \frac{3}{4}x2\pi\sqrt{\frac{l}{g}} = \frac{3T}{4}$$

184. C

Y = 0.2 sin $(10\pi t+1.5\pi)$ cos $(10\pi t+1.5\pi)$

net $10\pi t+1.5\pi$ =A

$$y = \frac{0.2\sin A\cos A\, x\, 2}{(2)} = \frac{0.2}{2}\sin 2A$$

$$= .1\sin 2(10\pi + 1.5\pi)$$

Y = .1 sin $(10\pi t+3\pi)$ w = 20p

Y = A sin $(\omega t+\phi)$ T = .1 sec

185. D

186. B

I_{et} = - L^2 xρg = - $\rho g L^2 x$

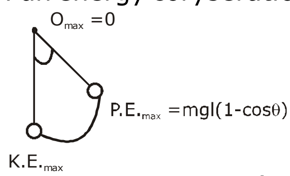
mA = -$\rho g L^2 x$ (A = Aceleation)

$L^3 5A = -\rho g L^2 x$

$$\therefore A = \frac{-\rho g x}{L\sigma} \quad \therefore \omega^2 = \frac{\rho g}{L\sigma} \quad \therefore T = 2\pi\sqrt{\frac{L\sigma}{\rho g}}$$

187. C

Fun energy coryseration



$KE_{max} = PE_{max} = mg\ell(1-\cos\theta)$

188. B

F = KX   m = 3kρ

100 = K x 5 x 10^{-2}

K= 200 N/M

$$T = 2\pi\sqrt{\frac{M}{K}} = 2\pi\sqrt{\frac{3}{200}} = \frac{\pi}{5}\sqrt{\frac{3}{2}}$$

189. C

190. A

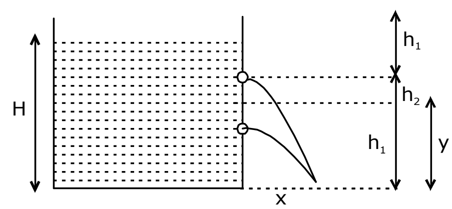
191. D

Fundamental by theory

192. C

193. D

We know that the range is same for the liquid comming out of the hole at same distance below the top and above the bottom



$H = h_1 + h_2$

for range to max y = H/2 = $\frac{h_1 + h_2}{2}$

194. D

$$v_T = \frac{2}{9}r^2\frac{(\rho-\sigma)}{\eta}g$$

Let R be the new radius of the drop

$$\therefore \frac{4}{3}\pi R^3 = 2\frac{4}{3}\pi r^3$$

$$R = (2)^{1/3} r$$

$$v'_T = \frac{2}{9}\frac{\left(2^{1/3}r\right)^2(\rho-\sigma)g}{\eta}$$

$$v'_T = (2)^{2/3}v_T$$

195. A

$$v = \sqrt{2\times g\times 2} = \sqrt{40}$$

W.E.T

$W_{fth} = E_f - E_i$

$$-(v\rho_{water})h = -\frac{1}{2}mv_i^2$$

196. C

$$\gamma = \frac{T_1}{\frac{A(\ell_1-\ell)}{\ell}} = \frac{T_2}{A\left(\frac{\ell_2-\ell}{\ell}\right)}$$

$$\ell = \frac{\ell_1T_2 - T_1\ell_2}{T_2 - T_1}$$

197. A

$$B = \beta = \frac{-h\rho g}{\frac{dv}{v}}$$

$$\beta = 9.8\times10^{10}N/m^2$$

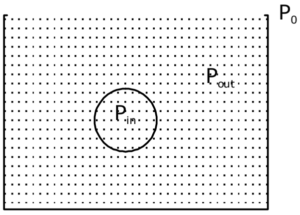
198. A

Theory base

199. B

Theory base

200. D



$$P_{in} - P_{out} = \frac{2T}{r}$$

$$P_{in} = P_{out} + \frac{2T}{r}$$

$$= P_0 + h\rho g + \frac{2T}{r} = 2.0014\times10^5\ N/m^2$$

201. A

202. B

203. D

$$T = \frac{F}{l} = \frac{F}{Rd\theta}$$

$$F = 2T'\sin\frac{d\theta}{2} = TRd\theta$$

$$2T'\frac{d\theta}{2} = TRd\theta$$

$$T' = TR$$

204. B

205. C

206. B

$$\frac{2\pi}{\lambda} = \frac{\pi}{3}$$

$$\frac{\lambda}{2} = 3cm$$

207. A

208. D

3rd.x

3 loop, $\frac{2\pi}{\lambda} = 0.6$

$$3\lambda/2 = \ell$$

209. D

210. B

$$Y = \frac{1}{1+(x-\frac{t}{2})^2}$$

211. B

$$\frac{\lambda}{2} = 2\times8.75cm$$

$\lambda = 35cm$

$$f = \frac{v}{\lambda}$$

212. D

$$I_{max} = I_1 + I_2 + 2\sqrt{I_1I_2}$$

$$I_{min} = I_1 + I_2 - 2\sqrt{I_1I_2}$$

213. A

$$R = 4\sin\frac{\pi x}{15}$$

214. C

$$\Delta x = 1m,\ \Delta\phi = \frac{2\pi}{\lambda}(1m)$$

$$\Delta\phi = \frac{\pi}{2}\ I = 4I_0\cos^2\left(\frac{\Delta\phi}{2}\right) = 2I_0$$

215. A

$$\Delta\phi = \phi/4$$

$$a_{net} = \sqrt{A^2 + A^2 + 2AA\cos\phi/4}$$

216. B

$$\frac{v}{2L} = 240$$

$$f_2 = \frac{v}{4L} = 120\,\text{Hz}$$

217. A

$$\frac{3v}{4L_1} = \frac{3v}{2L_2}$$

218. B

$$f \propto \frac{1}{\ell} \Rightarrow \frac{f_1}{f_2} = \frac{\ell_2}{\ell_1}$$

219. A

$$e = \frac{\ell_2 - 3\ell_1}{2}$$

220. D

$$\ell_2 - \ell_1 = \frac{\lambda}{2}$$

221. B

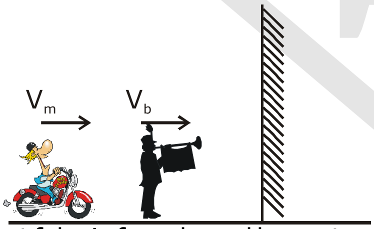
$\lambda = 2m$, $v = 2f$

222. B

$$f_{open} = \frac{(n+1)v}{2L}$$

$$f_{close} = \frac{(2n+1)v}{4L}$$

223. C
224. D
225. A
226. C



Let f_1 he is freq. heard by metor cyclist after Reflection from wall

$$f_1 = \frac{(v+v_m)}{(v-v_b)} f$$

Let f2 is the freq. heard by motorcylist directly

$$f_2 = \frac{(v+v_m)}{(v+v_b)} f$$

227. C

No effect As there is no relative motion

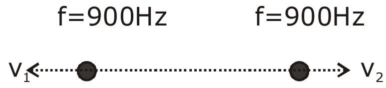
228. A

$$f' = \frac{(v+v/5)}{v} f = 1.2f$$

λ Remains constant As source remain Fix.

229. D

230. B



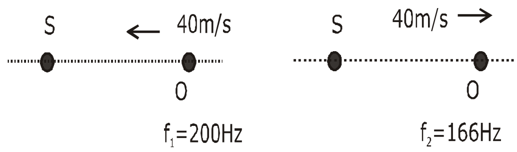
$v_1 > v_2$

v_1 and $v_2 <<<<< v$

$$f_1 = \frac{v_f}{(v_1+v)}, f_2 = \frac{v_f}{(v_2+v)} \therefore \text{Beat} = (f_2 - f_1)$$

$$6 = \frac{v_f(v_1-v_2)}{(v+v_2)(v+v_1)} = \frac{v_f(v_1-v_2)}{(v)(v)} = 2\text{m/s}$$

231. C



$$200 = \left(\frac{v+40}{v}\right) f \qquad 160 = \left(\frac{v-40}{v}\right) f$$

v = 360 m/s

232. B

$$n = \left(\frac{v_s}{v_s - v}\right) f \qquad n' = \left(\frac{v_s + v}{v_s}\right) f$$

$n' < n$

233. A

$$n = 1200\,\text{Hz} \qquad n' = \left(\frac{v-10}{v-20}\right) 1200$$

1219Hz

234. D

$$f_{max} = \frac{330}{(330-30)} \times 440, \quad f_{min} = \frac{330}{(330+30)} \times 440$$

235. D

$m \times 0.2 \times (40-32) = 100 \times 0.5 \times (32-20)$
m = 375 gm

236. D

Heat required for melting ice
= mL = 100 × 80 = 8 kcal
Hear relesed = ms ΔT = 300 × 1 × 25
= 7.5 kcal
so ice remain unmelted

237. C

$\because$ metal same so specific heat is also same

238. C

Length = letent heat

239. C

Q = msΔT = 50×0.6×50=1500 cal in 1 minute

240. C

$$\text{Specific heat} \propto \frac{1}{\text{slope}}$$

241. B

Theory based

242. B

$$\frac{d\theta}{dt} \propto \left(\frac{\theta_1+\theta_2}{2} - \theta_0\right)$$

$$\left(\frac{\theta_1+\theta_2}{2}\right)_1 > \left(\frac{\theta_1+\theta_2}{2}\right)_2$$

$t_1 < t_2 < t_3$

243. D

$\frac{E_1}{E_2} = \frac{A_1}{A_2}\frac{T_1^4}{T_2^4}$, $(E = eA\sigma T^4)e = 1$ for black body

244. D

$$\frac{E_1}{E_2} = \frac{T_1^4}{T_2^4}$$

245. B

$$\frac{T_s}{T_m} = \frac{4200}{140} = 30:1$$

246. D

$$\left(\frac{\Delta\theta}{\Delta t}\right) \propto \Delta\theta$$

Heat loss $\propto$ temperature diffrence

$$\frac{\left(\frac{\Delta\theta}{\Delta t}\right)_1}{\left(\frac{\Delta\theta}{\Delta t}\right)_2} = \frac{(80-20)}{(40-20)} = 20\,\text{cal/s}$$

247. A

$$\lambda_1 T_1 = \lambda_2 T_2$$

$$4 \times 200 = \frac{\lambda}{2} 2400$$

$$\lambda_2 = \frac{1}{3}$$

248. B

$$\frac{I_1}{I_2} = \frac{R_2}{R_1}$$

as Temp. defference same $R \propto l$

$$\frac{I_1}{I_2} = \frac{2}{\pi} = 0.64$$

249. C

$$\frac{Q_1}{Q_2} = 0.64\,(<1)$$

$$Q_2 > Q_1$$

250. B

$$\frac{K_1A_1(T_1-T_2)}{l} = \frac{K_2A_2(T_1-T_2)}{l}$$

251. D

By Theory

252. C

$$R_1 = \frac{l}{K_1\pi R^2} \quad ....(1)$$

$$R_{th_2} = \frac{l}{K_2\pi((2R)^2 - R^2)} \quad ....(2)$$

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{K_{eq}\pi(2R)^2}{l} = \frac{K_1\pi(R)^2}{l} + \frac{K_2\pi 3R^2}{l}$$

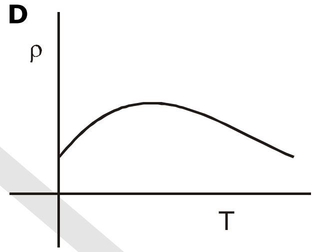
253. D

$$K_AA_A = K_BA_B$$

$$K_A\pi R_A{}^2 = K_B\pi R_B{}^2$$

$$K_A = \frac{K_B}{4}$$

254. D



Electromagnetism

267. A

$E = \frac{-dv}{dx}$, at x = 2m

$\frac{dv}{dx} = 0 \quad \therefore E = 0$

268. A

$$\varphi = \frac{q_{in}}{\varepsilon_0}$$

Now $\varphi' = \frac{q_{in}}{2\varepsilon_0} = \frac{\varphi}{2}$

269. C

$q_1 \quad q_2 \quad f_1 = 100 = \frac{Kq_1q_2}{r^2}$

$q_1 \to 1.1q_1 \quad q_2 = 0.9q_2$

$$f_2 = \frac{K(1.1q_1)(0.9q_2)}{r^2} = 1.1 \times 0.9 \times 100 = 99N$$

270. B

$$V_A = \frac{KQ}{a}$$

$$V_B = \frac{KQ}{b}$$

$$\omega = q\,(V_b - V_a) = KQq\left(\frac{1}{a} - \frac{1}{b}\right)$$

271. C

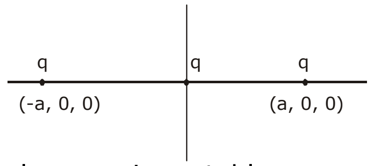
$$E=\frac{KQ}{R^2}=\frac{K\sigma(4\pi R^2)}{R^2}=\frac{\sigma}{\varepsilon_0}$$

$R\to 2R$ and σ = unchanged

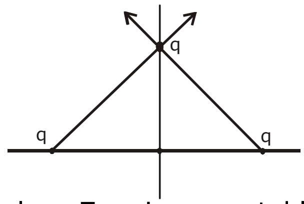
$$E'=\frac{K\sigma[4\pi(2R)^2]}{(2R)^2}$$

$$\frac{\sigma}{\varepsilon_0}=E \quad \text{same}$$

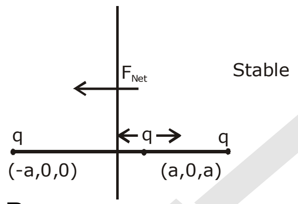
272. C.



along y axis unstable

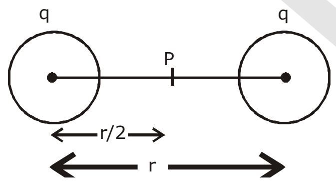


along Z- axis -> unstable
along X-axis



273. B

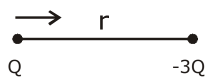
$$E=\frac{Kq}{(r/2)^2}=\frac{4Kq}{r^2}$$



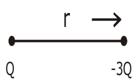
$$V_P=\frac{Kq}{r/2}+\frac{Kq}{r/2}==\frac{4Kq}{r}$$

$$V_P=rE$$

274. C



$$\vec{E}=\frac{K(3Q)}{r^2}=\frac{3KQ}{r^2}$$

at -3Q 

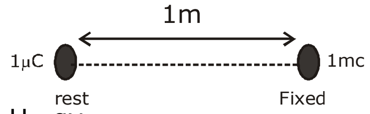
$$\vec{E}=\frac{KQ}{r^2}=\frac{\vec{E}}{3}$$

275. A

Low potential $\to$ High potential
Work done $\to$ Potential energy $\uparrow$
$W = q\Delta V$

276. C

m = 0.002 kg



U= qv
$K_i + U_i = K_f + U_f$

$$0+(1\times10^{-6})\frac{K(1\times10^{-3})}{1}$$

$$=\frac{1}{2}mv^2+(1\times10^{-6})\frac{K(1\times10^{-3})}{10}$$

$$K\times10^{-9}=\frac{1}{2}\times0.002\,v^2+\frac{10^{-9}}{10}K$$

$$K\times10^{-9}\left[1-\frac{1}{10}\right]=0.001v^2$$

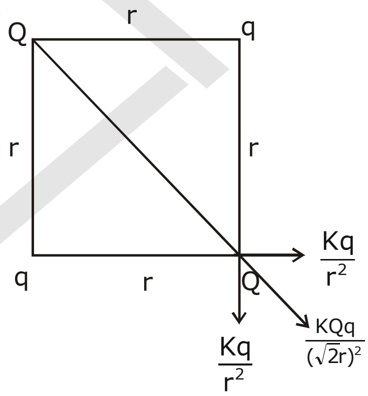
$$K\times10^{-9}\times\frac{9}{10}=0.001v^2$$

$$9\times10^9\times10^{-9}\times\frac{9}{10}=0.001v^2$$

$$v^2=\frac{81}{10\times10^3}=8100$$

v = 90 m/sec.

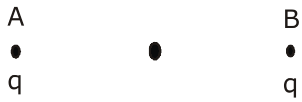
277. B



$$\frac{\sqrt{2}Kq}{r^2}+\frac{KQ}{2r^2}=0\quad,\quad \sqrt{2}q+\frac{Q}{2}=0$$

$$\Rightarrow Q=-2\sqrt{2}q$$

278. D



Decreases then increases

279. C

X $\to$ W.D. Zero
Y and Z $\to$ initial and final point same
$\therefore$ Work done same
$\therefore$ W electric = +ve
W $\to$ W.D. electric = - ve

280. C

$W \rightarrow$ High Potential $\rightarrow$ Low Potential

$X \rightarrow$ Circular Motion

$Y, Z \rightarrow$ Low Potential $\rightarrow$ High Potential

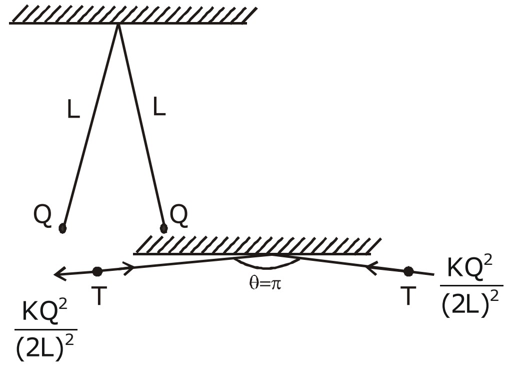
Ans. X, Y, Z

281. A

$\phi = \int \vec{E}\, d\vec{s}, \qquad = \pi R^2 E$

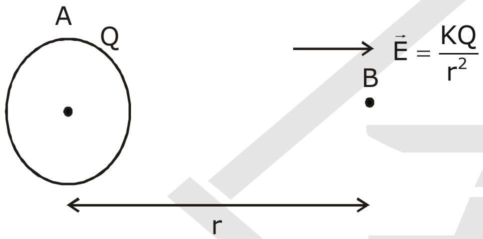
282. C

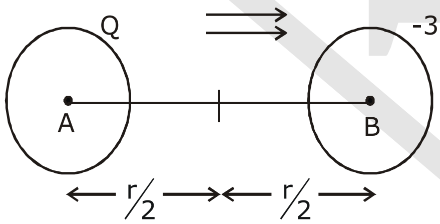
No gravity



$\theta = \pi, \qquad T = \frac{KQ^2}{4L^2}$

283. D



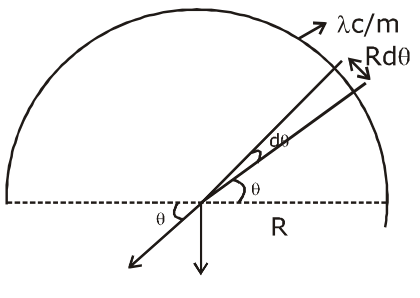


$$E_1 = \frac{KQ}{(r/2)^2} + \frac{K(3Q)}{(r/2)^2}$$

$$E_1 = \frac{4KQ}{r^2} + \frac{12KQ}{r^2}$$

$$E_1 = \frac{16KQ}{r^2} = 16E$$

284. A



$$dE = \frac{KdQ}{R^2} = \frac{K\lambda R d\theta}{R^2}$$

$$= \frac{K\lambda d\theta}{R}$$

Only Vertical component added

$$E = \int_0^{\pi} \frac{K\lambda}{R} \sin\theta\, d\theta = \frac{2K\lambda}{R}$$

285. D

$$v = \frac{KQ}{R}$$

$$\frac{4}{3}\pi R^3 = n \times \frac{4}{3}\pi r^3$$

$$R = n^{1/3} r$$

$$r = n^{-1/3} R$$

$$Q = nq$$

$$v' = \frac{kq}{r} = K\left(\frac{Q}{n}\right) \cdot \frac{1}{n^{-1/3} R}$$

$$v' = \frac{1}{n^{2/3}} \cdot \frac{KQ}{R}$$

$$v' = n^{-2/3} v$$

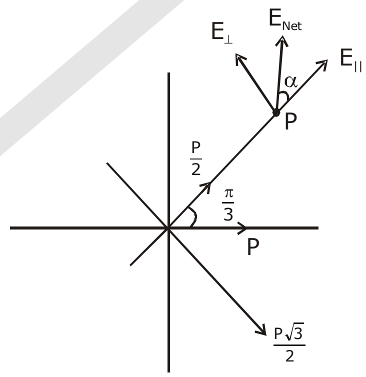
286. A

$\vec{\tau} = \vec{P} \times \vec{E}$

$\tau \rightarrow \max$

When $\theta = 90^0$

287. B



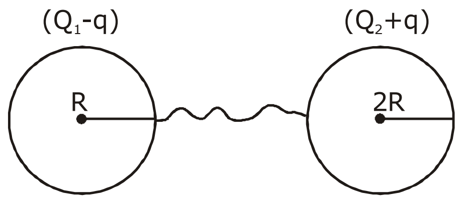
$$\tan\alpha = \frac{\frac{KP\left(\sqrt{3}/2\right)}{r^3}}{\frac{2KP/2}{r^3}}$$

$$\Rightarrow \tan\alpha = \frac{\sqrt{3}}{2}$$

$$\alpha = \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$$

$$\theta = \frac{\pi}{3} + \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$$

288. C



$$E_1 = \frac{V}{R_1}$$

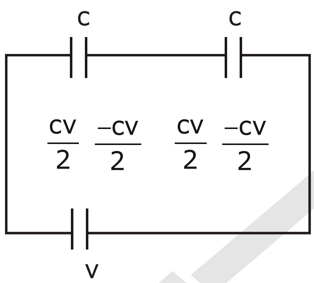
$$E_2 = \frac{V}{R_2}$$

$$\frac{E_1}{E_2} = \frac{R_2}{R_1}$$

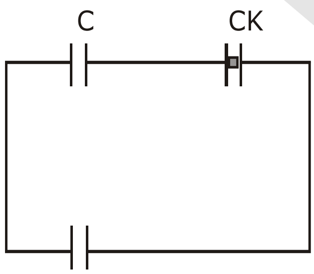
$$\frac{E_1}{E_2} = \frac{2R}{R}$$

$$\frac{E_1}{E_2} = \frac{2}{1}$$

289. A



$$C_{eq} = \frac{C}{2} \quad Q = \frac{cv}{2}$$



$$C_{eq} = \frac{C \times CK}{C + CK} = \frac{CK}{K+1}$$

$$Q = \frac{CKV}{K+1}$$

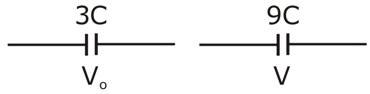
$$Q_{battery} = \frac{CKV}{K+1} - \frac{CV}{2}$$

$$= \frac{CV}{2}\left[\frac{K-1}{K+1}\right]$$

290. D

For isolated capacitor

$Q = Q_0$ (Remains same)

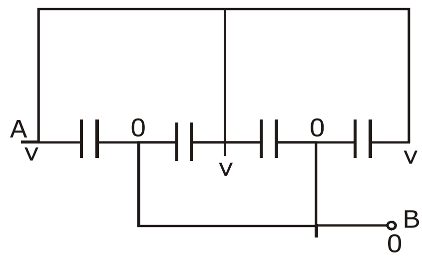


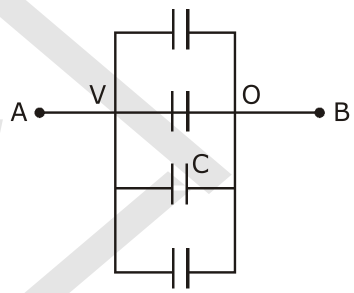
$Q = 3CV_0 = 9CV$

$$\Rightarrow V = \frac{V_0}{3}$$

$$E_o = \frac{V_o}{d}, E = \left[\frac{V_0/3}{d}\right] = \frac{E_o}{3}$$

291. A





Ceq = 4 C
= 4 x 8 μf
= 32 μf

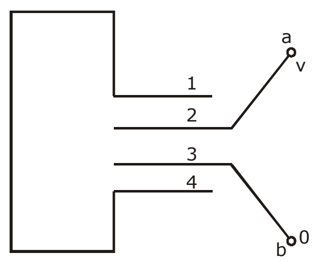
292. C

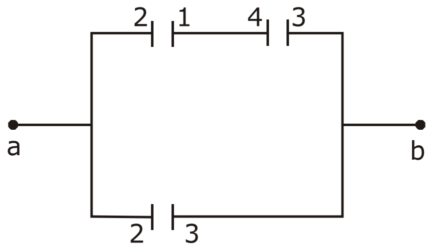
$$C = \varepsilon_o A / d - t + t/K$$

$$\frac{\varepsilon_o}{3} = \frac{\varepsilon_o A}{d - 1 + 1/2}$$

$$3 = d - 0.5 \Rightarrow d = 3.5\,\text{mm}$$

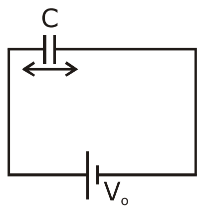
293. D





$$C_{eq} = \frac{C}{2} + C = \frac{3C}{2} = \frac{3}{2}\ \frac{\varepsilon_o A}{2}$$

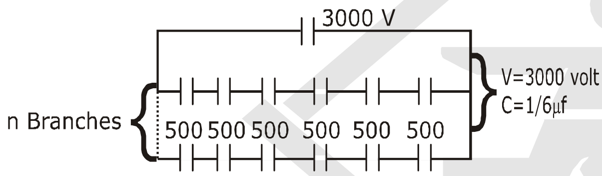
294. B



$$V_1 = \frac{V_0 KC}{C + KC}$$

$$V_1 = \frac{V_0 K}{1 + K}$$

295. C

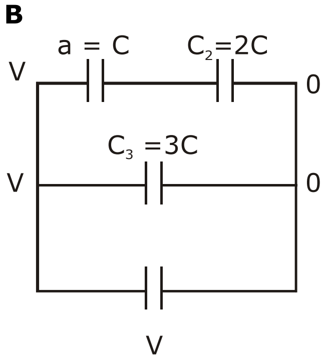


$$\frac{n}{6} = 2$$

n = 12

= 12 × 6 = 72 CAD

296. B



$$Ceq = \frac{2C}{3}$$

$$Q = \frac{2C}{3} V$$

$$Q_3 = 3CV = \frac{3 \times 3Q}{2} = \frac{9Q}{2}$$

297. C

$$i = \frac{V}{R} e^{-t/RC} = \frac{2}{10^4} e^{-\frac{0.02}{10^4 \times 2 \times 10^{-6}}}$$

$$= 7.4 \times 10^{-5} A$$

298. A

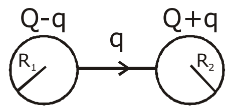
$$U_o = \frac{1}{2} CV^2$$

Dielectric insert

$$C' = CK$$

$$U_f = \frac{1}{2}(CK)\, v^2 = KU_o$$

299. B

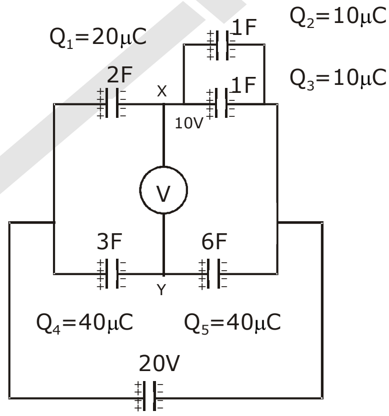


$$V = \frac{K(Q_1 + Q_2)}{R_1 + R_2}$$

$$V = \frac{2KQ}{R_1 + R_2}$$

$$Q = \frac{V}{2K}(R_1 + R_2)$$

300. C



$$\therefore V_x - V_y = \frac{-Q_1}{2} + \frac{Q_4}{3}$$

$$V_x - V_y = \frac{-20}{2} + \frac{40}{2}$$

$$V_x - V_y = -10 + \frac{40}{3}$$

$$V_x - V_y = \frac{10}{3}\ \text{Volt}$$

= 3.33 Volt

301. B

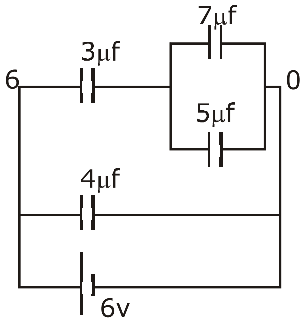
$$\frac{1}{C_{eq}}=\frac{d/2}{\varepsilon_o A}+\frac{d/2}{\varepsilon_o A}=\frac{d}{\varepsilon_o A}$$

$$\frac{1}{C_{eq}}=\frac{1}{C}\Rightarrow C_{eq}=C$$

302. A

$$C_{eq}=\frac{\varepsilon_o A}{d/2}\Rightarrow\frac{2\varepsilon_o A}{d}\Rightarrow C_{eq}=2C$$

303. C

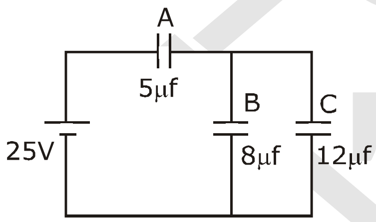


$$V_1=V_2=\frac{1}{3}:\frac{1}{7} \qquad =7:3$$

$$V_2=\frac{3}{10}\times 6=\frac{9}{5}$$

$$Q=CV_2=\frac{5\times 9}{5}=9\mu C$$

304. A



$$C_{eq}=\frac{5\times 20}{25}=4\mu F$$

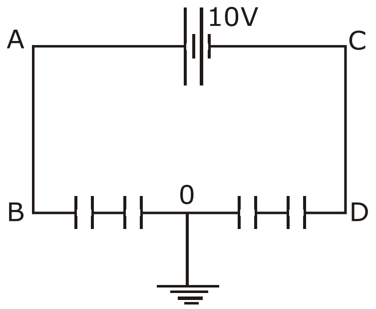
$$Q_A=25\times 4=100\mu C$$

$$Q_B:Q_C=8:12=2:3$$

$$Q_B=\frac{2}{5}\times 100=40\,\mu C \qquad Q_C=60\mu\, C$$

$$Q_A:Q_B:Q_C=100:40:60=5:2:3$$

305. B



$$V_B-V_D=10V$$

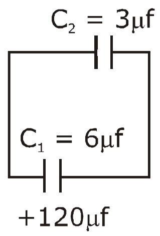
$$V_B-V_0=\frac{10\times C/2}{C/2+C/2}=5V$$

$V_B-V_0=5$

Hence $V_B=5V$

Hence $V_D=-5V$

306. C



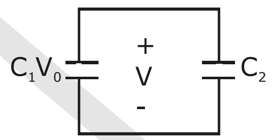
$$120=(3+6)V$$

$$V=\frac{120}{9}=\frac{40}{3}\text{ Volt}$$

$$Q_{C_2}=\frac{40}{3}\times 3=40\mu C$$

307. A

$$U_1=\frac{1}{2}C_1V_0^2$$



$$C_1V_o=(C_1+C_2)V$$

$$V=\frac{C_1V_0}{C_1+C_2}$$

$$U_2=\frac{1}{2}(C_1+C_2)\frac{C_1^2V_0^2}{(C_1+C_2)^2}=\frac{1}{2}\frac{C_1^2V_0^2}{(C_1+C_2)}$$

$$\frac{U_1}{U_2}=\frac{1/2C_1V_0^2}{1/2\,\frac{C_1^2V_0^2}{(C_1+C_2)}}$$

$$\frac{U_1}{U_2}=\frac{C_1+C_2}{C_1}$$

308. D

$i=2\times 10^{-2}\times 30\ =0.6$ A

309. B

n $\rightarrow$ ulaterned

$\uparrow i=neAV_d\Rightarrow V_d\uparrow$

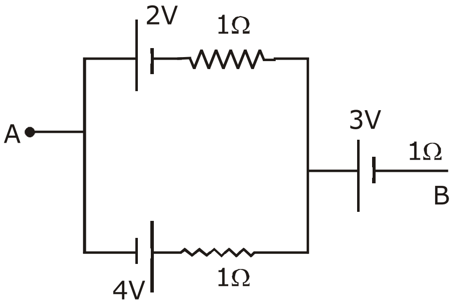
310. C

$$R_1=\frac{\rho l}{A}=\frac{\rho l}{\pi r^2}$$

$$R_2=\frac{\rho l}{\pi(2r)^2-\pi r^2}=\frac{\rho l}{3\pi r^2}$$

$$\frac{R_2}{R_1}=\frac{1}{3}$$

311. A



$$i=\frac{4+2}{2}=3A$$

$$V_A-2+3-3=V_B \Rightarrow V_A-V_B=2V$$

312. C

$pr^2\ell = k$

$$\ell = \frac{k}{\pi r^2}$$

$$\therefore R = \frac{PK}{\pi^2 r^4}$$

$$\frac{\Delta R}{R} \times 100 = -4\left(\frac{\Delta r}{r}\times 100\right)$$

$= -4 \times -0.\%$

$0.4\ \%$

313. C

Let n No. of cells

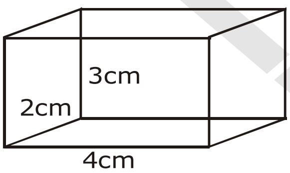
$$0.6 = \frac{1.5n}{0.5n+20}$$

$$0.3n+12=1.5n \Rightarrow 12=1.2n$$

$$n=10$$

314. A

$$R_1=\rho x\frac{4}{2\times 3}=\frac{2}{3}\rho$$

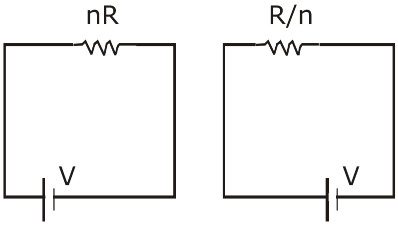


$$R_2=\rho x\frac{3}{8}=\frac{3}{8}\rho$$

$$R_3=\frac{\rho x2}{4\times 3}=\frac{\rho}{6}$$

$$\text{Ratio} = \frac{2/3\,\rho}{\rho/6}=4$$

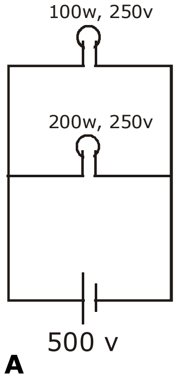
315. B



$$\frac{Heat_1}{Heat_2}=\frac{1}{n^2}$$

316. C

Both bulbs will be fused



317. A

$$P=\frac{v^2}{R} \qquad R\downarrow \quad P\uparrow$$

318. B

$$P=i^2R \qquad R\uparrow \quad P\uparrow$$

319. B

$$\text{Slope } \frac{I}{V}=\frac{1}{R}$$

$(\text{Slope})_1 > (\text{Slope})_2$

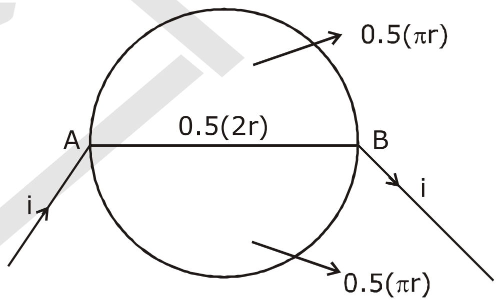
$$\frac{1}{R_1}>\frac{1}{R_2} \Rightarrow R_2>R_1$$

$$T\uparrow \quad R\downarrow \qquad \therefore T_2>T_1$$

320. B

$$i^2Rt=ms\Delta t$$

321. C



$$\frac{1}{R_{eq}}=\frac{1}{0.5\pi r}+\frac{1}{0.5\times 2r}+\frac{1}{0.5\pi r}$$

$$=\frac{2}{\pi r}+\frac{1}{r}+\frac{2}{\pi r}=\frac{4}{\pi r}+\frac{1}{r}$$

r= 1

$$\frac{1}{R_{eq}}=\frac{4+\pi}{\pi} \Rightarrow R_{eq}=\left(\frac{\pi}{\pi+4}\right)\Omega$$

$$\frac{P}{Q}=\frac{R(S_1+S_2)}{S_1S_2}$$

322. C

$$\frac{9\times 6R_1}{6+R_1}=44$$

$$27R_1=(22\times 6)+22R_1$$

$$5R_1=132$$

$$R_1=26.4\Omega$$

323. C

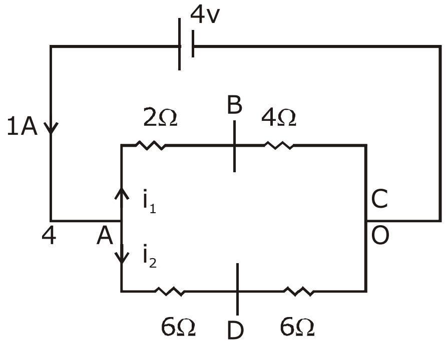
Slope = R = $\frac{\rho l}{A}$

Double when length double

324. A

Req = 4 Ω

$i = 1A$



$i_1 : i_2 = \frac{1}{6} : \frac{1}{12} = 2 : 1$

$i_1 = \frac{2}{3}A$

$i_2 = \frac{1}{3}A$

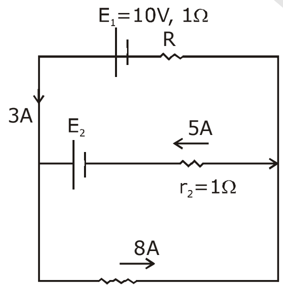
$V_B = 4 - \left(\frac{2}{3} x\, 2\right) = \frac{8}{3}V$

$V_D = 4 - \left(\frac{1}{3} x\, 6\right) = 2V$

$V_B - V_D = \frac{8}{3} - 2 = \frac{2}{3} = 0.67V$

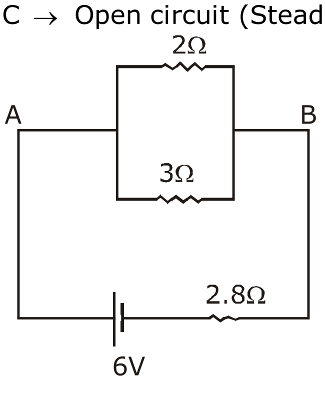
325. A

3A according to kirchott's junction rule



326. B

C $\rightarrow$ Open circuit (Steady state)



$i = \frac{V}{R} = \frac{6}{1.2 + 2.8} = \frac{6}{4} = 3/2\,A$

$i_{2\Omega} = \frac{3}{5} x \frac{3}{2} = \frac{9}{10} = 0.9A$

327. D

Max^m current in 1 and 5

So 1 and 5

328. C

$\frac{\text{Energy}}{\text{time}} = i^2R = (7)^2 \times 60 = 49 \times 60\ J/sec$

Q = ms ΔT

49 x 60 x 60 = 42 x (4200) Δt

Δt = 1^{0}C

329. A

V = i_g (r_g +S)

12 = 1 x 10^{-3} [100+S]

12000 - 100 = S

$\Rightarrow S = 11900\,\Omega = 11.9K\Omega$

330. C

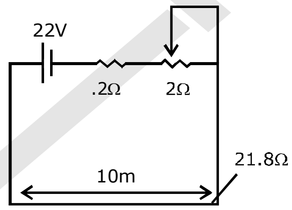
$\frac{E}{l}.x_1 = E_1$

$\frac{E}{l}.x_2 = E_2$

$x_2 > x_1$

$E_2 > E_1$

331. A



$i_{min} = \frac{22}{0.2 + 22 + 21.8}$

$= \frac{22}{44} = \frac{1}{2}A$

$V = \frac{1}{2} x\, 21.8 = 1.09$

$\frac{v}{l} = \frac{10.9}{10} = 1.09$

$i_{max} = \frac{22}{0.2 + 21.8} = \frac{22}{22} = 1A$

$V = 1 x\, 21.8 = 21.8$ volt

$\frac{V}{l} = \frac{21.8}{10} = 2.18$

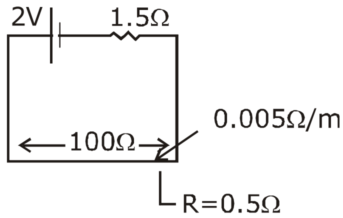
332. C

$$i = i_g\left(1+\frac{r_g}{S}\right)$$

$$i = \frac{10}{100}i\left[1+\frac{99}{S}\right]$$

$$10 = 1+\frac{99}{S} \Rightarrow 9 = \frac{99}{S} \Rightarrow S = 11\Omega$$

333. C



$$i = \frac{2}{1.5+0.5} = 1A$$

$$v = 0.5 \times 1 = 0.5\ \text{volt}$$

$$\text{P.G.} = \frac{0.5}{100} = 5\times10^{-3}\ v/m$$

334. B

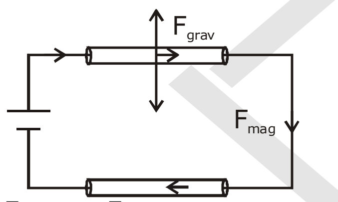
Not depend on diameter of wire

335. C

$$F = \frac{m_0 I_1 I_2 \ell}{2\pi}\left[\frac{1}{d}-\frac{1}{d+a}\right]$$

$$= 1.5 \times 10^{-8}$$

336. A

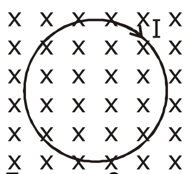


$$F_{mag} = F_{grav}$$

$$\frac{\mu_0 I_1 I_2 \ell}{2\pi d} = mg$$

$$I = \sqrt{\frac{2\pi dmg}{\mu_0 \ell}} = 47\ A$$

337. C



$$F_{Loop} = 0$$

338. A

Spring will be compressed because parallel wires carrying current in same direction attracts each other

339. D

$$F = \frac{\mu_0 I_1 I_2}{2\pi d}$$

$$F' = \frac{\mu_0 I_1 I_2}{9\times 2\pi \times 2d}$$

$$F' = \frac{F}{18}$$

340. D

$\mu = NIA$

$= 10 \times 2 \times \pi r^2$

$= 10 \times 2 \times \pi \times 1 \times 10^{-2}$

$= 0.2 \times 3.14 = 0.628$

341. A

$T = NIAB \sin\theta$

$$T = Ni\ \pi r^2 \left(\frac{\mu_0 I}{2R}\right) \sin 90°$$

$$T = Ni\ \pi r^2 \left\{\frac{\mu_0 I}{2R}\right\}$$

342. B

$w = \mu B(\cos\theta_1 - \cos\theta_2)$

$= 2\mu B$

$= 2NIAB$

$= 2\, NI\pi R^2 B$

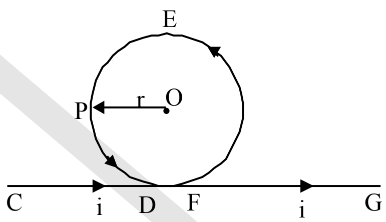
343. A

$$B = \left(\frac{\mu_0 I}{2\pi r}+\frac{\mu_0 I}{2r}\right)$$

$$= \frac{\mu_0 i}{2r}\left(1+\frac{1}{\pi}\right),\ \odot$$

344. A

$B_O = B_{CG} + B_{DEF}$



$$B_0 = \frac{\mu_0 i}{2\pi r} + \frac{\mu_0 i}{2r} = \frac{\mu_0 i}{2r}\left(1+\frac{1}{\pi}\right) \odot$$

Its direction will be normal to plane of paper upwards.

345. C

The magnetic induction produced due to a current carrying arc at its centre of curvatureis-

$$B = \frac{\mu_0 i\alpha}{4\pi r} \quad \text{......... (A)}$$

$$\therefore \alpha = \frac{\pi}{4} \quad \text{...........(B)}$$

From eqs. (A) and (B)

$$B = \frac{\mu_0 i\pi}{4\times4\times\pi r} = \frac{\mu_0 i}{16 r}$$

346. A

$$B_0 = B_{PSR} + B_{PQR} \quad \text{.... (A)}$$

$$B_{PSR} = \frac{\mu_0 i}{2\pi}\left[\frac{2\pi-2\phi}{r}\right] = \frac{\mu_0 i}{2\pi r}[\pi-\phi] \quad \text{.... (B)}$$

$$B_{PQR} = \frac{\mu_0 i}{4\pi}\cdot\frac{2\sin\theta}{OQ}$$

From the figure OQ = r cos θ

$$B_{PQR} = \frac{\mu_0 i}{4\pi}\frac{2\tan\phi}{r} \quad .... (C)$$

From eqs. (A) and (C)

$$B = \frac{\mu_0 i}{2\pi r}[\pi - \phi] + \frac{\mu_0 i}{2\pi r}\tan\phi$$

$$= \frac{\mu_0 i}{2\pi r}[\pi - \phi + \tan\phi]$$

347. A

$\ell = (2\pi r)n$ or $n = \frac{\ell}{2\pi r}$

$$B = \frac{\mu_0 n i}{2r} = \frac{\mu_0 i\ell}{4\pi r^2} \text{ or}$$

$$B = \frac{4\pi\times10^{-7}\times6.28\times1}{2\times2\times\pi\times(0.10)2} = 6.28 \times 10^{-5} \text{ Tesla.}$$

348. B

$E_{kp} = eV$, $\therefore E_k = qV$,
$\therefore E_k \propto q$, $\therefore V$ = constant
$E_{kp} : E_{kd} : E_{ka} : : 1 : 1 : 2.$

349. A

The electron will pass undeviated if the electric force and magnetic force are equal and opposite. Thus
E.e. = Bev or B = E/v
but E = V/d

$$\text{Therefore, } B = \frac{V}{v.d.} = \frac{600}{3\times10^{-3}\times2\times10^{6}}$$

$\therefore B = 0.1\ wb/m^2$.
The direction of field is perpendicular to the plane of paper vertically downward.

350. A

Kinetic energy of the proton $= \frac{1}{2}mv^2$
$= 5$ MeV

$$\text{or } v^2 = \frac{2\times5\text{MeV}}{m} = \frac{2\times5\times10^{6}\times1.6\times10^{-19}}{1.6\times10^{-27}}$$

$= 3.1 \times 10^7$ m/s.

The magnetic field is horizontal from south to north and velocity $\vec{v}$ is vertically downward, i.e. angle between $\vec{v}$ and is $\vec{B}$ is 90º therefore force on proton
F = qvB sin 90 = qvB = evB
$= 1.6\times10^{-19}\times3.1 \times 10^7 \times 1.5$
$= 7.44 \times 10^{-12}$ N.
According to Fleming left had rule, the direction of force is horizontal from west to east.

351. C

$$\text{We have } F = qvB = \frac{mv^2}{r} \text{ or } v = \frac{qBr}{m}$$

$$= \frac{3.2\times10^{-19}\times1.2\times0.45}{6.8\times10^{-27}} = 2.6 \times 10^7 \text{ m/s.}$$

$$\text{The frequency of rotation } n = \frac{v}{2\pi r}$$

$$= \frac{2.6\times10^{7}}{2\times3.14\times0.45} = 9.2 \times 10^6\ \text{sec}^{-1}.$$

Kinetic energy of α-particle,

$$E_K = \frac{1}{2} \times 6.8 \times 10^{-27} \times (2.6 \times 10^7)^2$$

$= 2.3 \times 10^{-12}$ joule.

$$= \frac{2.3\times10^{-12}}{1.6\times10^{-19}} \text{ eVolt} = 14 \times 10^6 \text{ eV}$$

= 14 MeVolt.
If V is accelerating potential of α-particle, then Kinetic energy = qV
14×10^6 eVolt = 2eV (since charge on α-particle = 2e)

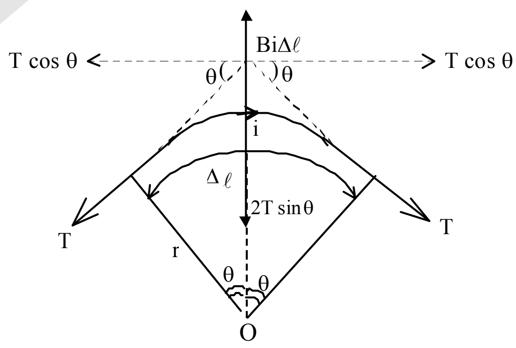
$$\therefore V = \frac{14\times10^{6}}{2} = 7 \times 10^6 \text{ Volt.}$$

352. A

$F = Bi\ell\sin\theta = 0.25 \times 5 \times 0.25 \sin 65^\circ$
$= 0.3125 \sin 65^\circ$

353. C

When the current is passed in the loop, magnetic force 'Bil' acts at every point of the loop. This force is at right angles to the current but lies in the plane of the loop. So the loop stretches out into a circle. Figure shows a part of this circle. The tension in the loop is T. Then according to the geometry of the figure.



$2T\sin\theta = Bi\,\Delta\ell$
where $\Delta\ell$ is the length of the element.
Since, θ is small, $\sin\theta \cong \theta$, therefore
$2\theta.T = Bi\,\Delta\ell$
or $(\Delta\ell/r)$. $T = Bi\,\Delta\ell$ or $T = B.\,ri$
but $2\pi r = \ell$ length of wire

$$\therefore T = \frac{Bi.\ell}{2\pi} = \frac{1\times157\times0.5}{3\times3.14} = 0.125 \text{ N.}$$

354. A

Let ab be a metal wire sliding on rails PQ and RS, in a region of uniform field of induction, $\vec{B}$ pointing vertically upward. The magnetic field $\vec{B}$ is normal to length of wire ab ($\theta = 90^o$); therefore magnetic force on the wire of length (ab = d) is given by F = Bid sin 90º = Bid

By Fleming left hand rule, this force is directed away from battery as shown in fig. If m is mass of wire and a the acceleration,

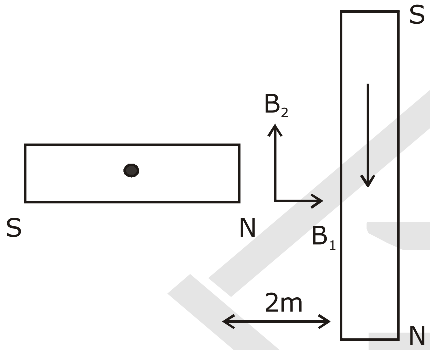
then F = ma = Bid. or $a = \frac{Bid}{m}$ = const.

$\therefore$ From relation v = u + at, we have velocity after time t

(initial velocity u = 0)

$v = 0 + \frac{Bid}{m}t$ or $v = \frac{Bid}{m}t$

355. A



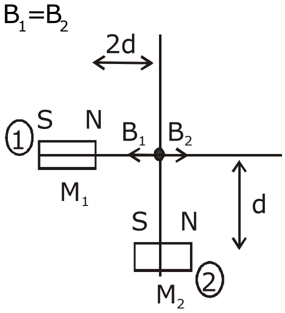
$$B_1 = \frac{2\mu_o}{4\pi}\frac{M}{r^3} = \frac{2\mu_o}{4\pi}$$

$$B_2 = \frac{\mu_o}{4\pi}\frac{M}{r^3} = \frac{\mu_o}{4\pi}$$

$$B_{net} = \sqrt{B_1^2 + B_2^2} = \frac{\mu_o}{4\pi}\sqrt{5}$$

356. B

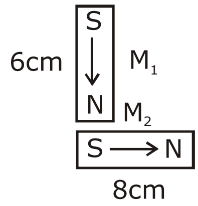
$B_1 = B_2$



$$\frac{2\mu_o}{4\pi}\cdot\frac{M_1}{(2d)^3} = \frac{\mu_o}{4\pi}\cdot\frac{M_2}{d^3}$$

$$\frac{M_1}{M_2} = \frac{4}{1}$$

357. A



$$M = \sqrt{M_1^2 + M_2^2}$$

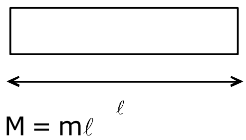
$$M_1 = \frac{3\mu}{7}, \quad M_2 = \frac{4\mu}{7}$$

$$M = \frac{\mu}{1.4}$$

358. A

$$\frac{B_1}{B_2} = \frac{\tau_1}{\tau_2} \quad [\tau = MB]$$

359. D



$M = m\ell$

$$M_1 = m.\frac{3\ell}{\pi}$$

$$M_1 = \frac{3M}{\pi}$$

360. C
By theory

361. A
By Theory

362. A
By theory

363. C
By Theory

364. C
By Theroy

365. A
By Theory

366. C
By Theroy

367. D
By Theory

368. D
By Theroy

369. D
By Theroy

370. B
Anticlockwise

371. C

$$q = \frac{\Delta\phi}{R} = \frac{B(\pi r^2) - 0}{R} \propto r^2$$

372. A

$$\phi_1 = B_1 A = \frac{\mu_o i}{2\pi r} A$$

$$\phi_2 = 0$$

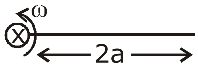
$$\varepsilon_{av} = \frac{\Delta\phi}{\Delta t}$$

373. A

$q = \frac{\Delta\phi}{R} = \frac{Ba^2}{R}$

374. C

$emf = \frac{B\omega(2a)^2}{2}$



375. B

$M = \frac{N_s\phi_s}{i_p}\ [\phi s = \mu_o n i_p\ \pi a^2]$

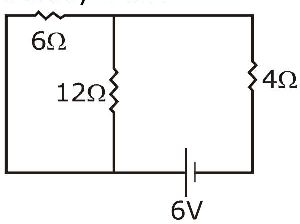
$= = \mu_o nN\pi a^2$

376. A

Time constant

$\frac{L}{R} = .25\sec$

Steady State



$i = \frac{V}{R} = \frac{6}{8} = \frac{3}{4} = 0.75A$

377. D

$\varepsilon = \varepsilon_o \sin\omega t$

$= (i_o x_L)\sin\omega t$

$\varepsilon_o\ x\ f$

$\frac{E_1}{E_2} = \frac{f_1}{f_2}$

378. B

$\varepsilon = \frac{Ldi}{dt}$

L= 0.2H

379. C

Displacement vector same

So induced current remain same

380. A

$\frac{90}{100} i_o = i_o(1 - e^{-Rt_1/L})$

$t_1 = \frac{L}{R}\ln 10 \quad .....(1)$

$\frac{99}{100} i_o = i_o(1 - e^{-Rt_2/L})$

$t_2 = \frac{2L}{R}\ln 10 \quad ...(2)$

$\frac{t_1}{t_2} = \frac{1}{2}$

381. B

Current will decrease in each loop

382. D

$i = i_0(1 - e^{-Rt/L})$

$\frac{1}{2} = e^{-2\omega t}$

$t = \frac{\ln 2}{200} = 3.5\text{m}\sec$

383. B

$A \rightarrow$ negatively charged

$\varepsilon = (\vec{V} \times \vec{B}).d\vec{l}$

384. A

$\varepsilon = \frac{\phi_2 - \phi_1}{t} = 5V$

$i = \frac{\varepsilon}{R} = 0.5A$

385. B

$i_{rms} = \sqrt{\frac{\int_0^{\tau} \frac{i_0^2 t^2}{\tau^2} dt}{\int_0^{\tau} dt}} = \frac{i_o}{\sqrt{3}}$

386. A

$Z_1 = \sqrt{4^2 + 3^2} = 5\Omega$

$Z_2 = \sqrt{4^2 + (6-3)^2} = 5\Omega$

$\frac{Z_1}{Z_2} = \frac{1}{1}$

387. B

$\tan 45^0 = \frac{XL}{R} \Rightarrow X_L = R$

$\tan 45^0 = \frac{X_C - X_L}{R} \Rightarrow R = X_C - R \Rightarrow X_C = 2R$

$Z = \sqrt{R^2 + (X_C - X_L)^2} = R\sqrt{2}$

388. C

$P = V_{rms} i_{rms} \cos\phi, Z = \sqrt{2}R$

$\tan\phi = \frac{X_L}{R} = 1 \Rightarrow \phi = 45^0$

$P = \frac{E_o}{\sqrt{2}} \cdot \frac{E_o/\sqrt{2}}{\sqrt{2}R} \cdot \frac{1}{\sqrt{2}} = \frac{E_0^2}{4R}$

389. A

$v = 120\sin 100\pi t \cos 100\pi t$

$v = 60\sin 200\pi t$

Max^m voltage = 60

$f = \frac{200\pi}{2\pi} = 100Hz$

390. D

$P = V_{rms} i_{rms} \cos\phi = 50W$

Power factor = $\cos\pi/3 = 0.5$

391. A

$e_o = 100$

$i_o = 200mA$

$X_C = \frac{e_o}{i_o} = 500 = \frac{1}{\omega C}$

$C = 2\mu f$

392. B

$Z = 50\angle\frac{\pi}{6} = 50(\cos\pi/6 + i\sin\pi/6)$

Resistance = $25\sqrt{3}\Omega$

Reactance = 25Ω

393. B

$V = V_1 + V_2\cos\omega t$

$V_{rms} = \sqrt{\frac{1}{T}\int_0^T V^2 dt}$

$V_{rms} = \sqrt{\frac{1}{T}\int_0^T V^2 dt} = \sqrt{V_1^2 + \frac{V_2^2}{2}}$

Heat / Sec. = $\frac{V_{rms}^2}{R}$

Optics

403. C

No. of Images = $\frac{360}{\theta} - 1 = 7$

$\frac{360}{\theta} = 8$

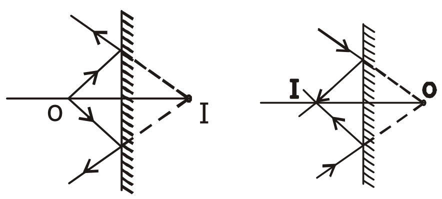
$\theta = \frac{360}{8} = 45^0$

404. B

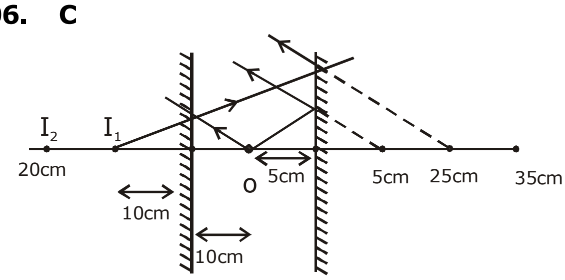
$W_{ref.ray} = 2w_{miror}$

$W_{ref.ray} = 6$ rad/sec

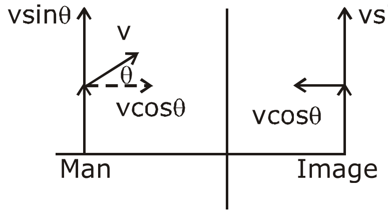
405. A



406. C



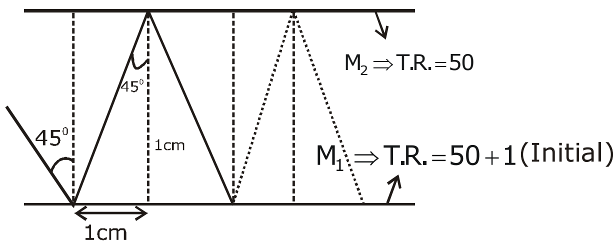
407. B



$\vec{V}_{IM} = \vec{V}_I - \vec{V}_M$

$\vec{V}_{IM} = -2V\cos\theta$

408. D



Total Reflection = 101

409. A

Focal length of mirror is independent of refractive index of medium

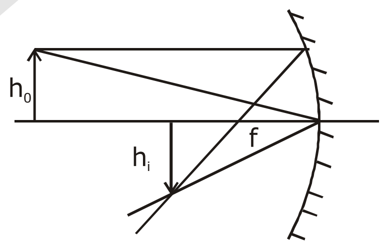
$\because f = R/2$

410. C

Given R = 40 cm $\qquad f = \frac{40}{2} = 20cm$

Concave miror f = -20 cm

$\frac{h_i}{h_o} = -\frac{1}{2} = \frac{-v}{u}$



$\frac{h_i}{h_o} = \frac{-1}{2} = \frac{-v}{u}$

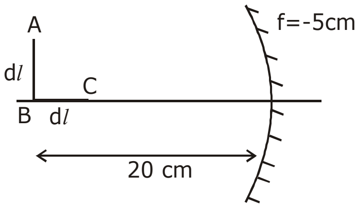
$v = \frac{u}{2}$

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$\frac{2}{u} + \frac{1}{u} = -\frac{1}{20} \Rightarrow \frac{3}{u} = -\frac{1}{20} \Rightarrow u = -60\,cm$

v = -30 cm

411. B



For AB u = - 20cm

f = -5 cm

there v = -20/3 cm

$h_i = \frac{-v}{u}h_o = \frac{-dl}{3}$

For BC

$dv = \frac{-v^2}{u^2}dv \quad = -\left(\frac{20}{3 \times 20}\right)^2 \times dl = \frac{-dl}{9}$

Ratio = 3:1

412. C

Image & object meet at a point centre of curvature so R = 50 cm

f = 25 cm

413. A

If f = 25 cm

u = -30 cm

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{v} - \frac{1}{30} = -\frac{1}{25}$

$\Rightarrow \frac{1}{v} = \frac{-1}{25} + \frac{1}{30} \Rightarrow \frac{1}{v} = \frac{-30+25}{750} = -\frac{5}{750}$

$v = -150\,\text{cm}$

414. C

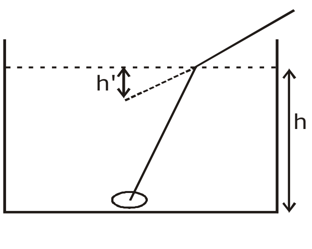
For real object and real Image

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \quad \Rightarrow \quad -\frac{1}{v} - \frac{1}{u} = -\frac{1}{f}$

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \quad \Rightarrow \quad \frac{1}{v} = -\frac{1}{u} + \frac{1}{f}$

y = mx + c

415. A



$\frac{h'}{h} = \frac{1}{\mu}$

$h' = \frac{h}{\mu}$

416. B

$\sin 60 = \sqrt{3} \sin r$

$r = 60^0$

$\sin 30^0 = \frac{d}{5}$

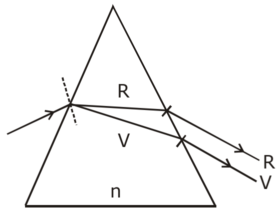
$d = \frac{5}{2}\text{cm}$

317. B

$n_V > n_R$

sin i = n sir r

$\sin r = \frac{\sin i}{n}$



318. B

min^m deviation i = e

$i = e = 60^0$

$\Rightarrow \delta = i + e - A$

$\delta = 60^0 + 60^0 - 60^0 = 60^0$

319. A

$\frac{\mu_P}{\mu_s} = \frac{\sin\left[\frac{\delta u + A}{2}\right]}{\sin A/2} \Rightarrow \sqrt{2} = \frac{\sin\left[\frac{\delta m + 60^0}{2}\right]}{\sin 30^0}$

$\frac{\delta m + 60^0}{2} = 45^0$

$\delta m = 30^0$

420. D

$\mu_a = 1 \qquad \mu_w = \frac{4}{3} = 1.33$

less converging $\left(\frac{\mu_e}{\mu_s} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) > 0$

less diverging $\left(\frac{\mu_e}{\mu_s} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) < 0$

From above discussion $\frac{\mu_e}{\mu_s} < 1$

$\Rightarrow 1 < \mu_e < 1.33$

421. A

given

$\left(\frac{\mu_e}{\mu_s} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$

$(1.50 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{20}$ ....(1)

Now in liquid of refractive index μ = 1.60

$\left(\frac{1.50}{1.60} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}$.........(2)

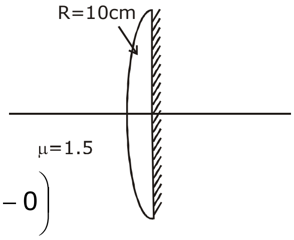
eq. (1) / eq. (2)

$-\frac{0.50 \times 1.60}{1 \times 0.10} = \frac{f}{20} \Rightarrow f = -160\text{cm}$

422. D

$$\frac{1}{f_{eq}} = +\frac{1}{f_m} - 2\left[\frac{1}{f_{e1}} + \frac{1}{f_{e2}} + \right]$$

$$= 0 - 1\left[\frac{1}{f}\right]$$

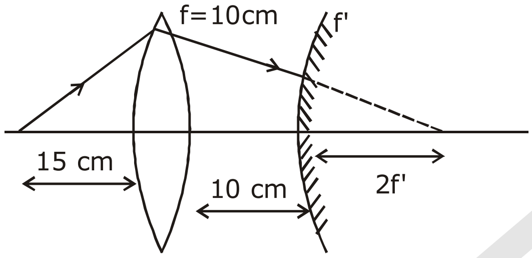


$$f_{eq} = -f/2$$

$$\frac{1}{f} = (1.5-1)\left(\frac{1}{10} - 0\right)$$

$$\frac{1}{f} = \frac{1}{20} \Rightarrow f_{eq} = -10\,\text{cm}$$

423. B



Lens formula $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

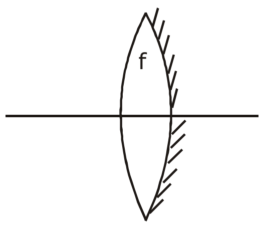
$$\frac{1}{v} + \frac{1}{15} = \frac{1}{10} \Rightarrow \frac{1}{v} = \frac{1}{10} - \frac{1}{15}$$

$$\frac{1}{v} = \frac{15-10}{150}$$

v = 30 cm $\Rightarrow 10 + 2f' = 30\,\text{cm}$

$f' = 10\,\text{cm}$

424. B



$$\frac{1}{f} = (\mu-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{10} == (1.5-1)\left(\frac{1}{R} + \frac{1}{R}\right) = \frac{1}{R}$$

$R = 10\text{cm}$

Now $\frac{1}{f_{eq}} = \frac{1}{f_m} - 2\left[\frac{1}{f_{e1}} + \frac{1}{f_{e2}}\right]$

$$\frac{1}{f_{eq}} = \frac{-1}{5} - 2\left[\frac{1}{10}\right]$$

$$\frac{1}{f_{eq}} = \frac{-2}{5} \Rightarrow f_{eq} = -5/2$$

$$u = 2f_{eq} = 5\,\text{cm}$$

425. C

$$\frac{h_i}{h_0} = \frac{v}{u} = n$$

v = nu

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \quad \Rightarrow \quad \frac{1}{nu} - \frac{1}{u} = \frac{1}{f}$$

$$\Rightarrow \frac{1}{u}\left[\frac{1-n}{n}\right] = \frac{1}{f}$$

$$u = \frac{(1-n)f}{n} = \frac{-(n-1)f}{n}$$

426. D

Minimum distance b/w Image & object on a converging lens

= 4 f

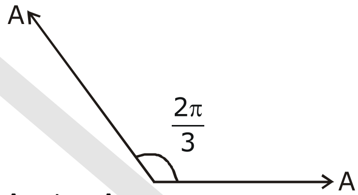
$\Rightarrow x + 2f + x' \geq 4f$

$x + x' \geq 2f$

427. C

Only Intensity decreases but f doesn't change so Image will not shift.

428. C



Anet = A

429. D

Amplitudes ratio $\Rightarrow$ 4:1

430. D

$$y_1 = a_1 \cos \omega t$$

$$y_2 = a_2 \cos\left[\frac{\pi}{2} - \omega t\right] = a_2 \cos(\omega t - \pi/2)$$

Then the Resultant is

$$a = \sqrt{a_1^2 + a_2^2 + 2a_1a_2 \cos \pi/2}$$

$$a^2 = a_1^2 + a_2^2$$

$$I \propto a^2 \Rightarrow I = Ka^2$$

$$I = K(a_1^2 + a_2^2)$$

431. A

$$\frac{dy}{D} = \Delta x \qquad \frac{dy}{D} = 7\lambda \Rightarrow y = \frac{7D\lambda}{d}$$

$$\frac{d_1}{d_2} = \frac{\lambda_1}{\lambda_2}$$

432. B

$$\beta = \frac{\lambda D}{d} \quad v = f\lambda \quad \Rightarrow \lambda = \frac{v}{f}$$

$$\lambda' = \frac{\lambda}{2}, \quad \beta' = \beta/2$$

433. **B**

$A_1 = A$, $A_2 = A.$, $A_{net} = A$

Then A_1 and A_2 differ by $120^0 (2\pi/3)$.

434. **A**

$\beta = 0.4\,mm = \dfrac{\lambda D}{d}$

$n_1\lambda_1 = n_2\lambda_2$

$\lambda_2 = \dfrac{n_1\lambda_1}{n_2} = \dfrac{3 \times \lambda_1}{4} = \dfrac{3\lambda_1}{4}$

$\Rightarrow \beta' = \dfrac{\lambda_2 D}{d} = \dfrac{3\lambda D}{4d} = \dfrac{3}{4}\beta$

$\beta' = \dfrac{3}{4} \times 0.4 = 0.3\,mm$

435. **C**

$\Delta x = (\mu - 1)t = (1.5 - 1)2000 = 1000\,\overset{0}{A}$

436. **A**

Power at the aperture = IA

$P_A = \left(\dfrac{10}{\pi}\right) \times \pi r_A^2 = 10 r_A^2$

$P_B = \left(\dfrac{10}{\pi}\right) \times \pi r_B^2 = 10 r_B^2$

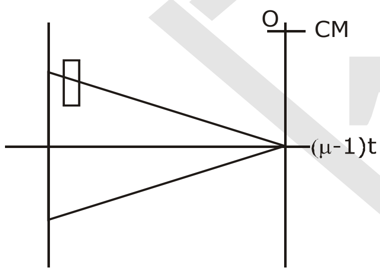
Power received at spot F

$= 10 r_A^2 \times \dfrac{10}{100} + 10 r_B^2 \times \dfrac{10}{100} = r_A^2 + r_B^2$

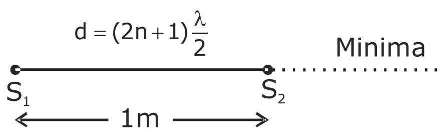
$= 10^{-6} + 4 \times 10^{-6}\,w = 5 \times 10^{-6}\,w$

437. **D**

Fringe pattern shift upward



438. **B**



$\Rightarrow (2n+1)\dfrac{\lambda}{2} = 1$

$\lambda = 2m$

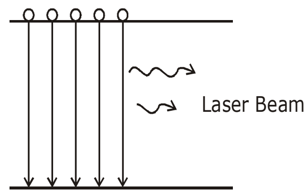
439. **D**

$\Delta x = (2n - 1)\dfrac{\lambda}{2}$

n = 5

$\Delta x = \dfrac{9\lambda}{2}$

440. **C**

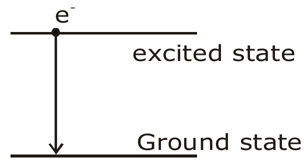


441. **D**

442. **B**

Modern Physics

448. **A**



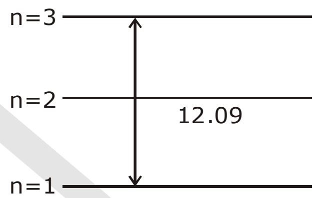
$r \downarrow K.E. \uparrow P.E. \downarrow T.E. \downarrow$

$K.E. = \dfrac{Kze^2}{2r}$, $P.E. = -\dfrac{Kze^2}{r}$, $T.E. = -\dfrac{Kze^2}{2r}$

449. **A**

$i = qt$, $i = \dfrac{e}{T} = \dfrac{ev}{2\pi r}$ $\quad i = \dfrac{eV}{2\pi r}$

450. **C**



No. of spectral line

$= \dfrac{n(n-1)}{2} \Rightarrow = \dfrac{3(3-1)}{2} = 3$

451. **D**

Shortest wavelength i.e. energy differ ence maximum

452. **C**

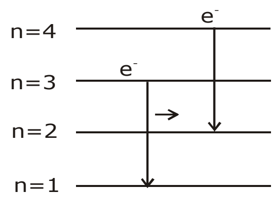
R O Y G B I V

$\xrightarrow{\quad\quad\lambda\quad\quad}$

If visible region Balmer series is present

$E_R < E_B$, $E_2 < E_3$

453. **A**



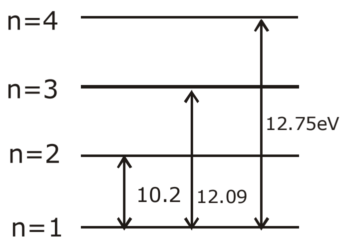
$\dfrac{1}{\lambda} = Rz^2\left[\dfrac{1}{1} - \dfrac{1}{3^2}\right]$ .....(1)

$\dfrac{1}{\lambda'} = Rz^2\left[\dfrac{1}{2^2} - \dfrac{1}{4^2}\right]$ .....(2)

eq (1) / eq. (2)

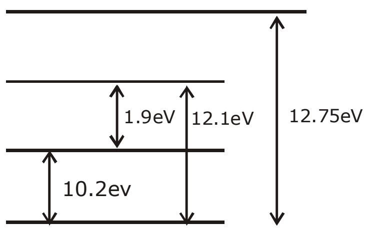
$\dfrac{\lambda}{\lambda'} = \dfrac{8}{9} \times \dfrac{16}{3} = \dfrac{128}{27} \Rightarrow \lambda' = \dfrac{128}{27}\lambda$

454. A



So e^- reaches maximum n = 4
So transition occur
$4 \to 1, 3 \to 1, 2 \to 1$
$4 \to 2, 4 \to 3, 3 \to 2$

455. D



Two or three atom are used

456. D
Which is used to excite the e^- from ground state

457. B

$$\lambda = \frac{h}{\sqrt{2qVm}}$$

For neutron q = 0
$\lambda \to \infty$

458. C
Speed = count = K.E. = const.
λ = Const.

459. D
For 5^{th} orbit $2\pi r = 5\lambda$

460. C
Initially nucleus at rest condition so after decay both particle have equal momentum is opposite direction

$$\lambda = \frac{h}{\sqrt{2qV_m}}$$

& momentum P = mv

461. D

$$K.E. = \frac{P^2}{2m}$$

462. B
In Intial half K.E. = 15 ev $\Rightarrow (\lambda_1)$
In next half K.E. = 15-10 = 5 eV $\Rightarrow (\lambda_2)$

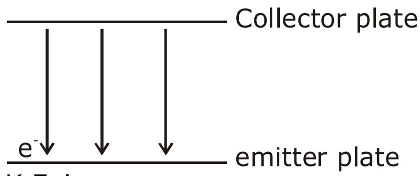
463. C
magnetic field doesn't change speed So λ doesn't change

464. C

$$\frac{f}{2}KT = \frac{1}{2}mv^2 \Rightarrow V = \sqrt{\frac{fKT}{m}}$$

$$\lambda = \frac{h}{mv} \Rightarrow \lambda = \frac{h}{\sqrt{fmKT}}$$

465. B



K.E. increases

466. D

V I B G Y O R

$\longrightarrow$ Infrared

$\lambda \uparrow \quad f \downarrow$

If photon of blue colour doesn't emit electron then Red, Infrared, Yellow doesn't exit

467. B
e^- will come out when energy gained by e^- is more than work function

468. C

$$I_i = \frac{\rho}{4\pi r^2} = \frac{\rho}{4\pi(1)^2} = \frac{\rho}{4\pi}$$

Energy incident = IA

$$\Rightarrow \text{No. of Photon} = \frac{IA}{hc}(\lambda)$$

$$I_f = \frac{\rho}{4\pi(2)^2} = \frac{\rho}{4(4\pi)}$$

$$\text{Energy} = I_F A$$

$$\text{No. of Photon} = \frac{(\text{Photon})_i}{4}$$

469. D

$$\varepsilon_{n_4} - \varepsilon_{n_1} = 2.55\text{ev}$$

$$(K.E.) = 2.55 - 1.9 = 0.65\text{ ev}$$

470. B

$$(K.f)_i = hf - \phi$$

$$(K.f)_f = nhf - \varphi$$

$$(K.\varepsilon.)_f = n[(K.E.)_i + \phi] - \phi$$

$$(K.E.)_f = n(K.E.)_i + (n-1)\phi$$

471. C [By Theory]
472. A [By Theory]
473. B [By Theory]
474. B [By Theory]
475. A [By Theory]

476. D
If may come out with a K.E., $hv - \varphi$

477. B
Photon energy

$$\varepsilon = \frac{1240}{400} = 3.1\text{ev}$$

Stopping potential = 2 v

So $(K.E.)_{max}$ = 2 eV

$\phi = 3.1 - 2 = 1.1 eV$

Now $\varepsilon = \frac{1240}{300} = 4.13\,eV$

$(K.E.)_{max}$ = 4.13 - 1.1 = 3.03 eV

478. **A**

Photon energy = $\frac{1240}{5.6 \times 10^3}$ eV

Energy rodiated = $\frac{100 \times 5}{100} = 5\,J/sec.$

No. of Photon / sec. $= \frac{5 \times 5.6 \times 10^3}{12400 \times 1.6 \times 10^{-19}}$

$= 1.4 \times 10^{19}$

479. **A** [Theory Based]
480. **D** [Theory Based]
481. **B** [Theory Based]
482. **A** [Theory Based]
483. **A** [Theory Based]
484. **C** [Theory Based]
485. **C** [Theory Based]
486. **A** [Theory Based]
487. **C** [Theory Based]
488. **B** [Theory Based]
489. **B** [Theory Based]
490. **B** [Theory Based]
491. **D** [Theory Based]
492. **A**
493. **D**
494. **C**
495. **B**

1 molar mass = L no of atom

$\frac{dN}{dt} = -\lambda N = \frac{\lambda m L}{M}$

496. **C**

$\frac{hc}{\lambda} = \frac{1}{2}(2m)c^2 \Rightarrow \lambda = \frac{h}{2mc}$

497. **C** t = T (half life)

498. **B**

After inserting gas activity increase again

$A = A_0 e^{-\lambda t}$

$\ln \frac{A}{A_0} = -\lambda t \Rightarrow \ln A = -\lambda t + \ln A_0$

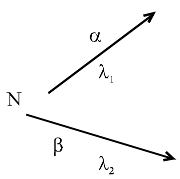
499. **A** [Theory Based]

500. **A**

$\lambda = \ln 2 \left(\frac{1}{4} + \frac{1}{16} \right)$

$\lambda = \frac{10 \ln 2}{32}$

$t_{1/2} = 3.2$



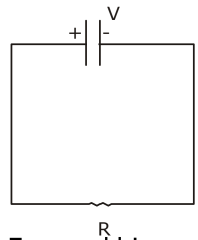
So after 12 years

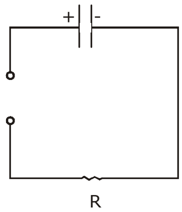
remaining = 6.25%

501. **C** [By Theory]
502. **C**
503. **C**
504. **A** [By Theory]

505. **C**

506. **B**





Forward bias

$\Rightarrow Q = CVe^{-t/RC}$

at t = RC

$Q = \frac{CV}{e}$

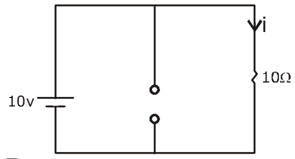
Reverse bias

So open CKT

at t = RC

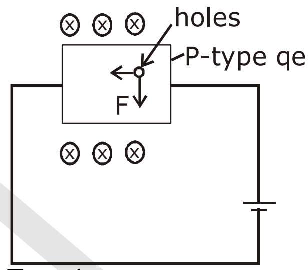
Q = CV

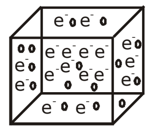
507. **A**



$i = \frac{10}{10} = 1A$

508. **B**



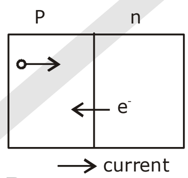


Top view

509. **A**

Hole , e^- recombination & generation occur simultaneously so p-n junction makes neutral.

510. **A**



511. **B**

$\frac{1}{2}mv^2 = 1eV \Rightarrow v\sqrt{\frac{2 \times 1.6 \times 10^{-19}}{m}}$

$v^2 - u^2 = 2a$

$\frac{2 \times 1.6 \times 10^{-19}}{m} = \frac{2 \times q\varepsilon}{m} \times 5 \times 10^{-8}$

$\varepsilon = \frac{1}{5 \times 10^{-8}} = 2 \times 10^7$

512. **D** [By Theory]
513. **D** [By Theory]
514. **B** [By Theory]
515. **C** [By Theory]
516. **B**
517. **C**
518. **C**
519. **D**
520. **D**