P10-17

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ADVANCED PATTERN PART TEST-4(APT-4)

TARGET : JEE (MAIN+ADVANCED) 2018

SUBJECT : PHYSICS COURSE : VIJAY (01JR)

Date : 14-01-2018 Time: 2 Hours Maximum Marks : 168

Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.

GENERAL :

1. The sealed booklet is your Question Paper. Do not break the seal till you are instructed to do so.
2. The question paper CODE is printed on the right hand top corner of this sheet.
3. Use the Optical Response Sheet (ORS) provided separately for answering the question.
4. Blank spaces are provided within this booklet for rough work.
5. Write your Name and Roll Number in the space provided on the below cover.
6. After the open booklet, verify that the booklet contains all the **40** questions along with the options are legible.

QUESTION PAPER FORMAT AND MARKING SCHEME :

7. This questions paper consists of **four sections.**
8. Each section as detailed in the following table :

Section	Question Type	Number of Questions	Category-wise Marks for Each Question				Maximum Marks of the Section
			Full Marks	Partial Marks	Zero Marks	Negative Marks	
1	One or More Correct Option(s)	14	+4 If only the bubble(s) corresponding to all the correct option(s) is(are) darkened	+1 For darkening a bubble corresponding to each correct option, provided NO incorrect option is darkened	0 If none of the bubbles is darkened	–2 In all other cases	56
2	Comprehension (One or More Correct Option(s))	6	+4 If only the bubble(s) corresponding to all the correct option(s) is(are) darkened	+1 For darkening a bubble corresponding to each correct option, provided NO incorrect option is darkened	0 If none of the bubbles is darkened	–2 In all other cases	24
3	Match the Column	2	For each entry in Column-I +2 If only the bubble(s) corresponding to all the correct match(es) is(are) darkened	–	0 if not attempted	–1 In all other cases	16
4	Single digit Integer (0-9)	18	+4 If only the bubbles corresponding to the correct answer is darkened	–	0 if not attempted	–1 In all other cases	72

OPTICAL RESPONSE SHEET :

9. Darken the appropriate bubbles on the original by applying sufficient pressure.
10. The original is machine-gradable and will be collected by the invigilator at the end of the examination.
11. Don not tamper with or mutilate the ORS.
12. Write your name, roll number and the name of the examination centre and sign with pen in the space provided for this purpose on the original.
    Do not write any of these details anywhere else. Darken the appropriate bubble under each digit of your roll number.

DARKENING THE BUBBLES ON THE ORS :

13. Use a **BLACK BALL POINT** to darken the bubbles in the upper sheet.
14. Darken the bubble **COMPLETELY.**
15. Darken the bubble **ONLY** if you are sure of the answer.
16. The correct way of darkening a bubble is as shown here : ●
17. There is **NO** way to erase or "un-darkened bubble.
18. The marking scheme given at the beginning of each section gives details of how darkened and **not darkened** bubbles are evaluated.

DO NOT BREAK THE SEAL WITHOUT BEING INSTRUCTED TO DO SO BY THE INVIGILATOR

NAME OF THE CANDIDATE : ……

ROLL NO. : ……

I have read all the instructions and shall abide by them

- -

Signature of the Candidate

I have verified the identity, name and roll number of the candidate.

- -

Signature of the Invigilator

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PHYSICS

SECTION – 1 : (Maximum Marks : 56)

- This section contains **FOURTEEN** questions
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct
- For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS
- For each question, marks will be awarded in one of the following categories :

Full Marks	:	+4	If only the bubble(s) corresponding to all the correct option(s) is(are) darkened.
Partial Marks	:	+1	For darkening a bubble corresponding to **each correct option,** provided NO incorrect option is darkened.
Zero Marks	:	0	If none of the bubbles is darkened.
Negative Marks	:	–2	In all other cases.

- For example, if (A), (C) and (D) are all the correct options for a question, darkening all these three will result in +4 marks ; darkening only (A) and (D) will result in +2 marks and darkening (A) and (B) will result in –2 marks, as a wrong option is also darkened.

1. A non-relativistic particle of mass m is held in a circular orbit around the origin by an attractive force F (r) = –kr where k is positive constant. Assuming the Bohr quantization of the angular momentum of the particle, Select the correct alternatives, if the radius of the orbit is r and speed of the particle is v $\left(\hbar = \frac{h}{2\pi}\right)$.

(A) $v^2 = \left(\frac{n\hbar}{m}\right)\left(\frac{k}{m}\right)^{1/2}$

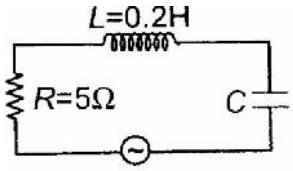
(B) $r^2 = \left(\frac{n\hbar}{k}\right)\left(\frac{k}{m}\right)^{1/2}$

(C) $v^2 = \left(\frac{n\hbar}{2m}\right)\left(\frac{k}{m}\right)^{1/2}$

(D) $r^2 = \left(\frac{n\hbar}{2k}\right)\left(\frac{k}{m}\right)^{1/2}$

Space for Rough Work

2. An alternating voltage E = 6 sin $20t + 8\cos 20t$ is applied to a series resonant circuit as shown. The correct statements are :



(A) The capacitance C is 12.5 mF.

(B) The resonant current in the circuit is $\sqrt{2}$ A

(C) Average power dissipated in the circuit is 10W

(D) The quality factor of the circuit is 0.8

3. A small ball of mass m carrying a charge of Q is dropped in a uniform horizontal magnetic field B. Depth of deepest point of its path from point of release is h. Choose the correct option(s) :

(A) Speed at deepest point is $\sqrt{2gh}$

(B) Speed at deepest point is $\frac{QBh}{m}$

(C) Speed at deepest point is $\frac{2mg}{QB}$

(D) Speed at deepest point is $\frac{2QBh}{m}$

4. When an electron moving at a high speed strikes a metal surface which of the following are possible?

(A) The entire energy of the electron may be converted into an X-ray photon.

(B) Any fraction of the energy of the of the electron may be converted into X-ray photon.

(C) The entire energy of the electron may get converted to heat.

(D) The electron may undergo elastic collision with the metal surface.

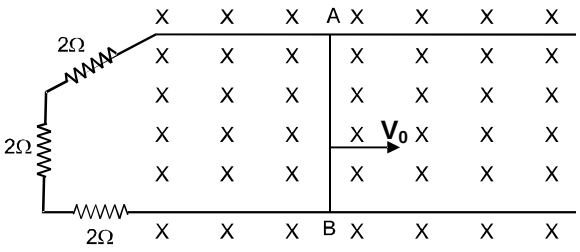
Space for Rough Work

PHYSICS

5. An air column in a pipe, which is closed at one end will be in resonance with a vibrating tuning fork of frequency 264 Hz, if the length of the pipe (in cm) is : (Speed of sound in air = 330 m/s)

(A) 31.25 (B) 62.5 (C) 93.75 (D) 125

6. The conductor AB of mass 1kg is sliding over two parallel conducting rails separated by a distance of 1m and is in a region of inward uniform magnetic field $\vec{B}_0 = 0.1\left(-\hat{k}\right)$. At time t = 0, AB is projected towards right with speed v_0.



(A) the velocity of AB as a function of time is given as $v = v_0 e^{-\frac{t}{600}}$

(B) the velocity of rod becomes $\frac{v_0}{2}$ at t = 600 ℓn(2)

(C) the induced current is $\frac{v_0}{120}$ A at t = 600 ℓn(2)

(D) the induced emf as a function of time is given as $\left(\frac{v_0}{10}\right) e^{-\frac{t}{600}}$

Space for Rough Work

7. An air column in a pipe closed at one end is made to vibrate in its second overtone by a tuning fork of frequency 440 Hz. The speed of sound wave in air is 330 m/s. End corrections may be neglected. Let P_0 denote the mean pressure at any point in the pipe, and ΔP_0 the maximum amplitude of pressure variation. Then :

(A) length of the pipe is $\frac{15}{16}$ m

(B) length of the pipe is $\frac{9}{16}$ m

(C) the maximum pressure at the open end is P_0

(D) the minimum pressure at the open end is P_0

8. A proton and an electron are moving with the same de–Broglie wavelength (consider the non–relativistic case). Then :

(A) In a magnetic field both the particles describe circles of equal radius

(B) both the particles have the same magnitude of momentum

(C) the speed of the proton and the electron are in the ratio m_e / m_ρ, where m_e is the electron mass and m_ρ, the proton mass

(D) the product of mass and kinetic energy is the same for both particles

9. A point charge of specific charge $\frac{q}{m}$ = 0.1 C/kg is projected in uniform magnetic field. The particle moves in magnetic field such that its position vector at any instant is given by $\vec{r} = 3\sin t\hat{i} + 3\cos t\hat{j} + 4t\hat{k}$. Select correct statements from following :

(A) Magnetic field in space is 10T

(B) The distance traveled by the particle in 5s is 20m

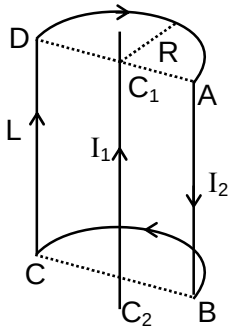
(C) Power of magnetic force is zero

(D) The radius of curvature of the path is 3m

Space for Rough Work

10. In a photo electric experiment, the collector plate is at 2.0 V with respect to the emitter plate made of copper ($\phi = 4.5\,eV$). The emitter is illuminated by a source of monochromatic light of wavelength 200 nm.
(A) the minimum kinetic energy of the photo electrons on the collector is 0.
(B) the maximum kinetic energy of the photo electrons on the collector is 3.7 eV
(C) if the polarity of the battery is reversed then the minimum kinetic energy of the photo electrons on the collector is 0.
(D) if the polarity of the battery is reversed then the maximum kinetic energy of the photo electrons on the collector is 3.7 eV

11. An infinitely long straight wire carrying a current I_1 is partially surrounded by ABCD loop as shown in figure, arc AD and BC have circular shape and the infinite wire passes through their centre C_1C_2. The loop has radius R and carries a current I_2. The axis of the loop coincides with the wire, ABCD plane and infinite length wire are coplanar. Length of CD = lenth of AB = L Then



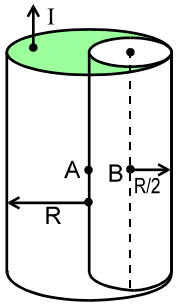
(A) Net force exerted on the loop by the wire is zero.
(B) Net force exerted on the wire by the loop is $\frac{\mu_0 I_1 I_2 L}{\pi R}$, in the plane ABCD and towards CD.
(C) Net force exerted by the wire on the loops is $\frac{\mu_0 I_1 I_2 L}{2\pi R}$, in the plane ABCD and towards CD.
(D) Net torque acting on the loop, about axes C_1C_2 is zero.

Space for Rough Work

PHYSICS

12. A source emit sound waves of frequency 1000 Hz. The source moves to the right with a speed of 32 m/s relative to ground. On the right a reflecting surface moves towards left with a speed of 64 m/s relative to ground. The speed of sound in air is 332 m/s :
(A) wavelength of sound in ahead of source is 0.3 m
(B) number of waves arriving per second which meets the reflected surface is 1320
(C) speed of reflected wave is 268 m/s
(D) wavelength of reflected waves is nearly 0.2 m

13. From a cylinder of radius R, a cylinder of radius R/2 is removed, as shown. Current flowing in the remaining cylinder is I. Magnetic field strength is :



(A) zero at point A (B) zero at point B (C) $\frac{\mu_0 I}{3\pi R}$ at point A (D) $\frac{\mu_0 I}{3\pi R}$ at point B

14. A charged particle is projected in magnetic field $\vec{B} = 10\hat{k}$ from origin in x-y plane. The particle moves in a circle and just touches a line y = 5 m at x = $5\sqrt{3}$ m. Then (mass of particle = 5×10^{-5} kg, charge = 1μc) -
(A) The particle is projected at an angle 60° with x-axis
(B) The radius of circle is 10 m
(C) speed of particle is 2m/s
(D) workdone by magnetic force on the particle is zero.

Space for Rough Work

SECTION – 2 : (Maximum Marks : 24)

- This section contains **THREE** paragraphs
- Based on each paragraph, there will be **TWO** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct.
- For each question, marks will be awarded in one of the following categories :

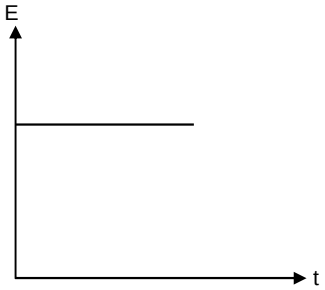
Full Marks	:	+4	If only the bubble(s) corresponding to all the correct option(s) is(are) darkened.
Partial Marks	:	+1	For darkening a bubble corresponding to **each correct option,** provided NO incorrect option is darkened.
Zero Marks	:	0	If none of the bubbles is darkened.
Negative Marks	:	–2	In all other cases.

- For example, if (A), (C) and (D) are all the correct options for a question, darkening all these three will result in +4 marks ; darkening only (A) and (D) will result in +2 marks and darkening (A) and (B) will result in –2 marks, as a wrong option is also darkened.

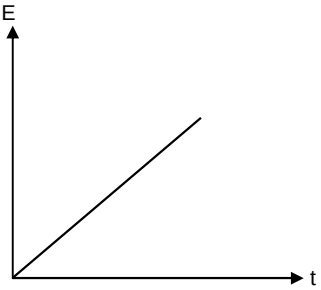
Paragraph for Question Nos. 15 to 16

A thin non conducting ring of mass m, radius R, carrying uniformly distributed charge q is placed on smooth horizontal plane. There exist an uniform time varying magnetic field in a cylindrical region directed vertically upward. Magnitude of magnetic field varies with time as $B = B_0 t^n$ tesla, where n is a number. Centre of ring coincides with centre of cylindrical region. Ring was at rest at t = 0. Neglect the magnetic field produced due to any kind of motion of ring.
Answer the following 2 questions.

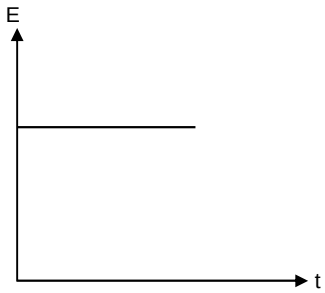
15. Choose the correct option(s) regarding magnitude of induced electric field at the periphery of the ring.

(A)


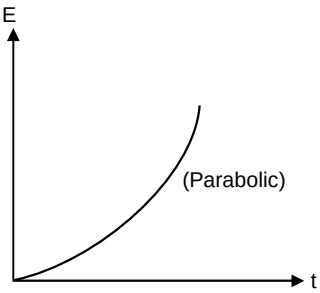
(if n = 1)

(B)


(if n = 2)

(C)


(if n = 2)

(D)


(if n = 3)

16. Choose the correct option(s) regarding instantaneous power P delivered to the ring by the source of magnetic field.

(A) if n = 1, $P = \frac{B_0^2 q^2 R^2}{4m} t$

(B) if n = 2, $P = \frac{B_0^2 q^2 R^2}{4m} t^3$

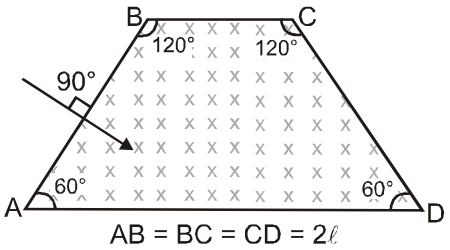
(C) if n = 4, $P = \frac{B_0^2 q^2 R^2}{m} t^7$

(D) if n = 3, $P = \frac{B_0^2 q^2 R^2}{4m} t^5$

Space for Rough Work

Paragraph for Question Nos. 17 to 18

A uniform magnetic field B_0, exists perpendicular to plane of paper in the region ABCD as shown in the figure. A positive charge q of mass m enters in the region at mid-point of line AB perpendicular to line AB with velocity v_0 (which is in the plane of paper)as shown in the figure. AB = BC = CD = 2ℓ



AB = BC = CD = 2ℓ

It is given that $mv_0 = qB_0\ell$.

Based on the given information answer the following questions :

17. Select correct statement(s) :

(A) Distance travelled by charged particle in the region ABCD is $\frac{4\pi\ell}{3}$.

(B) Distance travelled by charged particle in the region ABCD is $\frac{2\pi\ell}{3}$.

(C) Time spent in magnetic field is $\frac{\pi\ell}{v_0}$.

(D) Change in velocity till it comes out of magnetic field is $v_0\sqrt{3}$

18. If same particle enters with speed n v_0 such that it comes out via mid point of CD then select correct statement(s) :

(A) n = 2

(B) n = 3

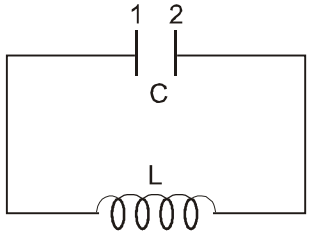
(C) time that charged particle will spend in region ABCD is $\frac{\pi\ell}{v_0}$.

(D) time that charged particle will spend in region ABCD is $\frac{4\pi\ell}{v_0}$.

Space for Rough Work

Paragraph for Question Nos. 19 to 20

Consider a L – C oscillation circuit. Circuit elements has zero resistance. Initially at t = 0 all the energy is stored in the form of electric field and plate-1 is having positive charge. Answer the following two questions based on above information.



19. Choose the correct option(s) :

(A) at time t = $\frac{2\pi}{3}\sqrt{LC}$ plate-2 attains half of the maximum +ve change for the first time.

(B) at time t = $\frac{\pi}{3}\sqrt{LC}$ plate-2 attains half of the maximum +ve change for the first time.

(C) at time t = $\frac{\pi}{4}\sqrt{LC}$ energy stored in the form of electric field and energy stored in the form of magnetic field is same.

(D) at time t = $\frac{2\pi}{3}\sqrt{LC}$ energy stored in the form of electric field is twice the energy stored in the form of magnetic field.

20. Choose the correct option(s) regarding emf induced across inductor :

(A) at time t = $\pi\sqrt{LC}$, magnitude of emf induced across inductor is maximum.

(B) at time t = $\frac{\pi}{2}\sqrt{LC}$, magnitude of emf induced across inductor is maximum.

(C) when energy stored in inductor is maximum, magnitude of emf induced across inductor is also maximum.

(D) when energy stored in inductor is minimum, magnitude of emf induced across inductor is also maximum.

Space for Rough Work

SECTION – 3 : (Maximum Marks : 16)

- This section contains **TWO** questions
- Each question contains two columns, **Column I** and **Column II**
- **Column I** has **four** entries (A),(B), (C) and (D)
- **Column II** has **four** entries (P),(Q), (R) and (S)
- Match the entries in **Column I** with the entries in **Column II**
- One or more entries in **Column I** may match with one or more entries in **Column II**
- The ORS contains a 4 × 4 matrix whose layout will be similar to the one shown below :

(A)	(P)	(Q)	(R)	(S)
(B)	(P)	(Q)	(R)	(S)
(C)	(P)	(Q)	(R)	(S)
(D)	(P)	(Q)	(R)	(S)

- For each entry in **Column I**, darken the bubbles of all the matching entries. For example, if entry (A) in **Column I** matches with entries (P), (Q) and (R), then darken these three bubbles in the ORS. Similarly, for entries (B), (C) and (D).

- Marking scheme :

  For each entry in **Column I**

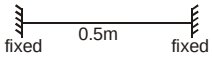
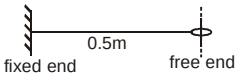
  +2 If only the bubble(s) corresponding to all the correct match(es) is (are) darkened

  0 If none of the bubbles is darkened

  –1 In all other cases

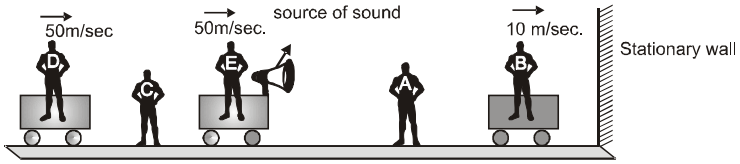
Space for Rough Work

21. In each of the four situations of column-I , a stretched string or an organ pipe is given along with the required data. In case of strings the tension in string is T = 102.4 N and the mass per unit length of string is 1 g/m. Speed of sound in air is 320 m/s. Neglect end corrections. The frequencies of resonance are given in column-II. Match each situation in column-I with the possible resonance frequencies given in Column-II.

Column-I	**Column-II**
(A) String fixed at both ends 	(P) 320 Hz
(B) String fixed at one end and free at other end 	(Q) 480 Hz
(C) Open organ pipe 	(R) 640 Hz
(D) Closed organ pipe 	(S) 800 Hz

Space for Rough Work

22. A source of sound, emitting frequency of 6000 Hz, moving towards a stationary reflecting wall with speed 50 m/sec. There are five observes A,B,C,D and E as shown in figure. Speed of sound is 350 m/sec.



Column–I contains observer and column–II contains the beat frequency observed by the observers. Match column–I with column–II.

	Column–f		**Column–**ff
(A)	observer A	(P)	400 Hz
(B)	observer B	(Q)	0(zero) Hz
(C)	observer C	(R)	1750 Hz
(D)	observer D	(S)	2000 Hz

Space for Rough Work

SECTION – 4 : (Maximum Marks : 72)

- This section contains **EIGHTEEN** questions
- The answer to each question is a **SINGLE DIGIT INTEGER** ranging from 0 to 9, both inclusive
- For each question, darken the bubble corresponding to the correct integer in the ORS
- Marking scheme :

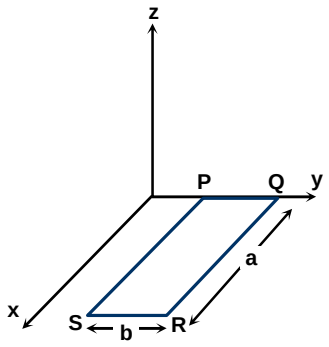
  +4 If the bubble corresponding to the answer is darkened

  0 If none of the bubbles is darkened

  –1 In all other cases

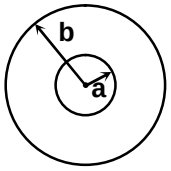
23. A photon strikes a hydrogen atom in its ground state to eject the electron with kinetic energy 16.4 eV. If 25% of the photon energy is taken up by the electron, the energy of the incident photon is (24 × X) eV then 'X' is:

24. A rectangular loop *PQRS* made from a uniform wire has length a, width b and mass m. It is free to rotate about the arm *PQ*, which remains hinged along a horizontal line taken as the y-axis (see figure). Take the vertically upward direction as the z-axis. A uniform magnetic field $\vec{B} = \left(3\hat{i} + 4\hat{k}\right)B_0$ exists in the region. The loop is held in the x-y plane and a current I is passed through it. The loop is now released and is found to stay in the horizontal position in equilibrium. Find the ratio $\frac{mg}{IB_0b}$.



Space for Rough Work

25. The current in the outer coil is varying with time as $I = 2t^2$. If the resistance of the inner coil is R and b >> a then the heat developed in the inner coil between t = 0 and t seconds is $\frac{4\mu_0^2\pi^2a^4t^3}{kb^2R}$. Find k.



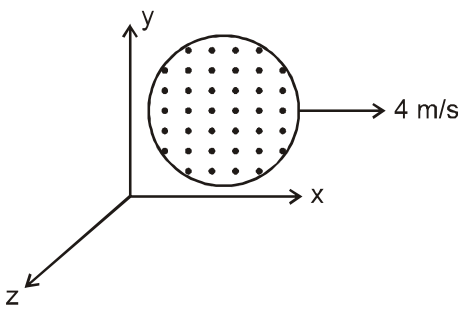
26. Two sound waves with wavelength 5m and 5.5m respectively, each propagate in a gas with velocity 330 m/s, then the number of beat per second is x. Find x.

27. A car while travelling produces noise of intensity level of 94 decibel. At a particular point on road maximum permissible level of noise is 100 decibel. Find how many such identical cars can be allowed to pass through that point simultaneously if sound waves emitted by all cars are in same phase at that point? (Use log 2 = 0.3)

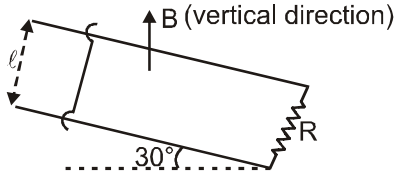
28. A closed organ pipe has length 'ℓ'. The air in it is vibrating in 3rd overtone with maximum amplitude 'a'. The amplitude at a distance of $\frac{3\ell}{7}$ from closed end of the pipe is $\frac{xa}{2}$ find x.

Space for Rough Work

29. A uniform magnetic field $\vec{B} = 0.25\hat{k}T$ exists in a circular region of radius R = 5 m. A loop of radius R = 5m lying in x – y plane encloses the magnetic field at t = 0 and then pulled at uniform velocity $\vec{v} = 4\hat{i}\,m/s$. Find the emf induced (in volts) is the loop at t = 2 sec.

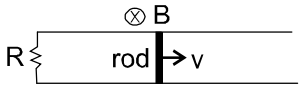


30. Figure shows inclined wire frame (made of conductor of negligible resistance) on which a U-shaped metal rod of negligible electrical resistance can slide without friction as shown in figure. Angle made by plane of wire frame with horizontal is 30º. If magnetic field intensity is B = 2T, mass of rod is 2kg, resistance R = 2Ω and length of rod is ℓ = 1m, then calculate maximum velocity (in m/s) of rod, if rod is released from rest. (Assume rails to be very long and g = 10 m/s²):

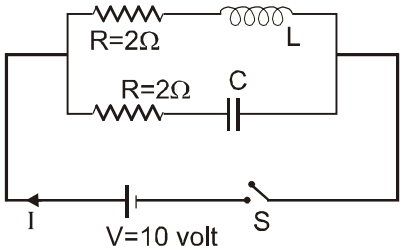


Space for Rough Work

31. A rod of mass m = 2 Kg and length ℓ = 10 cm moves such that its ends touch two fixed conducting parallel rails. A resistance R = 4Ω is connected between the rails as shown. If the rod is given an initial velocity 3m/sec and released, find the total amount of heat developed in the resistor in Joule. (Friction is absent every where)

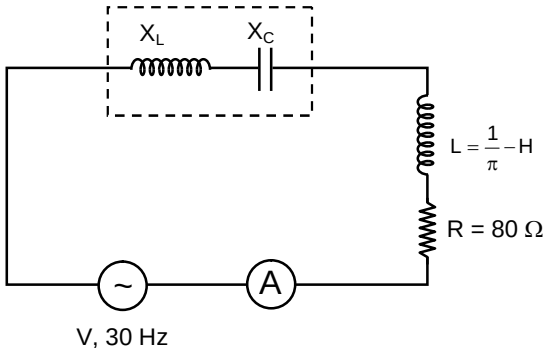


32. Find the current (in A) through the battery after the switch S is closed if L/R = RC = 1 ms.

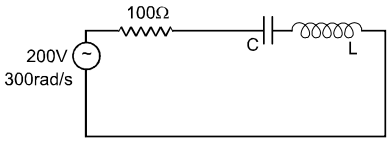


Space for Rough Work

33. In figure below if $X_L = X_C$ and reading of AC ammeter is 1 A. Source voltage is V Volt. Find $\frac{V}{20}$ in Volt.



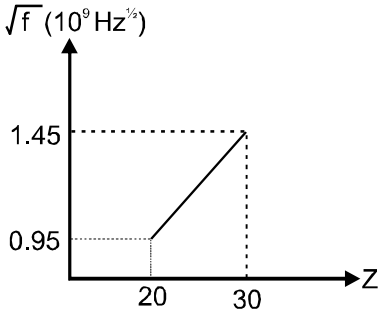
34. In the LCR circuit shown if only L is removed, the current leads the supply voltage by 30º. If only C is removed, the current lags the voltage by 60º. The resonant frequency is $\frac{50x}{\sqrt{3}\pi}$ Hz, then write the value of 'x'.



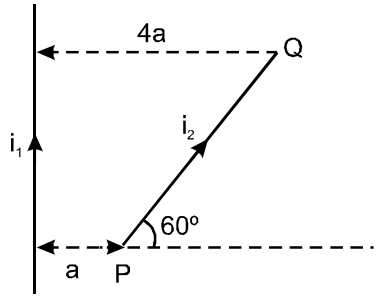
Space for Rough Work

PHYSICS

35. Moseley plot for k_α - X–ray is shown. If Moseley equation is given by $\sqrt{f}$ = a (Z – b). If constants 'a' is given by 5×10^P $Hz^{1/2}$ then 'P' is :



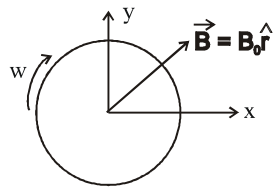
36. A long straight conductor carries current 'i_1'. A wire PQ carrying current 'i_2' is placed as shown. The net force on PQ is $\frac{2\mu_0 i_1 i_2}{\pi} \ell n x$, then write the value of 'x'.



Space for Rough Work

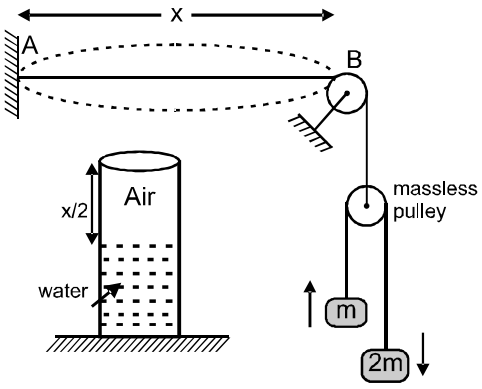
37. A rod of length ℓ and total charge 'q' which is uniformly distributed is rotating with angular velocity ω about an axis passing through the centre of rod and perpendicular to rod. Find the magnitude of magnetic dipole moment (in Amp. m^2) of rod. If q = 4C, ω = 3 rad/s and ℓ = 2m.

38. A thin non conducting disc of mass M = 2kg, charge Q = 2 x 10^{-2}C and radius $R = \frac{1}{6}m$ is placed on a frictionless horizontal plane with its centre at the origin of the coordinate system. A non uniform, radial magnetic field $\vec{B} = B_0\hat{r}$ exists in space, where B_0 = 10T and $\hat{r}$ is a unit vector in the radially outward direction. The disc is set in motion with an angular velocity $\mu = x \times 10^2$ rad/sec, about an axis passing through its centre and perpendicular to its plane, as shown in the figure. At what value of x, the disc will lift off from the surface.



Space for Rough Work

39. AB wire is vibrating in its fundamental mode. Wire AB is in resonance with resonance tube in which air column is also vibrating with its fundamental mode. Sound speed is 400 m/sec and linear mass density of AB wire is 10^{-4} kg/m and g = 10 m/sec^2, value of mass m = [$\beta(10^{-1})$] kg, then find value of β. Neglect the masses of wires in comparison to block's mass 'm'.



40. In a car race sound signals emitted by the two cars are detected by the detecter on the straight track at the end point of the race. Frequency observed are 330 Hz & 360 Hz and the original frequency is 300 Hz of both cars. Race ends with the separation of 100 m between the cars. Assume both cars move with constant velocity and velocity of sound is 330 m/s. Find the time (in sec.) taken by winning car to complete car race.

Space for Rough Work