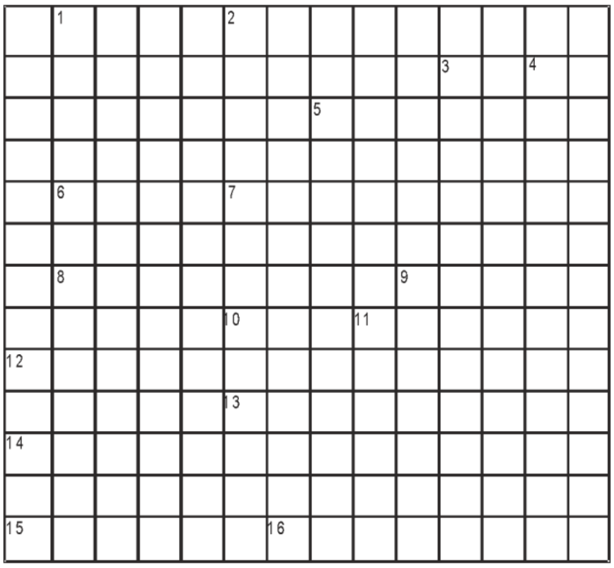
Note : ** Problems require knowledge of quantities from the syllabus of class XII.

Exercise-1

✍ Marked Questions can be used as Revision Questions.

PART - I : SUBJECTIVE QUESTIONS

****1.** Complete the cross word :



Across

1. Unit of pressure $\frac{N}{m^2}$ = ...(6)
3. Unit of a physical quantity whose dimension is $M^1L^2T^{-3}$ ....(4)
6. Unit of conductance $\left(= \frac{1}{\text{Resistance}}\right)$ which is equivalent to Siemens ......(3)
7. A quantity whose dimension is same as that of energy. ....(6)
8. A unit of pressure (1mm of Hg pressure) ....(4)
10. Abbreviation used for 10^{-6} ....(5)
12. Nuclear distances are measured in .....(5)
13. Unit of luminous intensity ....(7)
14. Angular speed of a fan is usually written in ....(3)
15. erg/cm = ...(4)
16. Unit of inductance ....(5)

Down

1. 10^{-12} m = One ....(9)
2. A unit of length measures atomic distances ....(8)
3. Unit of magnetic flux ....(5)
4. Unit of magnetic field ....(5)
5. A unit of distance that is equal to 3.08×10^{16}m, and is used to measure astro nominal distances ....(6)
9. Number of particles is expressed in.......(4)
11. Unit of a physical quantity which is dimensionless ......(6)
12. Unit of capacitance ....(5)

2.✍ If the velocity of light 'c', Gravitational constant 'G' & Plank's constant 'h' be chosen as fundamental units, find the dimensions of mass, length & time in this new system .

3. Test if the following equations are dimensionally correct :

(a) $s = \rho gh / \cos\theta$ (b) $v = \sqrt{\dfrac{\gamma RT}{M_0}}$ (c) $V = \dfrac{Pr^4 t}{\eta \ell}$ (d) $f = \sqrt{\dfrac{mg\ell}{I}}$

where h = height, S = surface tension, v = Speed of sound, ρ = density, P = pressure, V = volume, η = coefficient of viscosity, f = frequency and I = moment of inertia.

PART - II : ONLY ONE OPTION CORRECT TYPE

1. Which of the following sets can't enter into the list of fundamental quantities in any system of units?

(1) length, mass and velocity (2) length, time and velocity
(3) mass, time and velocity (4) length, time and mass

2. A dimensionless quantity

(1) never has a unit (2) always has a unit (3) may have a unit (4) does not exit

3. A unit less quantity

(1) never has a nonzero dimension (2) always has a nonzero dimension
(3) may have a nonzero dimension (4) does not exit

4. Which pair of following quantities has dimensions different from each other.

(1) Impulse and linear momentum (2) Plank's constant and angular momentum
(3) Moment of inertia and moment of force (4) Young's modulus and pressure

5. The velocity of water waves may depend on their wavelength λ, the density of water ρ and the acceleration due to gravity g. The method of dimensions gives the relation between these quantities as

(1) $v^2 = k\lambda^{-1} g^{-1} \rho^{-1}$ (2) $v^2 = k g \lambda$ (3) $v^2 = k g \lambda \rho$ (4) $v^2 = k\lambda^3 g^{-1}\rho^{-1}$

where k is a dimensionless constant

6. The value of $G = 6.67 \times 10^{-11}$ N m^2 $(kg)^{-2}$. Its numerical value in CGS system will be :

(1) 6.67×10^{-8} (2) 6.67×10^{-6} (3) 6.67 (4) 6.67×10^{-5}

7. Force applied by water stream depends on density of water (ρ), velocity of the stream (v) and cross-sectional area of the stream (A). The expression of the force can be

(1) ρAv (2) ρAv^2 (3) $\rho^2 Av$ (4) $\rho A^2 v$

8. If unit of length and time is doubled, the numerical value of 'g' (acceleration due to gravity) will be :

(1) doubled (2) halved (3) four times (4) remain same

PART - III : MATCH THE COLUMN

1. **Match the following :**

	Physical quantity	**Dimension**	**Unit**
(1)	Gravitational constant 'G'	(P) $M^1L^1T^{-1}$	(a) N.m
(2)	Torque	(Q) $M^{-1}L^3T^{-2}$	(b) N.s
(3)	Momentum	(R) $M^1 L^{-1}T^{-2}$	(c) Nm^2/kg^2
(4)	Pressure	(S) $M^1L^2T^{-2}$	(d) pascal

2.** **Match the following :**

	Physical quantity	**Dimension**	**Unit**
(1)	Stefan's constant 'σ'	(P) $M^1L^1T^{-2}A^{-2}$	(a) W/m^2

(2) Wien's constant 'b'	(Q) $M^1L^0T^{-3}K^{-4}$	(b) K.m.
(3) Coefficient of viscosity 'η'	(R) $M^1L^0T^{-3}$	(c) tesla .m/A
(4) Emissive power of radiation (Intensity emitted)	(S) $M^0L^1T^0K^1$	(d) $W/m^2.K^4$
(5) Mutual inductance 'M'	(T) $M^1L^2T^{-2}A^{-2}$	(e) poise
(6) Magnetic permeability 'μ_0'	(U) $M^1L^{-1}T^{-1}$	(f) henry

Exercise-2

✍ **Marked Questions can be used as Revision Questions.**

PART - I : ONLY ONE OPTION CORRECT TYPE

1.✍ Force F is given in terms of time t and distance x by F = A sin C t + B cos Dx. Then the dimensions of $\frac{A}{B}$ and $\frac{C}{D}$ are given by

(1) MLT^{-2}, $M^0L^0T^{-1}$ (2) MLT^{-2}, $M^0L^{-1}T^0$ (3) $M^0L^0T^0$, $M^0L^1T^{-1}$ (4) $M^0L^1T^{-1}$, $M^0L^0T^0$

2.✍** What are the dimensions of electrical resistance?

(1) $ML^2T^{-2}A^2$ (2) $ML^2T^{-3}A^{-2}$ (3) $ML^2T^{-3}A^2$ (4) $ML^2T^{-2}A^{-2}$

3. $\int \frac{x\,dx}{\sqrt{2ax-x^2}} = a^n \sin^{-1}\left[\frac{x}{a}-1\right]$. The value of n is :

(1) 0 (2) –1 (3) 1 (4) none of these

You may use dimensional analysis to solve the problem.

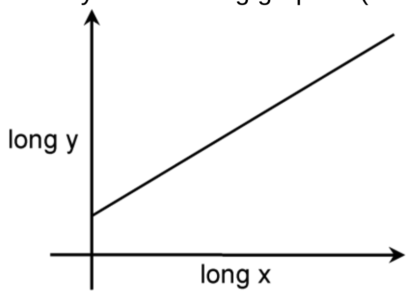
4.✍ An unknown quantity "α" is expressed as $\alpha = \frac{2ma}{\beta}\log\left(1+\frac{2\beta\ell}{ma}\right)$ where m = mass, a = acceleration, ℓ = length. The unit of α should be

(1) meter (2) m/s (3) m/s^2 (4) s^{-1}

5._ A quantity α is defined as $\alpha = \frac{e^2}{4\pi\varepsilon_0 c\hbar}$, where e is electric charge, $\hbar = \frac{h}{2\pi}$ is the reduced Planck's constant and c is the speed of light. The dimensions of α are **[Olympiad (State-1) 2017]**

(1) $[M^0\,L^0\,T^0\,I^0]$ (2) $[M^1\,L^{-1}\,T^2\,I^{-2}]$ (3) $[M^2\,L^1\,T^{-1}\,I^0]$ (4) $[M^0\,L^3\,T^{-1}\,I^{-2}]$

6._ The equation correctly represented by the following graph is (a and b are constants)



[Olympiad (State-1) 2017]

(1) x + y = b (2) $ax^2 + by^2 = 0$ (3) x + y = ab (4) $y = ax^b$

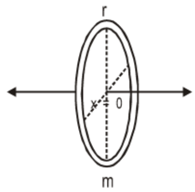
7._ The physical quantity that has unit volt-second is **[Olympiad (State-1) 2017]**

(1) energy (2) electric flux (3) magnetic flux (4) inductance

PART - II : SINGLE AND DOUBLE VALUE INTEGER TYPE

1. In the formula; $p = \frac{nRT}{V-b} e^{-\frac{a}{RTV}}$, find the dimensions of 'a' and 'b', where p = pressure, n = no. of moles, T = temperature, V = volume and R = universal gas constant.

2. A particle is performing SHM along the axis of a fixed ring. Due to gravitational force, its displacement at time t is given by x = a sin ωt.



In this equation ω is found to depend on radius of the ring (r), mass of the ring (m) and gravitational constant (G). Using dimensional analysis, find the expression of ω in terms of m, r and G.

PART - III : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

1. Choose the correct statement(s):
(1) All quantities may be represented dimensionally in terms of the base quantities.
(2) A base quantity cannot be represented dimensionally in terms of the rest of the base quantities.
(3) The dimension of a base quantity in other base quantities is always zero.
(4) The dimension of a derived quantity is never zero in any base quantity.

2. Choose the correct statement(s) :
(1) A dimensionally correct equation may be correct.
(2) A dimensionally correct equation may be incorrect.
(3) A dimensionally incorrect equation may be correct.
(4) A dimensionally incorrect equation must be incorrect.

3. A parameter α is given by $\alpha = \frac{h}{\sigma\theta^4}$
(here σ = Stefan's constant, h = Planck's constant, θ = absolute temperature) then
(1) Dimension of 'α' will be $L^2 T^2$
(2) Unit of 'α' may be $m^2 s^2$
(3) Unit of 'α' may be $\frac{(\text{Weber})(\Omega)^2(\text{Farad})^2}{(\text{Tesla})}$
(4) Dimension of 'α' will be equal to dimension of $\left(\frac{R\,i}{\phi_m}\right)$ where R = gas constant, i = Electrical current, φ_m = magnetic flux

PART - IV : COMPREHENSION

Comprehension

The Vander waal equation for 1 mole of a real gas is $\left(P + \frac{a}{V^2}\right)$ (V – b) = RT where P is the pressure, V is the volume, T is the absolute temperature, R is the molar gas constant and a, b are Vander waal constants.

1. The dimensions of a are the same as those of
(1) PV (2) PV^2 (3) P^2V (4) P/V

2. The dimensions of b are the same as those of
(1) P (2) V (3) PV (4) nRT

3. The dimensional formula for ab is
(1) $ML^2 T^{-2}$ (2) $ML^4 T^{-2}$ (3) $ML^6 T^{-2}$ (4) $ML^8 T^{-2}$

Exercise-3

✍ Marked Questions can be used as Revision Questions.

*** Marked Questions may have more than one correct option.**

PART - I : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

1.** Some physical quantities are given in **Column I** and some possible SI units in which these quantities may be expressed are given in **Column II**. Match the physical quantities in **Column I** with the units in **Column II.** **[IIT-JEE-2007; 6/184]**

Column I	Column II
(A) GM_eM_s G - universal gravitational constant, M_e - mass of the earth, Ms - mass of the Sun	(p) (volt) (coulomb) (metre)
(B) $\frac{3RT}{M}$ R - universal gas constant, T - absolute temperature, M - molar mass	(q) (kilogram) $(\text{metre})^3$ $(\text{second})^{-2}$
(C) $\frac{F^2}{q^2B^2}$ F - force, q - charge, B - magnetic field	(r) $(\text{metre})^2$ $(\text{second})^{-2}$
(D) $\frac{GM_e}{R_e}$ G - universal gravitational constant, M_e - mass of the earth R_e - radius of the earth	(s) (farad) $(\text{volt})^2$ $(\text{kg})^{-1}$

2.✍ Match List I with List II and select the correct answer using the codes given below the lists : **[JEE ADVANCED 2013; 4/60]**

List I	List II
P. Boltzmann constant	1. $[ML^2T^{-1}]$
Q. Coefficient of viscosity	2. $[ML^{-1}T^{-1}]$
R. Planck constant	3. $[MLT^{-3}K^{-1}]$
S. Thermal conductivity	4. $[ML^2T^{-2}K^{-1}]$

Codes :

	P	Q	R	S
(A)	3	1	2	4
(B)	3	2	1	4
(C)	4	2	1	3
(D)	4	1	2	3

3. To find the distance d over which a signal can be seen clearly in foggy conditions, a railways engineer uses dimensional analysis and assumes that the distance depends on the mass density ρ of the fog, intensity (power/area) S of the light from the signal and its frequency f. The engineer find that d is proportional to $S^{1/n}$. The value of n is: **[JEE (Advanced) 2014, P-1, 3/60]**

4.* Planck's constant h, speed of light c and gravitational constant G are used to from a unit of length L and a unit of mass M. Then the correct options(s) is (are) **[JEE (Advanced) 2015 ; P-1, 4/88, –2]**

(A) $M \propto \sqrt{c}$ (B) $M \propto \sqrt{G}$ (C) $L \propto \sqrt{h}$ (D) $L \propto \sqrt{G}$

5.* In terms of potential difference V, electric current I, permittivity ε_0, permeability μ_0 and speed of light c, the dimensionally correct equations(s) is(are) **[JEE (Advanced) 2015 ; P-2, 4/88, –2]**

(A) $\mu_0 I^2 = \varepsilon_0 V^2$ (B) $\varepsilon_0 I = \mu_0 V$ (C) $I = \varepsilon_0 V$ (D) $\mu_0 cI = \varepsilon_0 V$

PART - II : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

1. Which of the following units denotes the dimensions ML^2/Q^2, where Q denotes the electric charge? **[AIEEE-2006, 3/180]**

(1) H/m^2 (2) Weber (Wb) (3) Wb/m^2 (4) Henry (H)

2. The dimension of magnetic field in M, L, T and C (Coulomb) is given as **[AIEEE-2008, 3/105]**

(1) MT^2C^{-2} (2) $MT^{-1}C^{-1}$ (3) $MT^{-2}C^{-1}$ (4) $MLT^{-1}C^{-1}$

3. Let $[\epsilon_0]$ denote the dimensional formula of the permittivity of vacuum. If M = mass, L = length, T = time and A = electric current, then : **[JEE(Main) 2013, 4/120, –1]**

(1) $[\epsilon_0] = [M^{-1}L^{-3}T^2A]$ (2) $[\epsilon_0] = [M^{-1}L^{-3}T^4A^2]$ (3) $[\epsilon_0] = [M^{-1}L^2T^{-1}A^{-2}]$ (4) $[\epsilon_0] = [M^{-1}L^2T^{-1}A]$

Answers

EXERCISE-1

PART - I

1.

	^{1}P	A	S	C	^{2}A	L							
	I				N					^{3}W	A	^{4}T	T
	C				G		^{5}P			E		E	
	O				S		A			B		S	
	^{6}M	H	O		^{7}T	O	R	Q	U	E		L	
	E				R		S			R		A	
	^{8}T	O	R	R	O		E		^{9}M				
	R				^{10}M	I	C	^{11}R	O				
^{12}F	E	R	M	I				A	L				
A					^{13}C	A	N	D	E	L	A		
^{14}R	P	M						I					
A								A					
^{15}D	Y	N	E			^{16}H	E	N	R	Y			

2. $[M] = [h^{1/2}.C^{1/2}.G^{-1/2}]$; $[L] = [h^{1/2}.\ C^{-3/2}.G^{1/2}]$; $[T] = [h^{1/2}\ .\ C^{-5/2}\ .\ G^{1/2}]$

3. All are dimensionally correct.

PART - II

1. (1) **2.** (3) **3.** (1)
4. (3) **5.** (2) **6.** (1)
7. (2) **8.** (1)

PART - III

1. (1) → (Q) → (c) ; (2) → (S) → (a)

(3) → (P) → (b) ; (4) → (R) → (d)

2. (1) → (Q) → (d) ; (2) → (S) → (b)

(3) → (U) → (e) ; (4) → (R) → (a)

(5) → (T) → (f) ; (6) → (P) → (c)

EXERCISE-2

PART - I

1. (3) **2.** (2) **3.** (3)
4. (1) **5.** (1) **6.** (4)
7. (3)

PART - II

1. $[a] = ML^5T^{-2}mol^{-1}[b] = L^3$

2. ω = (some number) $\sqrt{\frac{Gm}{r^3}}$.

PART – III

1. (123) **2.** (124) **3.** (123)

PART - IV

1. (2) **2.** (2) **3.** (4)

EXERCISE-3

PART – I

1. (A) → (p), (q) ; (B) → (r), (s) ;

(C) → (r), (s) ; (D) → (r), (s)

2. (C) **3.** 3 **4.** (ACD)
5. (AC)

PART - II

1. (4) **2.** (2) **3.** (2)