JEE Advanced

Single Correct Answer Type

1. The dimensional formula for the modulus of rigidity is
a. ML^2T^{-2} b. $ML^{-1}T^{-3}$ c. $ML^{-2}T^{-2}$ d. $ML^{-1}T^{-2}$
(IIT-JEE 1982)

2. Dimensional formula of magnetic flux is
a. $ML^2T^{-2}A^{-1}$ b. $ML^0T^{-2}A^{-2}$
c. $M^0L^{-2}T^{-2}A^{-3}$ d. $ML^2T^{-2}A^3$
(IIT-JEE 1982)

3. Inductance L can be dimensionally represented as
a. $ML^2T^{-2}A^{-2}$ b. $ML^2T^{-4}A^{-3}$
c. $ML^{-2}T^{-2}A^{-2}$ d. $ML^2T^4A^3$
(IIT-JEE 1983)

4. Dimensional formula for torque is
a. L^2MT^{-2} b. $L^{-1}MT^{-2}$ c. L^2MT^{-3} d. LMT^{-2}
(IIT-JEE 1983)

5. Dimensional formula for latent heat is
a. $M^0L^2T^{-2}$ b. MT^{-2} c. ML^2T^{-2} d. ML^2T^{-1}
(IIT-JEE 1983, 89)

6. Dimensional formula for angular momentum is
a. ML^2T^{-2} b. ML^2T^{-1} c. MLT^{-1} d. $M^0L^2T^{-2}$
(IIT-JEE 1983)

7. Dimensional formula of capacitance is
a. $M^{-1}L^{-2}T^4A^2$ b. $ML^2T^4A^{-2}$
c. $MLT^{-4}A^2$ d. $M^{-1}L^{-2}T^{-4}A^{-2}$
(IIT-JEE 1983)

8. If L, C and R represent inductance, capacitance and resistance respectively, then which of the following does not represent dimensions of frequency
a. $\frac{1}{RC}$ b. $\frac{R}{L}$
c. $\frac{1}{\sqrt{LC}}$ d. $\frac{C}{L}$ **(IIT-JEE 1984)**

9. The dimensional formula for Planck's constant (h) is
a. $ML^{-2}T^{-3}$ b. ML^2T^{-2} c. ML^2T^{-1} d. $ML^{-2}T^{-2}$
(IIT-JEE 1985)

10. If E, M, J and G respectively denote energy, mass, angular momentum and gravitational constant, then $\frac{EJ^2}{M^5G^2}$ has the dimensions of
a. length b. angle c. mass d. time
(IIT-JEE 1990)

11. If L, R, C and V respectively represent inductance resistance, capacitance and potential difference, then the dimensions of $\frac{L}{RCV}$ are the same as those of
a. current b. $\frac{1}{\text{current}}$
c. charge d. $\frac{1}{\text{charge}}$
(IIT-JEE 1991)

12. A highly rigid cubical block A of small mass M and side L is fixed rigidly onto another cubical block B of the same dimensions and of low modulus of rigidity η such that the lower face of A completely covers the upper face of B. The lower face of B is rigidly held on a horizontal surface. A small force F is applied perpendicular to one of the side faces of A. After the force is withdrawn block A executes small oscillations. The time period of which is given by
a. $2\pi\sqrt{\frac{M\eta}{L}}$ b. $2\pi\sqrt{\frac{L}{M\eta}}$
c. $2\pi\sqrt{\frac{ML}{\eta}}$ d. $2\pi\sqrt{\frac{M}{\eta L}}$
(IIT-JEE 1992)

13. The dimensions of $(1/2)\varepsilon_0E^2$ (ε_0 is permittivity of free space, E is electric field) are
a. MLT^{-1} b. ML^2T^{-2}
c. $ML^{-1}T^{-2}$ d. ML^2T^{-1} **(IIT-JEE 2000)**

14. A quantity X is given by $\varepsilon_0 L\frac{\Delta V}{\Delta t}$, where ε_0 is the permittivity of the free space, L is the length, ΔV is potential difference, and Δt is the time interval. The dimensional formula for X is the same as that of
a. Resistance b. Charge
c. Voltage d. Current **(IIT-JEE 2001)**

15. A cube has sides of length 1.2×10^{-2} m. Calculate its volume.
a. $1.7 \times 10^{-6}\ m^3$ b. $1.73 \times 10^{-6}\ m^3$
c. $1.70 \times 10^{-6}\ m^3$ d. $1.732 \times 10^{-6}\ m^3$
(IIT-JEE 2003)

16. Pressure depends on distance as $P = \frac{\alpha}{\beta}\exp\left(-\frac{\alpha z}{k\theta}\right)$, where α, β are constants, z is distance, k is Boltzmann's constant, and θ is temperature. The dimensions of β are
a. $M^0L^0T^0$ b. $M^{-1}L^{-1}T^{-1}$
c. $M^0L^2T^0$ d. $M^{-1}L^1T^2$
(IIT-JEE 2004)

17. A wire of length $l = 6 \pm 0.06$ cm and radius $r = 0.5 \pm 0.005$ cm has mass $m = 0.3 \pm 0.003$ g. Maximum percentage error in density is
a. 4 b. 2
c. 1 d. 6.8 **(IIT-JEE 2004)**

18. Which of the following sets has different dimensions?
a. Pressure, Young's modulus, stress
b. Emf, potential difference, electric potential
c. Heat, work done, energy
d. Dipole moment, electric flux, electric field
(IIT-JEE 2005)

Multiple Correct Answer Type

1. L, C, and R represent the physical quantities inductance, capacitance, and resistance, respectively. The combinations which have the dimension of frequency are
   a. $1/RC$ b. R/L
   c. $1/\sqrt{LC}$ d. C/L **(IIT-JEE 1984)**
2. The dimensions of the quantities in one (or more) of the following pairs are the same. Identify the pair(s).
   a. Torque and work
   b. Angular momentum and work
   c. Energy and Young's modulus
   d. Light year and wavelength **(IIT-JEE 1986)**
3. If the dimensions of length are expressed as $G^x c^y h^z$; where G, c and h are the universal gravitational constant, speed of light and Planck's constant respectively, then
   a. $x=\frac{1}{2}, y=\frac{1}{2}$ b. $x=\frac{1}{2}, z=\frac{1}{2}$
   c. $y=\frac{1}{2}, z=\frac{3}{2}$ d. $y=-\frac{3}{2}, z=\frac{1}{2}$
   (IIT-JEE 1992)
4. Which of the following pairs has/have the same dimensions?
   a. Reynold number and coefficient of friction
   b. Curie and frequency of light wave
   c. Latent heat and gravitational potential
   d. Planck's constant and torque **(IIT-JEE 1995)**
5. The SI unit of inductance, henry, can be written as
   a. Weber/ampere b. Volt-second/ampere
   c. Joule/(ampere)^2 d. Ohm-second
   (IIT-JEE 1998)
6. Let $[\varepsilon_0]$ denote the dimensional formula of the permittivity of vacuum and $[\mu_0]$ that of the permeability of vacuum. If M = mass, L = length, T = time, and I = electric current, then
   a. $[\varepsilon_0] = M^{-1}L^{-3}T^2I$
   b. $[\varepsilon_0] = M^{-1}L^{-3}T^4I^2$
   c. $[\mu_0] = MLT^{-2}I^{-2}$
   d. $[\mu_0] = ML^2T^{-1}I$ **(IIT-JEE 1998)**
10. 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)
   a. $M \propto \sqrt{c}$ b. $M \propto \sqrt{G}$
   c. $L \propto \sqrt{h}$ d. $L \propto \sqrt{G}$
   (JEE Advanced 2015)
11. 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)
   a. $\mu_0 I_2 = \varepsilon V^2$ b. $\varepsilon_0 I = \mu_0 V$
   c. $I = \varepsilon_0 V$ d. $\mu_0 c I = \varepsilon_0 V$
   (JEE Advanced 2015)

Matching Type

1. Match the physical quantities given in Column I with dimensions expressed in terms of mass (M), length (L) time (T), and charge (Q) given in Column II.

Column I		Column II	
i.	Angular momentum	a.	ML^2T^{-2}
ii.	Torque	b.	ML^2T^{-1}
iii.	Inductance	c.	$M^{-1}L^{-2}T^2Q^2$
iv.	Latent heat	d.	ML^2Q^{-2}
v.	Capacitance	e.	$ML^3T^{-1}Q^{-2}$
vi.	Resistivity	f.	L^2T^{-2}

(IIT-JEE 1983)

2. Column I gives three physical quantities. Select the appropriate units for the choices given in Column II. Some of the physical quantities may have more than one choice correct.

Column I		Column II	
i.	Capacitance	a.	Ohm-second
ii.	Magnetic induction	b.	Coulomb (volt)$^{-1}$
iii.	Inductance	c.	Coulomb^2-joule^{-1}
		d.	Newton (ampere meter)$^{-1}$
		e.	Volt-Second (ampere)$^{-1}$

(IIT-JEE 1990)

3. Match the following:

Column I		Column II	
i.	Curie	A.	MLT^{-2}
ii.	Light year	B.	M
iii.	Dielectric strength	C.	Dimensionless
iv.	Atomic weight	D.	T
v.	Decibel	E.	ML^2T^{-2}
		F.	MT^{-3}
		G.	T^{-1}
		H.	L
		I.	$MLT^{-3}I^{-1}$
		J.	LT^{-1}

Choose the correct match
a. (i) G, (ii) H, (iii) C, (iv) B, (v) C
b. (i) D, (ii) H, (iii) I, (iv) B, (v) G
c. (i) G, (ii) H, (iii) I, (iv) B, (v) G
d. None of the above **(IIT-JEE 1992)**

4. 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.

	Column I		Column II
i.	GM_eM_s	a.	(volt) (coulomb) (metre)
ii.	$3RT/M$	b.	(kilogram) (metre)^3 (second)$^{-2}$
iii.	F^2/q^2B^2	c.	(meter)^2 (second)$^{-2}$
iv.	GM_e/R_e	d.	(farad) (volt)^2(kg)$^{-1}$

where G is universal gravitational constant; M_e, mass of the earth; M_s, mass of sun; R_e, radius of the earth; R, universal gas constant; T, absolute temperature; M, molar mass; F, force; q, charge; B, magnetic field. **(IIT-JEE 2007)**

5. Match List I with List II and select the correct answer using the codes given below the lists:

	List I		List II
P.	Boltzmann constant	1.	$[ML^2T^{-1}]$
Q.	Coefficient of viscosity	2.	$[ML^{-1}T^{-1}]$
R.	Plank 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

(JEE Advanced 2013)

Integer Answer Type

2. 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 finds that d is proportional to $S^{1/n}$. The value of n is **(JEE Advanced 2014)**
3. The energy of a system as a function of time t is given as $E(t) = A^2 \exp(-at)$, where $\alpha = 0.2s^{-1}$. The measurement of A has an error of 1.25%. If the error in the measurement of time is 1.50%, the percentage error in the value of $E(t)$ at $t = 5$ s is **(JEE Advanced 2015)**

Fill in the Blanks Type

1. Planck's constant has dimensions ________. **(IIT-JEE 1985)**
2. In the formula $X = 3YZ^2$, X and Z have dimensions of capacitance and magnetic induction, respectively. The dimensions of Y in M.K.S. system are ________. **(IIT-JEE 1985)**
3. The dimensions of electrical conductivity are ________. **(IIT-JEE 1997)**
4. The equation of state for real gas is given by $\left(P + \frac{a}{V^2}\right) \times (v - b) = RT$. The dimensions of the constant a are ________. **(IIT-JEE 1997)**

Subjective Type

1. Give the MKS units for each of the following quantities:
   a. Young's modulus
   b. Magnetic induction
   c. Power of a lens **(IIT-JEE 1980)**
2. A gas bubble from an explosion under water oscillates with a period T proportional to $p^a d^b E^c$, where p is the static pressure, d is the density of water, and E is the total energy of the explosion. Find the values of a, b, and c. **(IIT-JEE 1981)**
3. Write the dimensions of the following in terms of mass, time, length, and charge.
   a. Magnetic flux
   b. Rigidity modulus **(IIT-JEE 1982)**

ANSWER KEY

JEE Advanced

Single Correct Answer Type

1. d.	**2.** a.	**3.** a.	**4.** a.	**5.** a.
6. b.	**7.** a.	**8.** d.	**9.** c.	**10.** b.
11. b.	**12.** d.	**13.** c.	**14.** d.	**15.** a.
16. c.	**17.** a.	**18.** d.		

Multiple Correct Answers Type

1. a, b, c.	**2.** a, d.	**3.** b, d.
4. a, b, c.	**5.** a, b, c, d.	**6.** b, c.
10. a, c, d.	**11.** a, c.	

Matching Column Type

1. i. → b., ii. → a., iii. → d., iv. → f., v. → c., vi. → e.
2. i. → b, c. ii. → d., iii. → a., e.
3. a. i. → G, ii. → H, iii. → C, iv. → B, v. → C
4. i. → a., b., ii. → c., d., iii. → c., d., iv. → c., d.
5. c. p. → (4); q. → (2); r. → (1); s. → (3)

Integer Answer Type
2. 3 3. 4

Fill in the Blanks Type
1. ML^2T^{-1}
2. $[M^{-3}L^{-2}T^4Q^4]$
3. $[M^{-1}L^{-3}T^3A^2]$
4. $[ML^5T^{-2}]$

Subjective Type
1. Nm^{-2}. Tesla, dioptre.
2. $T = k\,p^{-5/6}\,d^{1/2}\,E^{1/3}$
3. $[M^1L^2T^{-1}Q^{-1}]$. $ML^{-1}T^{-2}$

HINTS AND SOLUTIONS

JEE Advanced

Single Correct Answer Type

1. d. Modulus of rigidity = $\frac{\text{Shear stress}}{\text{Shear strain}} = [ML^{-1}T^{-2}]$

2. a. $\varphi = BA = \frac{F}{I \times L}A = \frac{[MLT^{-2}][L^2]}{[A][L]} = [ML^2T^{-2}A^{-1}]$

3. a. $E = \frac{1}{2}Li^2$ hence $L = [ML^2T^{-2}A^{-2}]$.

4. a. Torque = force × distance = $[ML^2T^{-2}]$

5. a. $Q = mL \Rightarrow L = \frac{Q}{m}$ (Heat is a form of energy)

$$= \frac{ML^2T^{-2}}{M} = [M^0L^2T^{-2}]$$

6. b. Angular momentum = $mvr = [MLT^{-1}][L] = [ML^2T^{-1}]$

7. a. $[C] = \left(\frac{Q}{V}\right) = \left(\frac{Q^2}{W}\right) = \left[\frac{A^2T^2}{ML^2T^{-2}}\right] = [M^{-1}L^{-2}T^4A^2]$

8. d. $f = \frac{1}{2\pi\sqrt{LC}}$ $\therefore \left(\frac{C}{L}\right)$ does not represent the dimension of frequency

9. c. $E = h\nu \Rightarrow [ML^2T^{-2}] = [h][T^{-1}] \Rightarrow [h] = [ML^2T^{-1}]$

10. b. $\left[\frac{EJ^2}{M^5G^2}\right] = \frac{[ML^2T^{-2}]\times[ML^2T^{-1}]^2}{[M^5]\times[M^{-1}L^3T^{-2}]^2} = [M^0L^0T^0]$

11. b. RC has dimensions of time and V has the dimensions of L $\frac{dI}{dt}$.

Hence, $\left[\frac{L}{RCV}\right] = \left[\frac{1}{T}\times\frac{T}{A}\right] = \frac{1}{\text{current}}$

12. d. By substituting the dimensions of mass [M], length [L] and coefficient of rigidity $[ML^{-1}T^{-2}]$ we get $T = 2\pi\sqrt{\frac{M}{\eta L}}$ is the right formula for time period of oscillations

13. c. Here, $(1/2)\varepsilon_0 E^2$ represents energy per unit volume.

$$|\varepsilon_0||E^2| = \frac{\text{Energy}}{\text{Volume}} = \frac{[ML^2T^{-2}]}{[L^3]} = ML^{-1}T^{-2}$$

14. d. Dimensionally $\varepsilon_0 L = C$, where C = capacitance
Dimensionally $C\Delta V = q$, where q is charge
Dimensionally $\frac{q}{\Delta t} = I$, where I is current

15. a. $V = l^3 = (1.2 \times 10^{-2}\ \text{m})^3 = 1.728 \times 10^{-6}\ \text{m}^3 = 1.7 \times 10^{-6}\ \text{m}^3$
Hence, l has two significant figures. Thus, V will also have two significant figures.

16. c. Unit of K is joules per kelvin or the dimensional formula of K is $[ML^2T^{-2}\theta^{-1}]$. $\alpha z/k\theta$ should be dimensionless.

So, dimensional formula of $\alpha = \frac{[ML^2T^{-2}]}{[L]} = MLT^{-2}$

Dimensional formula of $P = [ML^{-1}T^{-2}]$

$$\Rightarrow \quad \beta = \left[\frac{\alpha}{P}\right] = \frac{[MLT^{-2}]}{[ML^{-1}T^{-2}]} = M^0L^0T^0$$

17. a. $\rho = \frac{m}{\pi r^2 l}$

$$\Rightarrow \quad \left(\frac{\Delta\rho}{\rho} \times 100\right) = \left(\frac{\Delta m}{m} + \frac{2\Delta r}{r} + \frac{\Delta l}{l}\right) \times 100$$

$$= \left(\frac{0.003}{0.3} + \frac{2 \times 0.005}{0.5} + \frac{0.06}{6}\right) \times 100 = 4\%$$

18. d. (a) Pressure, Young's modulus and stress have same dimensional formula

$$[P] = [Y] = [\sigma] = \frac{[\text{Force}]}{[\text{Area}]} = \frac{[MLT^{-2}]}{[L^2]} = [ML^{-1}T^{-2}]$$

(b) Emf, potential difference and electric potential have dimensional formula

$$[\varepsilon] = [\Delta V] = [V] = \frac{[\text{Energy}]}{[\text{Charge}]} = \frac{[ML^2T^{-2}]}{[AT]} = [ML^2T^{-3}A^{-1}]$$

(c) Heat, work done and energy all have the dimensional formula of energy.

(d) Dipole moment = charge × distance
$= [AT] \times [L] = [LTA]$

Electric field $[E] = \frac{[F]}{[q]} = \frac{[MLT^{-2}]}{[AT]} = [MLT^{-3}A^{-1}]$

Electric flux $[\phi] = [E][A] = [MLT^{-3}A^{-1}][L^2] = [ML^3T^{-3}A^{-1}]$

Multiple Correct Answer Type

1. a., b., c. RC has the dimensions of time, so $1/RC$ will have the dimensions of frequency. Similarly, L/R has the dimensions of time, so R/L will have the dimensions of frequency.

Now $\frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{\frac{L}{R}RC}} = \frac{1}{\sqrt{T \times T}} = \frac{1}{T}$ is the dimension of frequency.

2. a., d. $\tau = F \times r \times \sin\theta$, $W = F \times d$;
Light year = wavelength = $[L]$

3. b., d.
Length $\propto G^x c^y h^z$
$L = [M^{-1}L^3T^{-2}]^x [LT^{-1}]^y [ML^2T^{-1}]^z$
By comparing the power of M, L and T in both sides we get
$-x + z = 0$, $3x + y + 2z = 1$ and $-2x - y - z = 0$
By solving above three equations we get

$$x = \frac{1}{2}, y = -\frac{3}{2}, z = \frac{1}{2}$$

4. a., b., c.

a. Both Reynold number and coefficient of friction are dimensionless.

b. Curie has unit disintegrations/second. Both Curie and frequency have dimensions $[T^{-1}]$.

c. Latent heat = $\frac{\text{Heat energy}}{\text{Mass}}$

Gravitational potential = $\frac{\text{Gravitational energy}}{\text{Mass}}$.

Both have dimensions $[L^2T^{-2}]$.
Planck's constant has dimensions $[ML^2T^{-1}]$, whereas torque has dimensions $[ML^2T^{-2}]$.

5. a., b., c., d. $L = \frac{\phi}{I}$; $L = -e\Big/\left(\frac{dI}{dt}\right)$; $L = \frac{2U}{I^2}$; $L = R \times t$

6. b., c. By definition $F = \frac{Q_1Q_2}{(4\pi\varepsilon_0)r^2}$ and $\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi L}$

$$\text{Hence, } [\varepsilon_0] = \frac{[Q^2]}{[F][r^2]} = \frac{I^2T^2}{[MLT^{-2}][L^2]} = [M^{-1}L^{-3}T^4I^2]$$

$$[\mu_0] = \frac{[F]}{[I^2]} = \frac{[MLT^{-2}]}{[I^2]} = [MLT^{-2}I^{-2}]$$

10. a., c., d.
For M
$[M] = [h]^p[C]^q[G]^r$
$[M] = [M^1L^2T^{-1}]^p[L^1T^{-1}]^q[M^{-1}L^3T^{-2}]^r$
$[M] = [M]^{p-r}[L]^{2p+q+3r}[T]^{-p-q-2r}$

$\therefore \quad p - r = 1$ (i)
$2p + q + 3r = 0$ (ii)
$-p - q - 2r = 0$ (iii)

On solving (i), (ii) & (iii) we get

$$p = \frac{1}{2}, r = \frac{-1}{2} \text{ and } q = \frac{1}{2} \Rightarrow [M] \propto \sqrt{h}$$

$$[M] \propto \sqrt{C}$$

$$[M] \propto \frac{1}{\sqrt{G}}$$

Similarly for $[L]$
$p - r = 0$ (iv)
$2p + q + 3r = 1$ (v)
$-p - q - 2r = 0$ (vi)

On solving (iv), (v) & (vi)

$$p = \frac{1}{2}, q = \frac{-3}{2}, r = \frac{1}{2} \quad \Rightarrow \quad [L] \propto \sqrt{h}$$

$$[L] \propto \frac{1}{C^{3/2}}$$

$$[L] \propto \sqrt{G}$$

11. a., c. $[V] = [M^1L^2T^{-3}A^{-1}]$

$[I] = [A]$

$[c] = [L^1T^{-1}]$

$[\varepsilon_0] = [M^{-1}L^{-3}T^4A^2]$

$[\mu_0] = [M^1L^1T^{-2}A^{-2}]$

Option A

$[\mu_0 I^2] = [M^1L^1T^{-2}]$; $[E_0V^2] = [M^1L^1T^{-2}]$

Option B

$[\varepsilon_0 I] = [M^1L^{-3}T^4A^3]$

$[\mu_0 V] = [M^2L^3T^{-5}A^{-3}]$

Option C

$[I] = [A]$

$[\varepsilon_0 cV] = [A]$

Option D

$[\mu_0 cI] = [M^1L^2T^{-3}A^{-1}]$

$[\varepsilon_0 V] = [L^{-1}TA]$

Options A and C correct.

Multiple Column Type

1.
Angular momentum	ML^2T^{-1}
Latent heat	L^2T^{-2}
Torque	ML^2T^{-2}
Capacitance	$M^{-1}L^{-2}T^2Q^2$
Inductance	ML^2Q^{-2}
Resistivity	$ML^3T^{-1}Q^{-2}$

2.
Capacitance	Coulomb $(\text{volt})^{-1}$, Coulomb^2 Joule^{-1}
Inductance	Ohm second, Volt second $(\text{ampere})^{-1}$
Magnetic induction	newton (ampere Meter)$^{-1}$

3. a. i . → G, ii. → H, iii. → C, iv. → B, v. → C

4. i. → a., b., ii. → c., d., iii. → c., d., iv. → c., d.

$$GM_eM_s = Fr^2 = Nm^2 = \text{kg}\frac{\text{m}}{\text{s}^2} \times \text{m}^2 = \text{kg}\,\text{m}^3\,\text{s}^{-2}$$

Also: (volt) (coulomb) (metre) = N m^2

$$v_{\text{rms}} = \sqrt{\frac{3RT}{M}} \Rightarrow v_{\text{rms}}^2 = \frac{3RT}{M}$$

Unit of $\frac{3RT}{M}$ is m^2s^{-2}

Also (farad) $(\text{volt})^2(\text{kg})^{-1} = \text{m}^2\text{s}^{-2}$.

$$F = qvB \Rightarrow v^2 = \frac{F^2}{q^2B'^2}$$

Hence, unit of v^2 is m^2s^{-2} which is further equal to $FV\,\text{kg}^{-1}$

Escape velocity, $V_e = \sqrt{\frac{2GM}{R}} \Rightarrow V_e^2 = \frac{2GM}{R}$

So the unit of $\frac{GM}{R}$ is m^2s^{-2}.

5. c. p. → 4.; q. → 2.; r. → 1.; s. → 3.

p. $KE = \frac{3}{2}KT \Rightarrow [ML^2T^{-2}] = K'[K] \Rightarrow K' = [ML^2T^{-2}K^{-1}]$

q. $F = 6\pi\eta rv$

$\Rightarrow [ML^{-2}T^{-2}] = \eta[L][LT^{-1}] \Rightarrow \eta = [ML^{-1}T^{-1}]$

r. $E = hf \Rightarrow [ML^2T^{-2}] = \frac{h}{[T]} \Rightarrow h = [ML^2T^{-1}]$

s. $\frac{dQ}{dt} = \frac{K'A(\Delta T)}{\Delta x} \Rightarrow \frac{[ML^2T^{-2}]}{[T]} = \frac{k[L^2][K']}{[L]}$

$K' = [MLT^{-3}K^{-1}]$

Integer Answer Type

2. (3) $d = \rho^a S^b f^c$

$$d = \left(\frac{kg}{m^3}\right)^a \times \left(\frac{w}{m^2}\right)^b \times \left(\frac{1}{\text{sec}}\right)^c$$

$$d = (ML^{-3})^a\left(\frac{ML^2T^{-3}}{L^2}\right)^b\left(\frac{1}{\text{sec}}\right)^c$$

$$L^1 = M^{a+b}L^{-3a}T^{-3b-c}$$

$$-3a = 1 \Rightarrow a = -\frac{1}{3}$$

$a + b = 0$ $\quad\left(\therefore\ b = \frac{1}{3}\right)$

$-3b - c = 0$ $\quad(\therefore c = 1)$

$\therefore \quad d = \rho^{-\frac{1}{3}}S^{\frac{1}{3}}f^1$

$\therefore \quad d \propto S^{1/n}$ $\quad(\therefore n = 3)$

3. (4) $E(t) = A^2e^{-\alpha t}$

$\ln E = 2\ln A - \alpha t$

$\therefore \quad \frac{\Delta E}{E}\times 100 = 2\frac{\Delta A}{A}\times 100 - \alpha\Delta t \times 100$ $\quad$ (i)

For time : $\frac{\Delta t}{t}\times 100 = 1.5$

At $t = 5$ s, $\Delta t = \frac{1.5\times 5}{100} = \frac{7.5}{100}$

Using Eq(i)

% error in $E = 2\times(1.25) + \alpha\times\frac{7.5}{100}\times 100$

$= 2.5 + 1.5 = 4$

Fill in the Blanks Type

1. $E = hf,\ h = \frac{E}{f} = \frac{ML^2T^{-2}}{T^{-1}} = ML^2T^{-1}$

2. $[X] = [C] = [M^{-1}L^{-2}T^2Q^2]$

$[Z] = [B] = [MT^{-1}Q^{-1}]$

$$[Y] = \frac{[M^{-1}L^{-2}T^2Q^2]}{[MT^{-1}Q^{-1}]^2} = [M^{-3}L^{-2}T^4Q^4]$$

3. $\sigma = \frac{1}{\rho} = \frac{l}{RA} = \frac{l}{\frac{V}{I}A} = \frac{Il}{VA} = \frac{Il}{\frac{W}{q}A} = \frac{Ilq}{WA}\times\frac{t}{t}$

$$= \frac{I^2lt}{WA} = \frac{A^2LT^1}{ML^2T^{-2}L^2} = [M^{-1}L^{-3}T^3A^2]$$

4. In the equation,

$$\left(P + \frac{a}{V^2}\right)(V - b) = RT$$

$$[P] = \left[\frac{a}{V^2}\right]$$

or $$[a] = [PV^2] = \left[\frac{MLT^{-2}}{L^2} L^6\right] = [ML^5T^{-2}]$$

Subjective Type

1. The MKS unit of Young's modulus is N m^{-2}.
   The MKS unit of magnetic induction: Tesla.
   The MKS unit of power of lens is dioptre.
2. Given that $T \propto p^a d^b E^c$

$$[M^0L^0T^1] = [ML^{-1}T^{-2}]^a[ML^{-3}]^b[ML^2T^{-2}]^c$$

$$[M^0L^0T^1] = [M^{a+b+c}L^{-a-3b+2c}T^{-2a-2c}]$$

$$a + b + c = 0$$
$$-a - 3b + 2c = 0$$
$$-2a - 2c = 1$$

On solving, we get

$$a = -5/6,\ b = 1/2,\ c = 1/3$$
$$T \propto p^{-5/6}d^{1/2}E^{1/3}$$
$$T = kp^{-5/6}d^{1/2}E^{1/3}$$

where k is the proportionality constant.

3. Magnetic flux = $[M^1L^2T^{-1}Q^{-1}]$
   Modulus of rigidity = $ML^{-1}T^{-2}$