DAY FOURTY

Mock Test 3

Instruction

- This question paper contains of 50 Multiple Choice Questions of Physics, divided into two Sections; section A and section B.
- Section A contains 35 questions and all questions are compulsory.
- Section B contains 15 questions out of which only 10 questions are to be attempted.
- Each question carries 4 marks.

Section A

1 The magnetic field in a travelling electromagnetic wave has a peak value of 20 nT. The peak value of electric field strength is

(a) 3 V/m (b) 6 V/m (c) 9 V/m (d) 12 V/m

2 The value of resistance is 10.85452 Ω and the value of current is 3.23 A. The potential difference is 35.02935 V. Its value in significant number would be

(a) 3.8 V (b) 35.0 V (c) 35.03 V (d) 35.029 V

3 A body initially at rest is accelerate at the rate of $2\ \text{ms}^{-2}$ for 5s. If the body continues with uniform velocity for next 10 s, the total distance covered by the body is

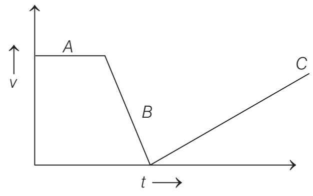
(a) 50 m (b) 125 m (c) 165 m (d) 225 m

4 **Assertion** Angle between $\mathbf{i} + \mathbf{j}$ and $\mathbf{i}$ is 45°.

Reason $\mathbf{i} + \mathbf{j}$ is equally include to both $\mathbf{i}$ and $\mathbf{j}$ and the angle between $\mathbf{i}$ and $\mathbf{j}$ is 90°.

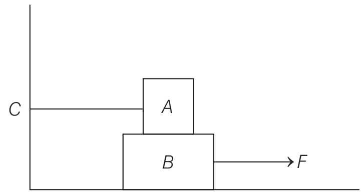
(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(c) Assertion is true but Reason is false.
(d) Assertion is false but Reason is true.

5 Velocity-time graph of motion of a body is shown below



(a) at B, force is zero
(b) at B, there is a force but towards motion
(c) at B, there is a force which opposes the motion
(d) None of the above

6 Block A of weight 100 kg rests on a block B and is tied with a horizontal string to the wall at C. Block B weighs 200 kg. The coefficients of friction between A and B is 0.25, and between B and surface is 1/3. The horizontal force F necessary to move the block B should be ($g = 10\,\text{ms}^{-2}$)

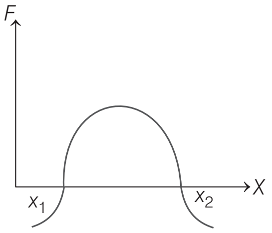


(a) 1150 N (b) 1250 N
(c) 1300 N (d) 1420 N

7 A stone tied to a string is rotated in a vertical plane. If mass of the stone is m, the length of the string is r and the linear speed of the stone is v when the stone is at its lowest point, then the tension in the string will be (g = acceleration due to gravity)

(a) $\frac{mv^2}{r} + mg$ (b) $\frac{mv^2}{r} - mg$
(c) $\frac{mv^2}{r}$ (d) mg

8 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



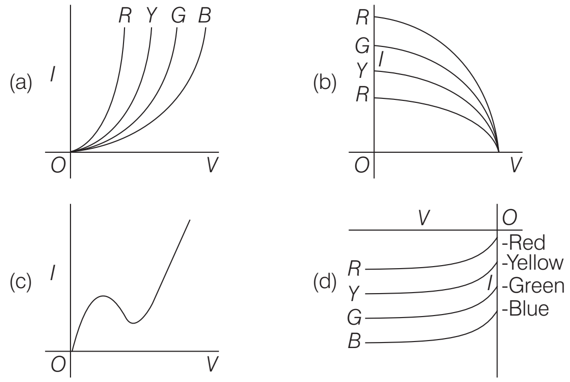
(a) $x = x_1$ (b) $x = x_2$
(c) Both x_1 and x_2 (d) Neither x_1 nor x_2

9 **Statement I** Velocity-time graph for an object in a uniform motion along a straight line is, parallel to the time axis.

Statement II In uniform motion of an object, velocity increases as the square of time elapsed.

(a) Both statement I and statement II are true.
(b) Both statement I and statement II are false.
(c) Statement I is true but statement II is false.
(d) Statement I is false but statement II is true.

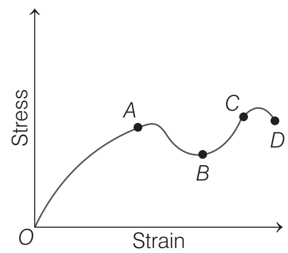
10 The I–V characteristic of an LED is



11 Which one of the following represents simple harmonic motion ?

(a) $x^2 = a + bv$ (b) $x = \sqrt{a + bv^2}$
(c) $x = a - bv$ (d) $x = \sqrt{a - bv^2}$

12 A graph is shown between stress and strain for metal. The part in which Hooke's law holds good is



(a) OA (b) AB (c) BC (d) CD

13 A metal disc of radius r floats on the surface of water. The water layer goes down and makes an angle θ with the vertical edge of the disc. If it displaces a weight w of water and the surface tension of water is T, then weight of the disc is

(a) $2\pi r T \cos\theta$ (b) $2\pi r T$
(c) $2\pi r T \cos\theta + w$ (d) $2\pi r T \cos\theta - w$

14 If at the same temperature and pressure, the densities of two diatomic gases are d_1 and d_2, respectively. The ratio of mean kinetic energy per molecule of gases will be

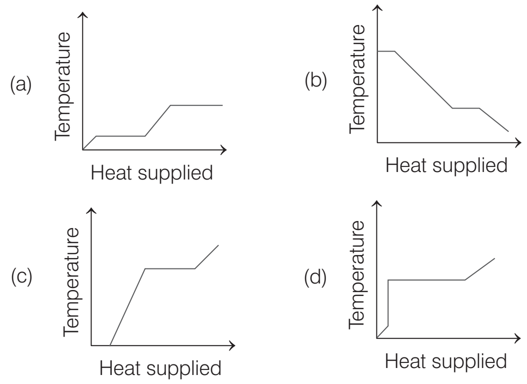
(a) 1 : 1 (b) $d_1 : d_2$
(c) $\sqrt{d_1} : \sqrt{d_2}$ (d) $\sqrt{d_2} : \sqrt{d_1}$

15 If the refractive index of water is 4/3 and that of given slab of glass immersed in it is 5/3, what is the critical angle for a ray of light tending to go from glass to water?

(a) $\sin^{-1}\left(\frac{3}{4}\right)$ (b) $\sin^{-1}\left(\frac{3}{5}\right)$ (c) $\sin^{-1}\left(\frac{4}{5}\right)$

(d) Data given is insufficient to make any calculation

16 A block of ice at $-10°$C is slowly heated and converted to steam at 100°C. Which of the following curves represent the phenomenon qualitatively?



17 In a compound microscope, magnifying power is 95 and the distance of object from objective lens is $\frac{1}{3.8}$ cm and the focal length of objective lens is $\frac{1}{4}$ cm, the magnification of eye-piece is

(a) 5 (b) 10
(c) 100 (d) insufficient data

18 Two polaroids are crossed. If now one of them is rotated through 30° and unpolarised light of intensity I_0 is incident on the first polaroid, then the intensity of transmitted light will be

(a) $\frac{I_0}{4}$ (b) $\frac{3I_0}{4}$
(c) $\frac{3I_0}{8}$ (d) $\frac{I_0}{8}$

19 In Young's experiment, light of wavelength 4000 Å is used to produce bright fringes of width 0.6 mm, at a distance of 2 m. If the whole apparatus is dipped in a liquid of refractive index 1.5, then the fringe width will be

(a) 0.2 mm (b) 0.3 mm
(c) 0.4 mm (d) 1.2 mm

20 A ring of mass M and radius R is rotating about its axis with angular velocity ω. Two identical bodies each of mass m, are now gently attached at the two ends of a diameter of the ring. Because of this, the kinetic energy loss will be

(a) $\frac{m(M+2m)}{M}\omega^2R^2$ (b) $\frac{Mm}{(M+2m)}\omega^2R^2$
(c) $\frac{Mm}{(M-2m)}\omega^2R^2$ (d) $\frac{(M+m)M}{(M+2m)}\omega^2R^2$

21 White light is used to illuminate the two slits in a Young's double slit experiment. The separation between slits is b and the screen is at a distance $d\,(>>b)$ from the slits. At a point on the screen directly infront of one of the slits, certain wavelengths are missing. One of the missing wavelengths is

(a) $\lambda = b^2/d$ (b) $\lambda = 2b^2/d$
(c) $\lambda = 3\,b^2/d$ (d) $\lambda = 2b^2/3d$

22 A charge q is distributed over two concentric hollow conducting sphere of radii r and $R\,(>r)$, such that their surface charge densities are equal. The potential at their common centre is

(a) zero (b) $\frac{q}{4\pi\varepsilon_0}\frac{(r+R)}{(r^2+R^2)^2}$
(c) $\frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r}+\frac{1}{R}\right]$ (d) $\frac{q}{4\pi\varepsilon_0}\frac{(r+R)}{(r^2+R^2)}$

23 When resonance is produced in a series L-C-R circuit, then which of the following is not correct?

(a) Current in the circuit is in phase with the applied voltage
(b) Inductive and capacitive reactances are equal
(c) If R is reduced, the voltage across capacitor will increase
(d) Impedance of the circuit is maximum

24 In a meter bridge with a standard resistance of 5 Ω in the left gap, the ratio of balancing lengths on the meter bridge wire is 2 : 3. The unknown resistance is

(a) 3.3 Ω (b) 7.5 Ω (c) 10 Ω (d) 15 Ω

25 The inductance of a coil, in which a current of 0.2 A is increasing at the rate of 0.5 As^{-1} represents a power flow of 0.5 W, is

(a) 2 H (b) 5 H (c) 10 H (d) 20 H

26 An ideal choke of 10 H is joined in series with resistance of 5 Ω and a battery of 5V. The current in the circuit in 2 s after joining in ampere, will be

(a) e^{-1} (b) $1-e^{-1}$
(c) $1-e$ (d) e

27 A series L-R circuit is connected to an AC source of frequency ω and the inductive reactance is equal to $2R$. A capacitance of capacitive reactance equal to R is added in series with L and R. The ratio of the new power factor to the old one is

(a) $\sqrt{\frac{2}{3}}$ (b) $\sqrt{\frac{2}{5}}$ (c) $\sqrt{\frac{3}{2}}$ (d) $\sqrt{\frac{5}{2}}$

28 The total binding energy of a nucleus is defined as the product of mass defect (in kg) and a constant. The value of constant is

(a) $8.854\times10^{-12}\ Fm^{-2}$ (b) $3\times10^{8}\ ms^{-1}$
(c) $9\times10^{16}\ m^2s^{-2}$ (d) 931 MeV

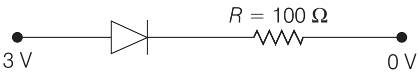
29 A radioactive element X with a half-life of 2 h decays giving a stable element Y. After a time of t hours, the ratio of X to Y atoms is 1 : 7. Then, its time period is

(a) 4 (b) 6
(c) in between 4 and 6 (d) 14

30 Generally, semiconductor can be used safely between the temperatures

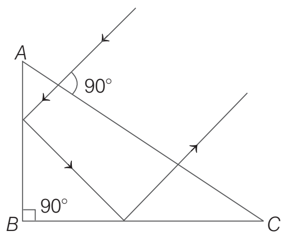
(a) – 75°C and 200°C (b) 0°C and 75°C
(c) – 25°C and 300°C (d) – 40°C and 1000°C

31 Assuming that the silicon diode (having negligible resistance), the current through the diode is (knee voltage of silicon diode is 0.7 V)



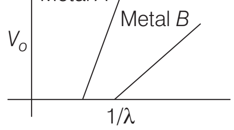
(a) zero (b) 7 mA (c) 2.3 mA (d) 23 mA

32 A ray falls on a prism ABC ($AB = BC$) and travels as shown in figure. The minimum refractive index of the prism material should be



(a) 4/3 (b) $\sqrt{2}$ (c) 1.5 (d) $\sqrt{3}$

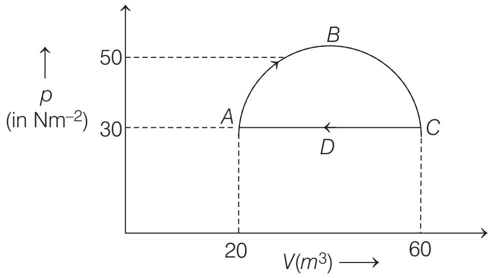
33 In an experiment on photoelectric effect, a student plots stopping potential V_0 against reciprocal of the wavelength λ of the incident light for two different metals A and B. These are shown in the figure.



Looking at the graphs, you can most appropriately say that

(a) work function of metal B is greater than that of metal A
(b) work function of metal A is greater than that of metal B
(c) data is not sufficient
(d) None of the above

34 A gas undergoes a cyclic process *ABCDA* as shown in figure. The part *ABC* of process is semi-circular. The work done by the gas is



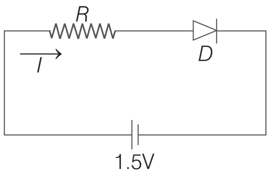
(a) 400π J (b) 2456 J
(c) 200π J (d) 1828 J

35 In a given process on an ideal gas, $dW = 0$ and $dQ < 0$, then for the gas

(a) the temperature will decrease
(b) the volume will increase
(c) the pressure will remain constant
(d) the temperature will increase

Section-B

36 The diode used in the circuit shown in the figure has a constant voltage drop of 0.5 V at all currents and a maximum power rating of 100 mW. What should be the value of the resistor *R*, connected in series with the diode, for obtaining maximum current *I* ?



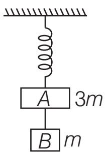
(a) 200 Ω (b) 6.67 Ω
(c) 5 Ω (d) 1.5 Ω

37 **Statement I** Inertia and moment of inertia are same quantities.

Statement II Moment of inertia represents the capacity of a body to oppose its state of motion.

(a) Both statement I and statement II are true.
(b) Both statement I and statement II are false.
(c) Statement I is true but statement II is false.
(d) Statement I is false but statement II is true.

38 Two blocks *A* and *B* of masses 3*m* and *m* respectively are connected by a massless and inextensible string. The whole system is suspended by a massless spring as shown in figure. The magnitudes of acceleration of *A* and *B* immediately after the string is cut, are respectively



(a) $g, \frac{g}{3}$ (b) $\frac{g}{3}, g$ (c) g, g (d) $\frac{g}{3}, \frac{g}{3}$

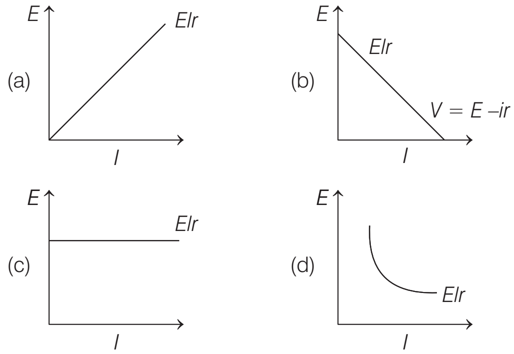
39 Two coherent sources with intensity ratio α interfere. Then, the ratio $\frac{I_{max} - I_{min}}{I_{max} + I_{min}}$ is

(a) 2α (b) $\frac{2\sqrt{\alpha}}{1+\alpha}$ (c) $\frac{2}{1-\alpha}$ (d) $\frac{4\sqrt{\alpha}}{1+\alpha}$

40 A body of mass 100 g is sliding from an inclined plane of inclination 30°. What is the frictional force, if $\mu = 0.7$?

(a) $0.7\sqrt{\frac{2}{3}}$ N (b) $\frac{0.7\sqrt{3}}{2}$ N
(c) $0.7\sqrt{3}$ N (d) $\frac{0.7\sqrt{2}}{3}$ N

41 A cell of emf *E* and internal resistance *r* is connected with external resistance *R*. The graph between terminal voltage and current is



42 **Statement I** To obtain same change in the value of *g*, depth *d* below the surface of earth must be equal to twice the height *h* above the surface of the earth.

Statement II *g* changes less with depth than with height.

(a) Both statement I and statement II are true.
(b) Both statement I and statement II are false.
(c) Statement I is true but statement II is false.
d) Statement I is false but statement II is true.

43 In an *n-p-n* transistor circuit, the collector current is 10 mA. If 90% of the electrons reach emitted the collector, then

(a) $I_e = 1$ mA, $I_b = 11$ mA
(b) $I_e = 11$ mA, $I_b = 1$ mA
(c) $I_e = -1$ mA, $I_b = 9$ mA
(d) $I_e = 9$ mA, $I_b = 1$ mA

44 A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of resulting system

(a) increases by a factor of 4
(b) decreases by a factor of 2
(c) remains the same
(d) increases by a factor of 2

45 **Assertion** For projection angle $\tan^{-1}(4)$, the horizontal and maximum height of a projectile are equal.

Reason The maximum range of projectile is directly proportional to square of velocity and inversely proportional to acceleration due to gravity.

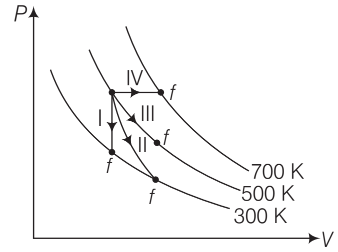
(a) Assertion and Reason are true and Reason is the correct explanation for Assertion
(b) Assertion and Reason are true but Reason is not a correct explanation for Assertion
(c) Assertion is true but Reason is false
(d) Assertion is false but Reason is true

46 The output of a two input OR gate is 1, if
(a) both inputs are zero
(b) either or both inputs are 1
(c) only both inputs are 1
(d) either input is zero

47 If **A** and **B** are unit vectors, then $(A \times B) \cdot (A \times B)$ is equal to
(a) 1 (b) zero
(c) $\frac{1}{2}$ (d) -1

48 A long solenoid of diameter 0.1 m has 2×10^4 turns per metre. At the centre of the solenoid, a coil of 100 turns and radius 0.01 m is placed with its axis coinciding with the solenoid axis. The current in the solenoid reduces at a constant rate to 0 A from 4 A in 0.05 s. If the resistance of the coil is $10\pi^2\ \Omega$, the total charge flowing through the coil during this time is
(a) $32\pi\ \mu C$ (b) $16\ \mu C$
(c) $32\ \mu C$ (d) $16\pi\ \mu C$

49 Thermodynamic processes are indicated in the following diagram



Match the following :

	Column-I		Column-II
P.	Process I	a.	Adiabatic
Q.	Process II	b.	Isobaric
R.	Process III	c.	Isochoric
S.	Process IV	d.	Isothermal

(a) P→ a, Q→ c, R→ d, S→ b
(b) P→ c, Q→ a, R→ d, S→ b
(c) P→ c, Q→ d, R→ b, S→ a
(d) P→ d, Q→ b, R→ a, S→ c

50 One end of the string of length l is connected to a particle of mass m and the other end is connected to a small peg on a smooth horizontal table. If the particle moves in circle with speed v, the net force on the particle (directed towards center) will be (T represents the tension in the string)
(a) T (b) $T + \frac{mv^2}{l}$
(c) $T - \frac{mv^2}{l}$ (d) Zero

Answers

1	(b)	2	(b)	3	(b)	4	(a)	5	(c)	6	(b)	7	(a)	8	(b)	9	(c)	10	(a)
11	(d)	12	(a)	13	(c)	14	(a)	15	(c)	16	(a)	17	(a)	18	(c)	19	(c)	20	(b)
21	(a)	22	(d)	23	(d)	24	(b)	25	(b)	26	(b)	27	(d)	28	(c)	29	(b)	30	(b)
31	(d)	32	(b)	33	(c)	34	(c)	35	(a)	36	(c)	37	(d)	38	(b)	39	(b)	40	(b)
41	(b)	42	(b)	43	(b)	44	(d)	45	(b)	46	(b)	47	(a)	48	(c)	49	(b)	50	(a)

Hints and Explanations

1 We know that, $\frac{E_0}{B_0} = c$

$\Rightarrow \quad E_0 = cB_0$
$= 3 \times 10^8 \times 20 \times 10^{-9} = 6$ V/m

2 Number of significant figures in $R = 5$
Number of significant figures in $I = 3$
Hence, potential difference $V (= RI)$ should contain 3 significant figures.
i.e. $V = 35$ V

3 Distance covered in first 5 s,

$$s_1 = ut + \frac{1}{2}at^2$$
$$= 0 + \frac{1}{2} \times 2 \times (5)^2 = 25 \text{ m}$$

Velocity after 5 s,

$$v = u + at$$
$$= 0 + 2 \times 5 = 10 \text{ ms}^{-1}$$

Distance covered in next 10 s,

$$s_2 = 10 \times 10 = 100 \text{ m}$$

Total distance

$$= s_1 + s_2 = 25 + 100 = 125 \text{ m}$$

4 $\cos\theta = \frac{(\hat{i} + \hat{j}) \cdot \hat{i}}{|(\hat{i} + \hat{j})\hat{i}|} = \frac{1}{\sqrt{2}} = \cos 45°$

So, $\theta = 45°$

5 At *B*, velocity is decreasing, so there is a force which opposes the motion.

6 Required force,

$$F = \mu_{AB} R_A + \mu_{BS} R_B$$
$$= 0.25 \times 100 \text{ kg} + \frac{1}{3}(100 + 200) \text{ kg}$$
$$= 25 \text{ kg} + 100 \text{ kg}$$
$$= 125 \text{ kg} = 125 \times 10 = 1250 \text{ N}$$

7 At point **B**,

$$T_B - mg = \frac{mv^2}{r}$$
$$\Rightarrow \quad T_B = \frac{mv^2}{r} + mg$$

8 When displaced from x_2 in negative direction, force is positive. So, this force is of restoring nature or bringing the body back. Hence, at x_2, body is in stable equilibrium position.

9 When the object moves with uniform velocity the magnitude of its velocity at $t = 0$, $t = 1$ s and $t = 2$ s will be constant.

Hence, velocity-time graph for an object in uniform motion is a straight line parallel to time axis.

10 LEDs are current dependent devices with its forward voltage drop **V.** Forward voltage drop for Red, Yellow, Green and Blue are related as
$V_{Blue} > V_{Green} > V_{Yellow} > V_{Red}$

11 Relation (d) which is $x = \sqrt{a - bv^2}$ correctly represent the SHM because, velocity

$$v = \omega\sqrt{a^2 - x^2}$$
or $$x = \sqrt{a^2 - v^2/\omega^2}$$
or $$x = \sqrt{a^2 - bv^2} \quad \left[\because b = \frac{1}{\omega^2}\right]$$

12 In the region **OA**, stress ∝ strain, i.e. Hooke's law hold good.

13 When water is depressed downwards at point of contact, then the force due to surface tension acts upwards.

Therefore, apparent weight

$$= F_T + w = 2\pi r T\cos\theta + w$$

14 Mean kinetic energy of gas depends only on the temperature. Here, temperature is given same, so ratio of kinetic energies will be 1:1.

15 Critical angle

$$C = \sin^{-1}\left(\frac{\mu_w}{\mu_g}\right) = \sin^{-1}\left(\frac{4/3}{5/3}\right)$$
$$= \sin^{-1}\left(\frac{4}{5}\right)$$

16 Temperature first increases from $-10°C$ to $0°C$. Then, remains constant at 0°C till whole ice is melted. Then, it increases from 0°C to 100°C. Again, it remains constant at 100°C till whole water converts into steam.

17 Magnifying power of compound microscope, $M = m_o \times m_e$

For objective, $\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$

$$\frac{1}{1/4} = \frac{1}{v_o} - \frac{1}{-1/3.8} \Rightarrow 4 = \frac{1}{v_o} + 3.8$$
$$\Rightarrow \quad v_o = 5 \text{ cm}$$
$$\therefore \quad m_o = \frac{v_o}{u_o} = \frac{5}{1/3.8} = 19$$

Hence, $m_e = \frac{m}{m_o} = \frac{95}{19} = 5$

18 Intensity of transmit light from one polaroid, $I_1 = \frac{I_0}{2}$

Therefore, intensity of light transmitted from second polaroid

$$I_2 = I_1 \cos^2\theta$$
$$= \frac{I_0}{2}\cos^2(90° - 30°)$$
$$= \frac{I_0}{2}\cos^2 60° = \frac{I_0}{2} \times \left(\frac{1}{2}\right)^2 = \frac{I_0}{8}$$

19 Fringe width, $\beta \propto \lambda$

$$\therefore \quad \frac{\beta_1}{\beta_2} = \frac{\lambda_1}{\lambda_2}$$
or $$\frac{\beta_1}{\beta_2} = \frac{\lambda_1}{\lambda_1/\mu}$$
$$\therefore \quad \beta_2 = \frac{\beta_1}{\mu} = \frac{0.6}{1.5} = 0.4 \text{ mm}$$

20 By conservation of angular momentum,

$$I_1\omega_1 = I_2\omega_2 \quad ...(i)$$

where, $I_1 = mR^2$ ...(ii)

and $I_2 = 2mR^2 + MR^2$ ...(iii)

Now, change in kinetic energy,

$$KE = \frac{1}{2}L_1 I_1^2 - \frac{1}{2}L_2 I_2^2 \quad ...(iv)$$

On substituting the values from Eqs. (i), (ii) and (iii) into Eq. (iv), we get

Change in KE $= \left(\frac{Mm}{M + 2m}\right)\omega^2 R^2$

21 Positions of minima are given by

$$y_n = \left(n - \frac{1}{2}\right)\frac{D\lambda}{d}$$
$$\lambda = \frac{2y_n d}{(2n - 1)D}$$

Here, $y_n = b/2, d = b, D = d$

$$\therefore \quad \lambda = \frac{b^2}{(2n - 1)d}$$

where, $n = 1, 2, 3, ...$

Hence, $\lambda = \frac{b^2}{d}, \frac{b^2}{3d}, ...$

22 $$q = 4\pi(r^2 + R^2) \cdot \sigma$$
$$\sigma = \frac{q}{4\pi(r^2 + R^2)}$$

Potential at centre,

$$V = \frac{\sigma r}{\varepsilon_0} + \frac{\sigma R}{\varepsilon_0} = \frac{\sigma}{\varepsilon_0}(r + R)$$
$$= \frac{q}{4\pi\varepsilon_0}\frac{(r + R)}{(r^2 + R^2)}$$

23 In series resonant **L-C-R** circuit,

$$X_L = X_C$$

∴ Impedance,

$$Z = \sqrt{(X_L - X_C)^2 + R^2} = \sqrt{0 + R^2}$$

$$Z_{min} = R$$

Power factor, $\cos\phi = \frac{R}{Z} = \frac{R}{R} = 1$

$\therefore \quad \phi = 0°$

Hence, current and voltage are in same phase and impedance of the circuit is minimum. Hence, option (d) is not correct.

24 For meter bridge, unknown resistance,

$$R = \frac{l_2}{l_1} \times X = \frac{3}{2} \times 5 = 7.5\ \Omega$$

25 Energy stored in inductance,

$$U = \frac{1}{2} L I^2$$

Power, $P = \frac{dU}{dt} = \frac{d}{dt}\left(\frac{1}{2} L I^2\right) = L I \frac{dI}{dt}$

$$\therefore \quad L = \frac{P}{I \times \frac{dI}{dt}} = \frac{0.5}{0.2 \times 0.5} = 5\ H$$

26 Time constant $\tau = \frac{L}{R} = \frac{10}{5} = 2\,s$

$$I_0 = \frac{e}{R} = \frac{5}{5} = 1\ A$$

$\therefore$ Current in 2 s,

$$I = I_0(1 - e^{-t/\tau}) = 1(1 - e^{-2/2}) = 1 - e^{-1}$$

27 For *L-R* circuit,

$$Z_1 = \sqrt{R^2 + (2R)^2} = R\sqrt{5}$$

$\therefore \quad \cos\phi_1$ = power factor

$$= \frac{R}{z_1} = \frac{R}{R\sqrt{5}} = \frac{1}{\sqrt{5}}$$

Now, for *L-C-R* circuit,

$$Z_2 = \sqrt{R^2 + (2R - R)^2} = R\sqrt{2}$$

$$\therefore \quad \cos\phi_2 = \frac{R}{Z_2} = \frac{R}{R\sqrt{2}} = \frac{1}{\sqrt{2}}$$

$$\therefore \quad \frac{\cos\phi_2}{\cos\phi_1} = \frac{\frac{1}{\sqrt{2}}}{\frac{1}{\sqrt{5}}} = \sqrt{\frac{5}{2}}$$

28 Total binding energy, $E = (\Delta m)\,c^2$,

where, Δm = mass defect.

Therefore, the value of constant in the above product is given by

$c^2 = 9 \times 10^{16}\ m^2 s^{-2}$.

29 Initial amount of radioactive element

$$= X + Y = 1 + 7 = 8$$

Now, $\quad N = N_0 \left(\frac{1}{2}\right)^n$

$$\therefore \quad 1 = 8\left(\frac{1}{2}\right)^n$$

$$\Rightarrow \quad \left(\frac{1}{2}\right)^3 = \left(\frac{1}{2}\right)^n \text{ or } n = 3$$

Hence, required time period,

$$t = n\ T_{1/2} = 3 \times 2 = 6\ h$$

30 Semiconductors can be used safely between temperatures 0°C and 75°C.

31 Current through diode,

$$I = \frac{\Delta V}{R} = \frac{3 - 0.7}{100} = \frac{2.3}{100}\ A = 23\ mA$$

32 $\angle i$ at both faces will be 45°. For TIR to take place,

$$i > \theta_C$$

or $\quad \sin i > \sin\theta_C$

$$\therefore \quad \frac{1}{\sqrt{2}} > \frac{1}{\mu} \text{ or } \mu > \sqrt{2}$$

33 We have, $eV_0 = \frac{hc}{\lambda} - \phi$

$$\Rightarrow \quad V_0 = \frac{hc}{e\lambda} - \frac{\phi}{e}$$

$$V_0 = mx + c$$

$\because$ Data is not sufficient.

34 Work done, W = Area ABCDA

$$= \frac{\pi R^2}{2} = \frac{\pi \times (20)^2}{2}$$

$$= 200\pi\ J$$

35 From first law of thermodynamics,

$$dQ = dU + dW$$

we have, $\quad dQ = dU \quad$ [as, $dW = 0$]

But $\quad dQ < 0$

$\therefore \quad dU < 0$

$n\,C_V\,\Delta T < 0$

or $\quad \Delta T < 0$

Hence, the temperature will decrease.

36 Current in the circuit,

$$I = \frac{P}{V} = \frac{100 \times 10^{-3}}{0.5} = 200 \times 10^{-3}\ A$$

Voltage across resistance **R**,

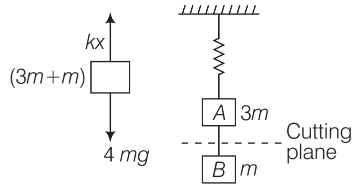
$$V' = 1.5 - 0.5 = 1.0\ V$$

$\therefore$ Resistance,

$$R = \frac{V'}{I} = \frac{1}{200 \times 10^{-3}} = 5\ \Omega$$

37 The inertia of a body depends only upon the mass of the body but the moment of inertia of a body about an axis not only depends upon the mass of the body but also on the distribution of mass about the axis of rotation.

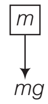
38 Initially system, is in equilibrium with a total weight of $4mg$ over spring.



$\therefore \quad kx = 4mg$

When string is cut at the location as shown above.

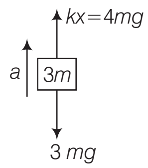
Free body diagram for *m* is



So,force on mass $m = mg$

$\therefore$ Acceleration of mass, $m = g$

For mass $3m$; free body diagram is



If a = acceleration of block of mass $3m$, then

$$F_{net} = 4mg - 3mg$$

$$\Rightarrow \quad 3m \cdot a_A = mg$$

or $\quad a_A = \frac{g}{3}$

So, accelerations for blocks *A* and *B* are

$$a_A = \frac{g}{3} \text{ and } a_B = g$$

39 $R = \frac{I_{max} - I_{min}}{I_{max} + I_{min}}$

$$= \frac{(a_1 + a_2)^2 - (a_1 - a_2)^2}{(a_1 + a_2)^2 + (a_1 - a_2)^2}$$

$$= \frac{4a_1 a_2}{2(a_1^2 + a_2^2)} = \frac{2a_1 a_2}{a_1^2 + a_2^2} = \frac{2(a_2/a_1)}{1 + \left(\frac{a_2}{a_1}\right)^2}$$

Given, $\left(\frac{a_2}{a_1}\right)^2 = \alpha$ and $\frac{a_2}{a_1} = \sqrt{\alpha}$

$$\therefore \quad R = \frac{2\sqrt{\alpha}}{1 + \alpha}$$

40 Friction force, $F = \mu\ mg\cos\theta$

$= 0.7 \times 100 \times 10^{-3} \times 10\cos 30°$

$= 0.7 \times \frac{\sqrt{3}}{2} = \frac{0.7\sqrt{3}}{2}$ N

41 Terminal voltage decreases as current increases.

42 $g_h = \frac{g}{\left(1 + \frac{h}{R}\right)^2} = g\left(1 + \frac{h}{R}\right)^{-2}$

or $g_h \approx g\left(1-\frac{2h}{R}\right)$ or $g-g_h=\frac{2gh}{R}$ ...(i)

and $g_d = g\left(1-\frac{d}{R}\right)$

or $g - g_d = \frac{gd}{R}$ ...(ii)

For same change in value of g,

$$g - g_h = g - g_d$$

or $\frac{2gh}{R} = \frac{gd}{R}$

or $d = 2h$

From Eqs. (i) and (ii), it is obvious that g changes less with depth than with height.

43 Given, $I_c = 10$ mA

Also, 90% of $I_e = 10 \Rightarrow \frac{90}{100} I_e = 10$

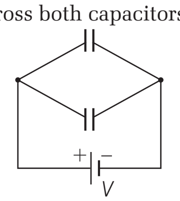
$\therefore$ $I_e = \frac{100}{9}$ mA ≈ 11 mA

Again, $I_b = I_e - I_c = 11 - 10 = 1$ mA

44 **Thinking Process** Energy stored in a system of capacitors

$$= \Sigma \frac{1}{2} CV^2$$

Also, potential drop remains same in parallel across both capacitors.



Initially stored energy

$$U_1 = \frac{1}{2} CV^2$$

Finally, potential drop across each capacitor will be still V.

So, finally stored energy

$$U_2 = \frac{1}{2} CV^2 + \frac{1}{2} CV^2$$

$$= \frac{1}{2}(2C)V^2$$

$$= 2\left(\frac{1}{2} CV^2\right) = 2U_1$$

45 Horizontal range of projectile,

$R = \frac{u^2 \sin 2\theta}{g}$, $R_{max} = \frac{u^2}{g}$ [at $\theta = 45°$]

The maximum height attained by projectile

$$H = \frac{u^2 \sin^2 \theta}{2g}$$

If $H = R$, then $\frac{u^2 \sin^2 \theta}{2g} = \frac{u^2 \sin 2\theta}{g}$,

$$\frac{\sin^2 \theta}{2} = 2 \sin \theta \cos \theta$$

So, $\tan \theta = 4$

$\therefore$ $\theta = \tan^{-1}(4)$

46 Output of two input OR gate is

$Y = A + B$.

i.e. $Y = 1$, if either or both inputs are 1.

47 As $(\mathbf{A} \times \mathbf{B})$ is parallel to $\mathbf{A} \times \mathbf{B}$, hence dot product will be unity.

48 **Thinking Process** Current induced in the coil is given by

$$= \frac{1}{R}\left(\frac{d\phi}{dt}\right)$$

$\Rightarrow$ $\frac{\Delta q}{\Delta t} = \frac{1}{R}\left(\frac{\Delta \phi}{\Delta t}\right)$

Given, resistance of the solenoid,

$$R = 10\pi^2 \ \Omega$$

Radius of second and coil $r = 10^{-2}$

$\Delta t = 0.05$ s, $\Delta i = 4 - 0 = 4$ A

Charge flowing through the coil is given by

$$\Delta q = \left(\frac{\Delta \phi}{\Delta t}\right)\frac{1}{R}(\Delta t)$$

$$= \mu_0 N_1 N_2 \pi r^2 \left(\frac{\Delta i}{\Delta t}\right)\frac{1}{R} \Delta t$$

$$= 4\pi \times 10^{-7} \times 2 \times 10^4 \times 100 \times \pi$$

$$\times (10^{-2})^2 \times \left(\frac{4}{0.05}\right) \times \frac{1}{10\pi^2} \times 0.05$$

$$= 32 \times 10^{-6} \text{ C} = 32 \ \mu\text{C}$$

49 In isochoric process, the curve is parallel to y-axis because volume is constant.

Isobaric is parallel to x-axis because pressure is constant.

Along the curve, it will be isothermal because temperature is constant.

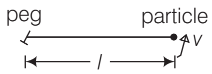
So, P → c

Q → a

R → d

S → b

50 Consider the string of length l connected to a particle as shown in the figure.



Speed of the particle is v. As the particle is in uniform circular motion, net force on the particle must be equal to centripetal force which is provided by the tension (T).

$\therefore$ Net force = Centripetal force

$\Rightarrow$ $\frac{mv^2}{l} = T$