

PHYSICS

SECTION-A

1. An AC current is given by $I = I_0 + I_1 \sin \omega t$, then its rms value will be;

- (1) $\sqrt{I_0^2 + 0.5I_1^2}$ (2) $\sqrt{I_0^2 + 0.5I_0^2}$
 (3) 0 (4) $I_0 / \sqrt{2}$

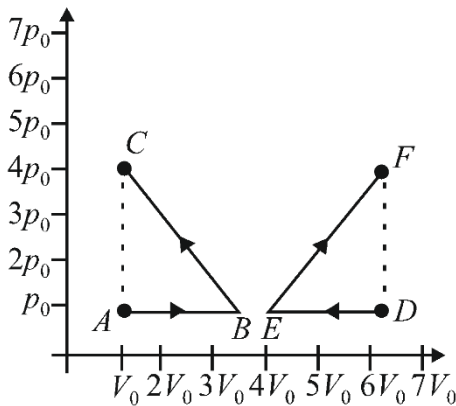
2. An ideal efficient transformer has a primary power input of 10 kW. The secondary current when the transformer is on load is 25 A. If the primary to secondary turns ratio is 8:1, then the potential difference applied to the primary coil is:

- (1) $\frac{10^4 \times 8^2}{25} V$ (2) $\frac{10^4 \times 8}{25} V$
 (3) $\frac{10^4}{25 \times 8} V$ (4) $\frac{10^4}{25 \times 8^2} V$

3. The depth d at which the value of acceleration due to gravity becomes $\frac{1}{n}$ times the value at the surface of the earth, is; [R = radius of the earth]

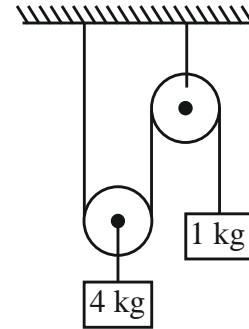
- (1) $\frac{R}{n}$ (2) $R \left(\frac{n-1}{n} \right)$
 (3) $\frac{R}{n^2}$ (4) $R \left(\frac{n}{n+1} \right)$

4. If W_{ABC} is the work done in process $A \rightarrow B \rightarrow C$ and W_{DEF} is work done in process $D \rightarrow E \rightarrow F$ as shown in the figure, then;



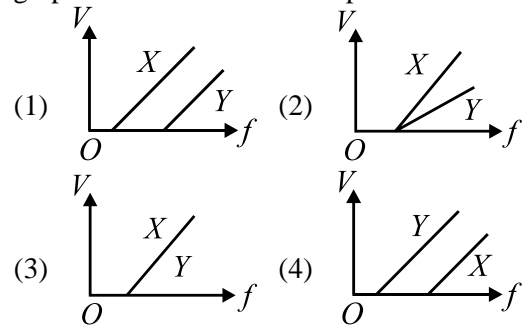
- (1) $|W_{DEF}| > |W_{ABC}|$
 (2) $|W_{DEF}| < |W_{ABC}|$
 (3) $W_{DEF} = W_{ABC}$
 (4) $W_{DEF} = -W_{ABC}$

5. In the system shown in the figure, the acceleration of 1 kg mass is



- (1) $\frac{g}{4}$ downwards (2) $\frac{g}{2}$ downwards
 (3) $\frac{g}{2}$ upwards (4) $\frac{g}{4}$ upwards

6. In a photoelectric experiment, electrons are ejected from metals X and Y by light of intensity I and frequency f . The potential difference V required to stop the electrons is measured for various frequencies. If Y has a greater work function than X, then which one of the following graphs best illustrates the expected results?



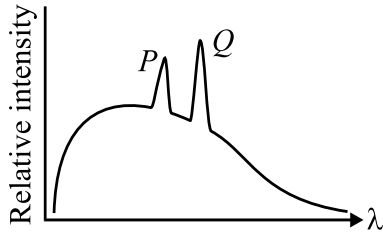
7. An electron with initial kinetic energy of 100 eV is further accelerated through a potential difference of 50V. Now the de-Broglie wavelength of electron becomes-

- (1) 1 \AA (2) $\sqrt{1.5} \text{ \AA}$
 (3) $\sqrt{3} \text{ \AA}$ (4) 12.27 \AA

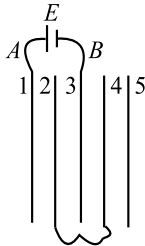
8. When a sphere rolls down an inclined plane, then identify the **correct** statement related to the work done by friction force-

- (1) the friction force does positive translational work.
 (2) the friction force does negative rotational work.
 (3) the net work done by friction is zero.
 (4) All of the above

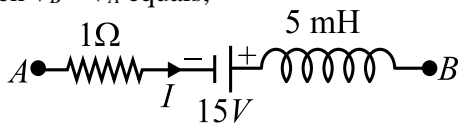
9. In a characteristic X-ray spectrum of some atom superimposed on continuous X-ray spectra;



- (1) P represents K_{α} line.
 (2) Q represents K_{β} line.
 (3) Q and P represents K_{α} and K_{β} lines respectively.
 (4) Relative positions of K_{α} and K_{β} depend on the particular atom.
10. Five conducting parallel plates having area A and separation between them d , are placed as shown in the figure. Plate number 2 and 4 are connected with wire and between point A and B , a cell of emf E is connected. The charge flow through the cell is;

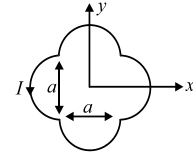


- (1) $\frac{3A\epsilon_0 E}{2d}$ (2) $\frac{2A\epsilon_0 E}{3d}$
 (3) $\frac{A\epsilon_0 E}{2d}$ (4) $\frac{2A\epsilon_0 E}{d}$
11. The network shown in the figure is part of a complete circuit. If at a certain instant, the current I is $5A$ and it is decreasing at a rate of 10^3 As^{-1} then $V_B - V_A$ equals;

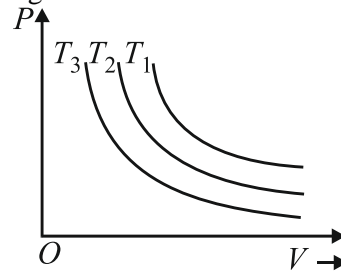


- (1) 20 V (2) 15 V
 (3) 10 V (4) 5 V
12. The coefficient of static friction between the box and the train's floor is 0.2 . The maximum acceleration of the train in which a box lying on its floor will remain stationary is (Take $g = 10 \text{ m s}^{-2}$)
- (1) 2 m s^{-2} (2) 4 m s^{-2}
 (3) 6 m s^{-2} (4) 8 m s^{-2}

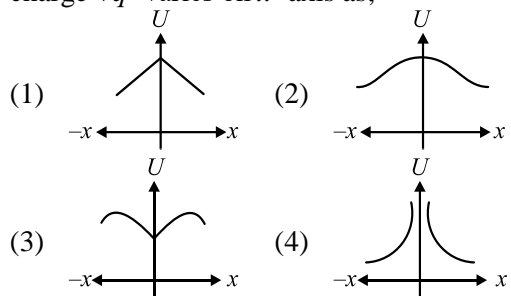
13. A loop carrying current I lie in the x - y plane as shown in the figure. The unit vector \hat{k} is coming out of the plane of the paper. The magnetic moment of the current loop is;



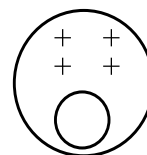
- (1) $a^2 I \hat{k}$ (2) $\left(\frac{\pi}{2} + 1\right) a^2 I \hat{k}$
 (3) $-\left(\frac{\pi}{2} + 1\right) a^2 I \hat{k}$ (4) $(2\pi + 1) a^2 I \hat{k}$
14. The isothermal diagram of a gas at three different temperatures T_1 , T_2 and T_3 , is shown in the given figure. Then



- (1) $T_1 < T_2 < T_3$ (2) $T_1 < T_2 > T_3$
 (3) $T_1 > T_2 > T_3$ (4) $T_1 > T_2 < T_3$
15. Four equal charges $+q$ are placed at four corners of a square with its centre at origin and lying in yz plane. The electrostatic potential energy of a fifth charge $+q'$ varies on x -axis as;



16. A spherical portion has been removed from a solid sphere having a charge distributed uniformly in its volume as shown in the figure. The electric field inside the emptied space is;

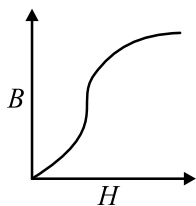


- (1) zero everywhere.
 (2) non-zero and uniform.
 (3) non uniform.
 (4) zero only at its centre.

17. A point mass moves along a circle having a radius 20 cm with a constant tangential acceleration 5 cm/s^2 . How much time is needed after motion begins for the normal acceleration of the point mass to be equal to tangential acceleration?

- (1) 1 s (2) 2 s
(3) 3 s (4) 4 s

18. The figure represents $B-H$ curve for commercial iron. As H is increased, permeability;



- (1) increases and becomes constant.
(2) increases, reaches a maximum and then decreases.
(3) decreases continuously till it becomes very small.
(4) decreases reaches a minimum and then increases.

19. A 14.5 kg mass, fastened to the end of a steel wire of unstretched length 1m, is whirled in a vertical circle with an angular velocity of 2 rev/s at the bottom of the circle. The cross-sectional area of the wire is 0.065 cm^2 . The elongation of the wire when the mass is at the lowest point of its path is;

$$[Y_{\text{steel}} = 2 \times 10^{11} \text{ N/m}^2]$$

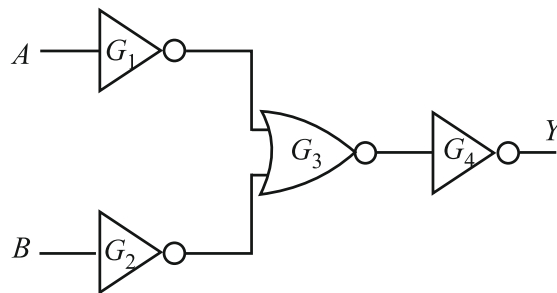
- (1) 9.67 mm (2) 6.67 mm
(3) 1.87 mm (4) 0.12 mm

20. The moment of inertia of a rod about an axis passing through its centre and perpendicular to it is $\frac{1}{12} ML^2$

(where, M is the mass and L is the length of the rod). The rod is bent in the middle so that the two halves make an angle of 60° . The moment of inertia of the bent rod about the same axis would be;

- (1) $\frac{1}{48} ML^2$ (2) $\frac{1}{12} ML^2$
(3) $\frac{1}{24} ML^2$ (4) $\frac{ML^2}{8\sqrt{3}}$

21. The combination of gates shown below produces



- (1) AND gate (2) XOR gate
(3) NOR gate (4) NAND gate

22. Two soap bubbles in vacuum of radius 3 cm and 4 cm coalesce to form a single bubble under isothermal conditions. Then the radius of bigger bubble is;

- (1) 7 cm (2) $\frac{12}{7}$ cm
(3) 12 cm (4) 5 cm

23. Two vectors \vec{A} and \vec{B} have equal magnitudes. The magnitude of $(\vec{A} + \vec{B})$ is 'n' times the magnitude of $(\vec{A} - \vec{B})$. The angle between \vec{A} and \vec{B} is;

- (1) $\cos^{-1} \left[\frac{n^2 - 1}{n^2 + 1} \right]$ (2) $\cos^{-1} \left[\frac{n - 1}{n + 1} \right]$
(3) $\sin^{-1} \left[\frac{n^2 - 1}{n^2 + 1} \right]$ (4) $\sin^{-1} \left[\frac{n - 1}{n + 1} \right]$

24. The horizontal and vertical displacements of a particle moving along a curved line are given by $x = 5t$ and $y = 2t^2 + t$. Time after which its velocity vector makes an angle of 45° with the horizontal is;

- (1) 0.5 s (2) 1 s
(3) 2 s (4) 1.5 s

25. A closed organ pipe and an open organ pipe are tuned to the same fundamental frequency. The ratio of their lengths is;

- (1) 1 : 2 (2) 2 : 1
(3) 1 : 4 (4) 4 : 1

26. A sample of radioactive material has mass m , decay constant λ , molecular weight M and Avogadro constant N_A . The initial activity of the sample is-

- (1) λm (2) $\frac{\lambda m}{M}$
(3) $\frac{\lambda m N_A}{M}$ (4) $m N_A \lambda$

27. A satellite is moving with a constant speed 'V' in a circular orbit about the earth. An object of mass 'm' is ejected from the satellite such that it just escapes from the gravitational pull of the earth. At the time of its ejection, the kinetic energy of the object is;

- (1) $\frac{1}{2}mV^2$ (2) mV^2
 (3) $\frac{3}{2}mV^2$ (4) $2mV^2$

28. Voltage applied to an AC circuit and current flowing in it is given by

$$V = 200\sqrt{2} \sin\left(\omega t + \frac{\pi}{4}\right) \text{ and } i = -\sqrt{2} \cos\left(\omega t + \frac{\pi}{4}\right)$$

Then, power consumed in the circuit will be;

- (1) 200 W (2) 400 W
 (3) $200\sqrt{2}$ W (4) Zero

29. A solid sphere rolls down two different inclined planes of the same height but of different inclinations;

- (1) in both cases the speeds and time of descend will be same.
 (2) the speeds will be same but time of descend will be different.
 (3) the speeds will be different but time of descend will be same.
 (4) speeds and time of descend both will be different.

30. In a stationary wave system, all the particles of the medium;

- (1) have zero displacement simultaneously at some instant.
 (2) have maximum displacement simultaneously at some instant.
 (3) are at rest simultaneously at some instant.
 (4) All of the above

31. Two liquids are at temperatures 20°C and 40°C. When same mass of both of them is mixed, the temperature of the mixture is 32°C. What is the ratio of their specific heats?

- (1) $\frac{1}{3}$ (2) $\frac{2}{5}$
 (3) $\frac{3}{2}$ (4) $\frac{2}{3}$

32. A power transmission line feeds input power at 2300V to a step-down transformer with its primary windings having 4000 turns. The output power is delivered at 230V by the transformer. If the current in the primary of the transformer is 5A and its efficiency is 90%, the output current would be;

- (1) 50 A (2) 45 A
 (3) 35 A (4) 25 A

33. Unpolarised light is incident on a dielectric of refractive index $\sqrt{3}$. What is the angle of incidence if the reflected beam is completely polarised?

- (1) 30° (2) 45°
 (3) 60° (4) 75°

34. **Assertion:** Internal forces cannot change linear momentum.

Reason: Internal forces cannot change kinetic energy of a system.

- (1) If both Assertion and Reason are true and the Reason is the correct explanation of the Assertion.
 (2) If both Assertion and Reason are true and the Reason is not a correct explanation of the Assertion.
 (3) If Assertion is true but Reason is false.
 (4) If Assertion is false and Reason is true

35. A small photocell is placed at a distance of 4 m from a photosensitive surface. When light falls on the surface the current is 5 mA. If the distance of cell is decreased to 1 m, the current will become;

- (1) 10 mA (2) 40 mA
 (3) 20 mA (4) 80 mA

SECTION-B

36. A prism of apex angle $A = 60^\circ$ has the refractive index $\mu = \sqrt{2}$. The angle of incidence for minimum deviation is;

- (1) 30° (2) 45°
 (3) 60° (4) None of these

37. **Assertion:** Moment of inertia of a rigid body about any axis passing through its centre of mass is minimum.

Reason: From theorem of parallel axis, $I = I_{cm} + Mr^2$

- (1) If both Assertion and Reason are true and the Reason is the correct explanation of the Assertion.
 (2) If both Assertion and Reason are true and the Reason is not a correct explanation of the Assertion.
 (3) If Assertion is true but Reason is false.
 (4) If Assertion is false and Reason is true.

38. In the nucleus of helium if F_1 is the net force between two protons, F_2 is the net force between two neutrons and F_3 is the net force between a proton and a neutron. Then;

- (1) $F_1 = F_2 = F_3$ (2) $F_1 > F_2 > F_3$
 (3) $F_2 > F_3 > F_1$ (4) $F_2 = F_3 > F_1$

39. Match the following columns and choose the correct option from the codes given below:

Column I		Column II	
(A)	Stress \times Strain	(P)	J
(B)	$\frac{YA}{l}$	(Q)	Nm^{-1}
(C)	Yl^3	(R)	Jm^{-3}
(D)	$\frac{Fl}{AY}$	(S)	m

- (1) A \rightarrow R, B \rightarrow Q, C \rightarrow P, D \rightarrow S
 (2) A \rightarrow Q, B \rightarrow R, C \rightarrow P, D \rightarrow S
 (3) A \rightarrow P, B \rightarrow S, C \rightarrow R, D \rightarrow Q
 (4) A \rightarrow Q, B \rightarrow R, C \rightarrow S, D \rightarrow P

40. A charged particle is rotating in uniform circular motion in a uniform magnetic field. Let r = radius of circle, v = speed of particle, K = kinetic energy, a = magnitude of acceleration, p = magnitude of

linear momentum, $\frac{q}{m} = \alpha$ = specific charge and ω = angular speed. Then, match the Column I with Column II and mark the correct option from the codes given below.

Column I		Column II	
(A)	If v is doubled	(P)	r will become two times
(B)	If B is doubled	(Q)	ω will become two times
(C)	If p is doubled	(R)	α will become two times
(D)	If α is doubled	(S)	None

- (1) A \rightarrow P, B \rightarrow Q, C \rightarrow P, D \rightarrow Q
 (2) A \rightarrow P, B \rightarrow R, C \rightarrow S, D \rightarrow Q
 (3) A \rightarrow S, B \rightarrow R, C \rightarrow S, D \rightarrow Q
 (4) A \rightarrow P, B \rightarrow R, C \rightarrow S, D \rightarrow S

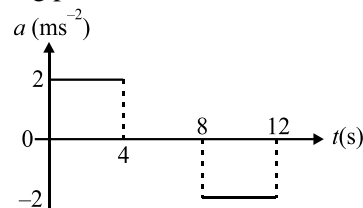
41. Two sound waves of wavelength 1 m and 1.01 m in a gas produce 10 beats in 3 s. The velocity of sound in the gas is;

- (1) 330 m/s (2) 337 m/s
 (3) 360 m/s (4) 300 m/s

42. What is the ratio of de-Broglie wavelength of electron in the second and third Bohr orbits in the hydrogen atoms?

- (1) 2/3 (2) 3/2
 (3) 4/3 (4) 3/4

43. A lift starts from rest. Its acceleration is plotted against time. When it comes to rest its height above its starting point is;



- (1) 20 m (2) 64 m
 (3) 32 m (4) 36 m

44. A bullet of mass 10gm moving with a speed of 20 m/s hits an ice block of mass 990 gm kept on a frictionless floor and gets stuck in it. How much ice will melt if 50% of the lost KE goes to ice? (Initial temperature of the ice block = 0°C , and latent heat of ice = 80 cal/g)

- (1) 0.001 gm (2) 0.002 gm
 (3) 0.003 gm (4) None of these

45. Two plane mirrors are inclined at 70° . A ray incident on one mirror at incidence angle θ , after reflection falls on the second mirror and is reflected from there parallel to the first mirror. The value of θ is

- (1) 50° (2) 45°
 (3) 30° (4) 25°

46. Which of the following statements are **CORRECT**?

Statement I: When a battery is connected across the junction diode with its negative terminal connected to the p-side and the positive terminal connected to the n-side, the diode is said to be forward biased.

Statement II: In forward bias condition, if the bias voltage is greater than the barrier potential, the majority carries move towards the junction and cross it.

Statement III: In reverse biasing of a diode, the majority carriers are pulled away from the junction, making the depletion layer wider.

- (1) I and II (2) II and III
 (3) I, II and III (4) I and III

47. Starting from the origin at time $t = 0$, with initial velocity $5\hat{j} \text{ ms}^{-1}$, a particle moves in the x - y plane with a constant acceleration of $(10\hat{i} + 4\hat{j}) \text{ ms}^{-2}$. At time t , its coordinates are $(20 \text{ m}, y_0 \text{ m})$. The values of t and y_0 are, respectively;

- (1) 2s and 18 m (2) 4s and 52 m
 (3) 2s and 24 m (4) 5s and 25m

48. Statement I: In photoelectric effect, an electron absorbs a quantum of energy ($h\nu$) of radiation.

Statement II: If the absorbed energy is less than the work function of the metal, then more tightly bound electrons will emerge with maximum kinetic energies.

- (1) Statement I and Statement II both are correct.
- (2) Statement I is correct, but Statement II is incorrect.
- (3) Statement I is incorrect, but Statement II is correct.
- (4) Statement I and Statement II both are incorrect.

49. Statement I: Particle-1 is dropped from a tower and particle-2 is projected horizontal from the same tower, then both the particles reach the ground simultaneously.

Statement II. Both the particles strike the ground with different speeds.

Which of the following statement(s) is/are correct?

- (1) Only I
- (2) Only II
- (3) Both I and II
- (4) Neither I nor II

50. A steel ball of mass m falls in a viscous liquid with terminal velocity v , then the steel ball of mass $8m$ will fall in the same liquid with terminal velocity;

- (1) v
- (2) $4v$
- (3) $8v$
- (4) $16\sqrt{2}v$

PHYSICS

ANSWER KEY

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

HINTS AND SOLUTION

1. (1)

$$I = I_0 + I_1 \sin \omega t$$

$$I_{\text{rms}}^2 = \frac{\int_0^T I^2 dt}{\int_0^T dt} = \frac{2\pi}{\omega}$$

$$= \frac{\int_0^T (I_0^2 + I_1^2 \sin^2 \omega t + 2I_0 I_1 \sin \omega t) dt}{\int_0^T dt}$$

$$I_{\text{rms}}^2 = \frac{I_0^2 T + \frac{I_1^2 T}{2} + 0}{T} \Rightarrow I_{\text{rms}} = \sqrt{I_0^2 + \frac{I_1^2}{2}}$$

2. (2)

$$\text{Input power} = \text{output power} = 10^4 \text{ W}$$

$$\therefore e_s i_s = 10^4 \Rightarrow e_s = \frac{10^4}{25}$$

$$\therefore \frac{e_s}{e_p} = \frac{n_s}{n_p} = \frac{1}{8} \Rightarrow e_s \times 8 = e_p = \frac{10^4 \times 8}{25} \text{ V}$$

3. (2)

Acceleration due to gravity at a depth d under the earth's surface

$$g' = g_s \left(1 - \frac{d}{R}\right)$$

$$\text{According to the question } g' = \frac{g_s}{n}$$

$$\frac{g_s}{n} = g_s \left(1 - \frac{d}{R}\right)$$

We can also write it as,

$$\frac{1}{n} = \left(1 - \frac{d}{R}\right)$$

$$d = R \left(\frac{n-1}{n}\right)$$

4. (4)

Work done by a gas in a process is: from the PV diagram is the area enclosed by the loop.

As we can see both loops ABC and DEF have the same area enclosed.

$$\text{Hence } W_{ABC} = -W_{DEF}$$

However, the magnitude are opposite.

5. (3)

If a is downward acceleration of 4 kg block, the upward acceleration of 1 kg block must be $2a$.

The equation of motion on 4 kg block is $4g - 2T = 4a$ (i)

The equation of motion on 1 kg block is $T - 1g = 1 \times 2a$ (ii)

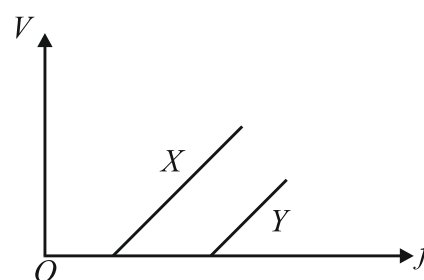
or $2T - 2g = 4a$... (iii)

On adding (i) and (iii), we get

$$2g = 8a \text{ or } a = \frac{g}{4}$$

\therefore Acceleration of 1 kg block = $2a = \frac{g}{2}$ upwards

6. (1)



Greater work function means more negative potential is required to stop the ejection of electrons. Moreover, the slope of both the graphs will be the same.

7. (1)

Additional kinetic energy it gains is.

$$K' = eV = 50 \text{ eV}$$

Total kinetic energy is equal to $150 \times 1.6 \times 10^{-19} \text{ J}$

The de Broglie wavelength is.

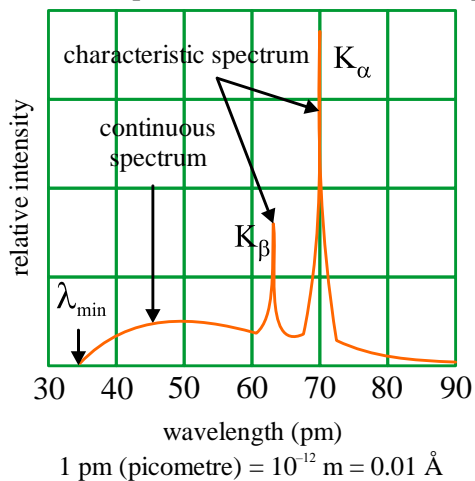
$$\lambda = \frac{h}{\sqrt{2mK}} = \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 150 \times 1.6 \times 10^{-19}}} = 1 \times 10^{-10} \text{ m}$$

$$\lambda = 1 \text{ \AA}$$

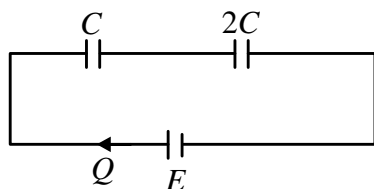
8. (3)

For a body to purely roll down the inclined plane, static friction will act at the contact point and the point will not slip on the surface. Hence work done by friction force is zero.

9. (3)
Q and P represents $K\alpha$ and $K\beta$ lines respectively.



10. (2)
Reduced form of circuit will be as follow:



$$\therefore C_{eq} = \frac{2C \times C}{2C + C} = \frac{2C}{3}$$

The charge flows through cell will be,

$$Q = C_{eq} \times E$$

$$\Rightarrow Q = \left(\frac{2C}{3}\right) E = \frac{2EC}{3}$$

$$\Rightarrow Q = \frac{2A\epsilon_0 E}{3d}$$

11. (2)
We will write voltage drop equation as we go from A to B.

$$V_A - iR + V + L \frac{di}{dt} = V_B$$

$$V_A - 5 \times 1 + 15 - 5 \times 10^{-3} \times (-10^3) = V_B$$

$$V_B - V_A = 15$$

12. (1)
As acceleration of the box is due to static friction,

$$\therefore ma = f_s \leq \mu_s N = \mu_s mg$$

$$a \leq \mu_s g$$

$$\therefore a_{\max} = \mu_s g = 0.2 \times 10 \text{ms}^{-2} = 2 \text{ms}^{-2}$$

13. (2)
M is outwards or along \hat{k} direction.

$$M = IA$$

$$A = a^2 + \left(\frac{\pi a^2}{4}\right) 2$$

$$\therefore M = \left(\frac{\pi}{2} + 1\right) a^2 I \hat{k}$$

14. (3)
The graph of the isothermal process shifts away from the origin as the temperature of the process is increased.

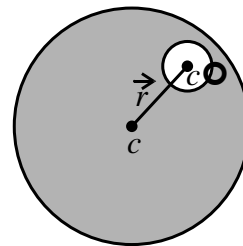
Therefore, the curve farthest from the origin should have the highest temperature whereas the curve closer to the origin have the lowest temperature. So, the correct answer is $T_1 > T_2 > T_3$.

15. (2)
At the centre of the square net force on the charge is zero. However, in this position the charge is in unstable equilibrium and hence its potential energy is maximum and finite. The four charges are assumed to be placed symmetrically about the origin in YZ plane.

16. (2)
We know electric field inside a cavity $\vec{E} = -\frac{\rho}{3\epsilon_0} \vec{r}$

When \vec{r} is vector joining centre of sphere to centre of cavity, this electric field is uniform inside the cavity.

Hence option (2) is correct.



17. (2)
 $\frac{v^2}{R} = a_t$
 $\frac{v^2}{20} = 5$
 $\Rightarrow v = \sqrt{100} = 10 \text{cm/s}$

Using $v = u + a_t \cdot t$

$$u = 0$$

$$10 = 0 + 5t \text{ or } t = 2 \text{s.}$$

18. (2)

The $B-H$ curve is used to study the magnetic properties of a material. Elements show different behaviour under magnetisation.

The ratio of magnetic induction to magnetic intensity is called magnetic permeability and is denoted by μ . The magnetic permeability can be used to measure a material's resistance to the magnetic field. The formula for permeability is given by

$$\mu = \frac{B}{H}$$

We know that iron is a ferromagnetic material. Materials like iron do not have a constant permeability. The permeability increases with increase in magnetic field, after reaching a maximum value it will start decreasing.

19. (3)

When the mass is placed at the position of the vertical circle, the total force on the mass is:

$$\begin{aligned} F &= mg + ml\omega^2 \\ &= 14.5 \times 9.8 + 14.5 \times 1 \times (12.56)^2 \\ &= 2429.53 \text{ N} \end{aligned}$$

Young's modulus = Stress/Strain

$$Y = \frac{F/A}{\Delta l} l = \frac{F}{A} \frac{l}{\Delta l}$$

$$\therefore \Delta l = \frac{Fl}{AY}$$

Young's modulus for steel = 2×10^{11} Pa

$$\Delta l = \frac{2429.53 \times 1}{0.065 \times 10^{-4} \times 2 \times 10^{11}}$$

$$\Rightarrow \Delta l = 1.87 \times 10^{-3} \text{ m}$$

Hence, the elongation of the wire is 1.87×10^{-3} m.

20. (2)

The total length of the rod is L . Since, the rod is bent at the middle, so each part of it will have same length $\frac{L}{2}$ and mass $\frac{M}{2}$.

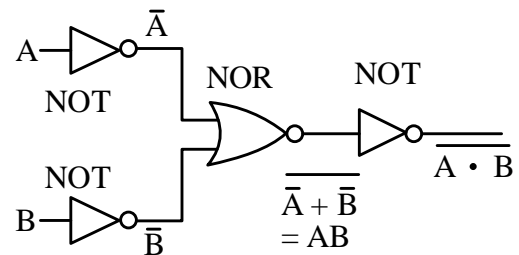
Moment of inertia of each part about an axis

$$\text{passing through its one end} = \frac{1}{3} \left(\frac{M}{2} \right) \left(\frac{L}{2} \right)^2$$

Hence, net moment of inertia about an axis passing through its middle point O is

$$\begin{aligned} I &= \frac{1}{3} \left[\frac{M}{2} \right] \left[\frac{L}{2} \right]^2 + \frac{1}{3} \left[\frac{M}{2} \right] \left[\frac{L}{2} \right]^2 \\ &= \frac{1}{3} \left[\frac{ML^2}{8} + \frac{ML^2}{8} \right] = \frac{ML^2}{12} \end{aligned}$$

21. (4)



Hence option (4) is correct.

22. (4)

Applying conservation of moles,

$$n_1 + n_2 = n$$

$$\Rightarrow \frac{P_1 V_1}{RT} + \frac{P_2 V_2}{RT} = \frac{PV}{RT}$$

$$\Rightarrow P_1 V_1 + P_2 V_2 = PV$$

$$\Rightarrow \left(\frac{4T}{r_1} \right) \left(\frac{4}{3} \pi r_1^3 \right) + \left(\frac{4T}{r_2} \right) \left(\frac{4}{3} \pi r_2^3 \right) = \left(\frac{4T}{r} \right) \left(\frac{4}{3} \pi r^3 \right)$$

$$\Rightarrow r_1^2 + r_2^2 = r^2$$

$$\Rightarrow r^2 = \sqrt{3^2 + 4^2} = 5 \text{ cm}$$

Hence the radius of the new bubble is 5 cm.

23. (1)

$$A^2 + A^2 + 2A^2 \cos \theta = n^2 (A^2 + A^2 - 2A^2 \cos \theta)$$

$$2 + 2\cos \theta = n^2 (2 - 2\cos \theta)$$

$$-2 + 2n^2 = 2n^2 \cos \theta + 2\cos \theta$$

$$\cos \theta = \frac{n^2 - 1}{n^2 + 1}$$

$$\theta = \cos^{-1} \left(\frac{n^2 - 1}{n^2 + 1} \right)$$

24. (2)

$$v_x = \frac{dx}{dt} = 5$$

$$v_y = \frac{dy}{dt}$$

$$= (4t + 1)$$

At 45° , $v_x = v_y$

$$\Rightarrow t = 1 \text{ s}$$

25. (1)

$$v_0 = v_c$$

$$\Rightarrow \frac{v}{2L_0} = \frac{v}{4L_c} \Rightarrow \frac{L_c}{L_0} = \frac{1}{2}$$

The ratio of the length of an close and open organ pipe is 1 : 2

26. (3)
Activity = number of disintegrations per unit time

$$\text{Activity} = \left| \frac{dN}{dt} \right| = \lambda N$$

where N = the total number of nuclei

$$\text{Also, } N = \text{number of moles} \times N_A = \left(\frac{m}{M} \right) N_A$$

$$\therefore \text{Initial activity} = \frac{\lambda m N_A}{M}$$

27. (2)
 V is the orbital velocity. If V_e is the escape velocity, then $V_e = \sqrt{2}V$. The kinetic energy at the time of ejection

$$KE = \frac{1}{2} m V_e^2 = \frac{1}{2} m (\sqrt{2}V)^2 = \frac{1}{2} m \times 2V^2 = mV^2$$

28. (4)
$$i = \sqrt{2} \sin \left[\left(\omega t + \frac{\pi}{4} + \frac{\pi}{2} \right) \right]$$

Hence, phase difference between V and i is $I = \frac{\pi}{2}$.

So, power consumed = 0.

29. (2)
For solid sphere, $\frac{k^2}{R^2} = \frac{2}{5}$
$$\therefore v = \frac{\sqrt{2gh}}{\sqrt{1 + \frac{2}{5}}} = \sqrt{\frac{10}{7}gh}$$

As h is same in both the cases, therefore speed will same in both cases.

Time of descend,

$$t = \frac{1}{\sin \theta} \sqrt{\frac{2h}{g} \left(1 + \frac{k^2}{R^2} \right)}$$

Where θ is angle of inclination.

For solid sphere, $\frac{k^2}{R^2} = \frac{2}{5}$

$$\therefore t = \frac{1}{\sin \theta} \sqrt{\frac{14h}{5g}}$$

As h is same but θ is different in both the cases, hence time of descend will be different in both the cases.

30. (4)
A stationary wave is called such because, there is no wave velocity.

This means that all parts of the wave have the same wave. They all attain maximum position at the sometime. They go to mean position at the sometime, and they go to rest and maximum velocity at the sometime as well. Hence all is correct.

31. (4)
 $Q_1 = Q_2$
 $\therefore m s_1 (32 - 20) = m s_2 (40 - 32)$
 $\frac{s_1}{s_2} = \frac{8}{12} = \frac{2}{3}$

32. (2)
$$\eta = \frac{P_{out}}{P_{in}} = \frac{V_s I_s}{V_p I_p}$$

$$\Rightarrow 0.9 = \frac{I_s \times 230}{5 \times 2300}$$

$$\Rightarrow I_s = 45 \text{ A}$$

33. (3)
According to Brewster's law,
 $\tan i_p = \mu = \sqrt{3}$
 $i_p = 60^\circ$

34. (3)
Internal forces will be cancelled pairwise. They will not change the external force acting on an object. Momentum will be conserved.

We know that $F_{\text{external}} = \frac{dP}{dt}$ here,

F_{external} = external force applied to a system and we also know that at rate of change of linear momentum equals to the external force.

So internal force doesn't even change the velocity of the centre of mass which is given by the net external force acting on the system.

So only external forces can change the linear momentum not the internal force.

Moreover, internal forces can never ever change the total mechanical energy (kinetic energy potential energy) of an object. But they can only just convert a part of kinetic energy to potential energy. So, they can change the kinetic energy but total energy remains conserved.

35. (4)

Intensity of light $I \propto \frac{1}{d^2}$, where d = distance from surface.

$$\Rightarrow \frac{I_2}{I_1} = \frac{d_1^2}{d_2^2} = \frac{4^2}{1} = 16 \Rightarrow I_2 = 16I_1$$

As current is proportional to intensity of light, new value of current = $16 \times 5 \text{ mA} = 80 \text{ mA}$.

36. (2)

We know,

$$\mu = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin\frac{A}{2}}$$

$$\Rightarrow \sqrt{2} = \frac{\sin i}{\sin\frac{60}{2}}$$

$$\Rightarrow \sin i = \sqrt{2} \times \sin(30)$$

$$\Rightarrow \sin i = \sqrt{2} \times \frac{1}{2}$$

Multiply and divide by $\sqrt{2}$, we get

$$\sin i = \frac{1}{\sqrt{2}}$$

$$\Rightarrow i = 45^\circ$$

37. (1)

From theorem of parallel axis

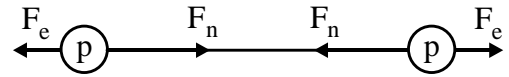
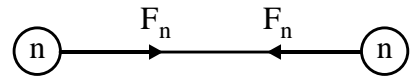
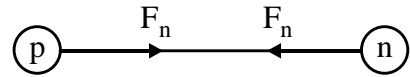
$$I = I_{CM} + Mr^2$$

Hence, moment of inertia is minimum about axis passing through CM among another parallel axis.

38. (4)

The strong nuclear forces between any two nucleons are same for any nucleon pair -proton -proton pair, proton- neutron pair or neutron-neutron pair.

But there will be an additional electrostatic repulsion between proton - proton pair because both are charged positively, and similar charges repel each other.



$$\text{So, } F_1 = (F_n - F_e)$$

$$F_2 = F_3 = F_n$$

Thus, $F_2 = F_3 > F_1$ option (4)

39. (1)

$$(A) \text{ Stress} \times \text{Strain} = \text{Nm}^{-2} \cdot \frac{\text{m}^3}{\text{m}^3} = \text{Jm}^{-3}$$

$$(B) \frac{YA}{l} = \frac{\text{Nm}^{-2} \text{m}^2}{\text{m}} = \text{Nm}^{-1}$$

$$(C) Yl^3 = \text{Nm}^{-2} \text{m}^3 = \text{Nm} = \text{J}$$

$$(D) \frac{Fl}{AY} = \frac{\text{Nm}}{\text{m}^2 \text{Nm}^{-2}} = \text{m}$$

Hence,

A \rightarrow r, B \rightarrow q, C \rightarrow p, D \rightarrow s.

40. (1)

$$\text{As, } r = \frac{mv}{Bq} = \frac{p}{Bq} = \frac{\sqrt{2Km}}{Bq}$$

$$\Rightarrow \omega = \frac{Bq}{m}$$

Hence,

A \rightarrow p, B \rightarrow q, C \rightarrow p, D \rightarrow q.

41. (2)

The velocity (v) is given by

$$v = f\lambda$$

$$\Rightarrow f = \frac{v}{\lambda}$$

Number of beats = difference in frequencies

$$\therefore f_1 - f_2 = v \left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2} \right)$$

$$\frac{10}{3} = v \left(\frac{1}{1} - \frac{1}{1.01} \right)$$

$$\frac{10}{3} = v \left(\frac{0.01}{1.01} \right)$$

$$\Rightarrow v = \frac{10 \times 1.01}{3 \times 0.01} = 336.7 \text{ m/s}$$

42. (1)

At 4 sec

$$(2\pi r_2) = 2\lambda_2$$

$$(2\pi r_3) = 3\lambda_3$$

$$\therefore \frac{\lambda_2}{\lambda_3} = \frac{3r_2}{2r_3} \dots (i)$$

Now, $r \propto n^2$

$$\therefore \frac{r_2}{r_3} = \left(\frac{2}{3}\right)^2$$

Substituting in Eq. (i), we get

$$\frac{\lambda_2}{\lambda_3} = \frac{2}{3}$$

43. (2)

$$u = at = 8 \text{ m/s}$$

$$s_1 = \frac{1}{2}at^2 = \frac{1}{2} \times 2 \times 4^2 = 16 \text{ m}$$

From 4s to 8s

$$a = 0, v = \text{constant} = 8 \text{ m/s}$$

$$\therefore s_2 = vt = (8)(4) = 32 \text{ m}$$

From 8s to 12s

$$s_3 = s_1 = 16 \text{ m}$$

$$\therefore s_{\text{Total}} = s_1 + s_2 + s_3 = 64 \text{ m}$$

44. (3)

Velocity of bullet + ice block,

$$V = \frac{(10g) \times (20 \text{ m/s})}{1000} \text{ g} = 0.2 \text{ m/s}$$

$$\text{Loss of } KE = \frac{1}{2}mv^2 - \frac{1}{2}(m+M)V^2$$

$$= \frac{1}{2} [0.01 \times (20)^2 - 1 \times (0.2)^2]$$

$$= \frac{1}{2} [4 - 0.04] = 1.98 \text{ J}$$

\therefore Heat received by ice block.

$$= \frac{1.98}{4.2 \times 2} \text{ cal}$$

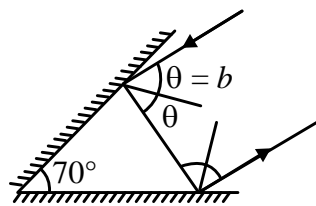
$$= 0.24 \text{ cal}$$

\therefore Mass of ice melted.

$$= \frac{0.24 \text{ cal}}{80 \text{ cal/g}}$$

$$= 0.003 \text{ g}$$

45. (1)



Angle of incidence = b = angle of reflection

Angle of incidence on the 2nd mirror

$$90 - [180 - 70 - (90 - b)] = 70 - b$$

Angle between the reflected ray & the mirror (2nd)

$$= b + 20$$

As it parallel to the 1st mirror

$$b + 20 = 70$$

$$b = 70 - 20$$

$$b = 50$$

46. (2)

When a battery is connected across the junction diode with its positive terminal connected to the p-side and the negative terminal connected to the n-side, the diode is said to be forward biased.

47. (1)

$$\vec{S} = t\vec{u} + \frac{1}{2}t^2\vec{a}$$

$$\Rightarrow 20\hat{i} + y_0\hat{j} = t_0(5\hat{j}) + \frac{1}{2}t_0^2(10\hat{i} + 4\hat{j})$$

Equating components wise,

$$20 = 5t_0^2$$

$$\Rightarrow t_0 = 2 \text{ sec}$$

and

$$y_0 = 5t_0 + 2t_0^2$$

$$\Rightarrow y_0 = 18 \text{ m}$$

48. (2)

In photoelectric effect, an electron absorbs a quantum of energy ($h\nu$) of radiation. If this absorbed energy exceeds the minimum energy (work function ϕ_0 of the metal), the most loosely bound electron will emerge with maximum kinetic energy, more tightly bound electron will emerge with kinetic energies less than the maximum value.

Einstein's photoelectric equation:

$$K_{\text{max}} = h\nu - \phi_0$$

49. (3)

$$t_1 = t_2 = \sqrt{\frac{2h}{g}} \text{ (where, } h = \text{height of tower)}$$

$$v_1 = \sqrt{2gh}$$

While $v_2 = \sqrt{v_1^2 + v_0^2}$ (where, $v_0 =$ initial velocity)

Therefore, both statements are correct.

50. (2)

$$v \propto r^2 \text{ and } m \propto r^3$$

$$\Rightarrow v \propto m^{2/3}$$

$$\therefore \frac{v_2}{v_1} = \left(\frac{m_2}{m_1}\right)^{2/3} = \left(\frac{8m}{m}\right)^{2/3} = 4$$

$$\Rightarrow v_2 = 4v$$