Sharath Gore

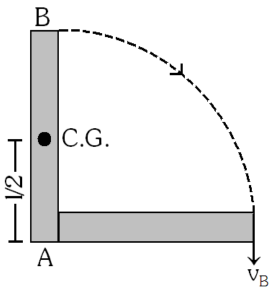
Physics mock test 5 2022-23

Time : 75 Min	Phy : Full Portion Paper	Marks : 200

Hints and Solutions

01) Ans: **D)** $Q_1 < Q_2 < Q_3$
Sol: Here initial and final states are same in all the processes.
$\therefore \ \Delta U = 0;$ in each case.
From first law of thermodynamics, $\Delta Q = \Delta W$
= Area enclosed by curve with volume axis.
As $(\text{Area})_1 < (\text{Area})_2 < (\text{Area})_1 \Rightarrow Q_1 < Q_2 < Q_3$.

02) Ans: **B)** $\sqrt{3gl}$



Sol:
Initially rod stands vertically, therefore its potential energy = mgl/2
But as it strikes the floor, its potential energy will be converted into rotational kinetic energy.

$\therefore \ mg\left(\frac{1}{2}\right) = \frac{1}{2} I\omega^2$

(where I is M. I. of rod about point A i.e. $I = \frac{ml^2}{3}$)

$\therefore \ mg\left(\frac{1}{2}\right) = \frac{1}{2}\left(\frac{ml^2}{3}\right)\left(\frac{v_B}{1}\right)^2 \Rightarrow v_B = \sqrt{3gl}$

03) Ans: **D)** One

04) Ans: **A)** $3\,\Omega$
Sol: Here, $R_t = R_0(1 + \alpha t)$
$\Rightarrow 4.2 = R_0(1 + 0.004 \times 100) = 1.4 R_0 \Rightarrow R_0 = 3\,\Omega$.

05) Ans: **B)** a neutron in the nucleus decays emitting an electron.
Sol: The negative $\beta -$ decay is given by the equation, $n = p^+ + e^- + \nu^-$.

06) Ans: **C)** 98° C
Sol: We know that, Temperature on any scale can be converted into other scale by $\frac{x - LFP}{UFP - LFP}$
= Constant for all scale

$\therefore \frac{x - 20}{150 - 20} = \frac{60}{100} \Rightarrow x = 98^\circ C$

07) Ans: **D)** Both (1) & (2).
Sol: Centripetal force = $\frac{mv^2}{r}$ and is always directed towards the centre of circle. Magnitude and direction of this centripetal force is not affected by sense of rotation.

08) Ans: **A)** $\left[M^0L^0T\right]$
Sol: $RC = T \ \because [R] = [ML^2T^{-3}I^{-2}]$ and
$[C] = [M^{-1}L^{-2}T^4I^2]$

09) Ans: **B)** Optical fibers are subjected to electromagnetic interference from outside.
Sol: Optical fibres are subjected to electromagnetic interference from outside.

10) Ans: **D)** 0.10 m
Sol: Radius, $r = \frac{mv}{Bq} = \frac{v}{(q/m)B}$

$\Rightarrow r = \frac{2 \times 10^5}{5 \times 10^7 \times 4 \times 10^{-2}} = 0.1\,m$

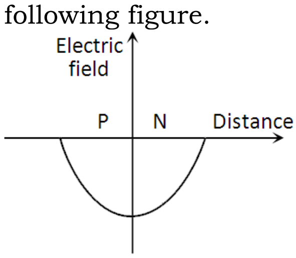
11) Ans: **D)** $\left(\frac{m+1}{m}\right)f$

Sol: We know, $m = \frac{f}{f+u} \Rightarrow -m = \frac{f}{f+u}$

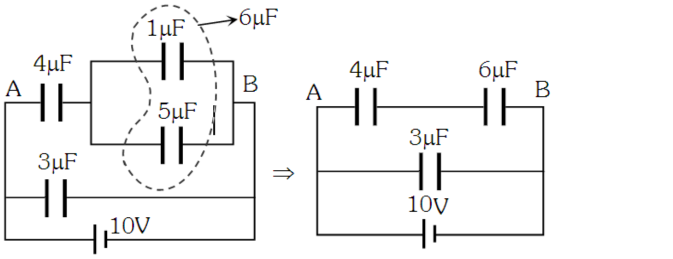
$\Rightarrow u = -\left(\frac{m+1}{m}\right)f$

12) Ans: **C)** 0.6
Sol: Suppose the current through $5\,\Omega$ resistance be i, then $i \times 25 = (2.1 - i)10 \Rightarrow i = \frac{10}{35} \times 2.1 = 0.6\,A$

13) Ans: **C)** electric field is maximum.
Sol: The electric field strength versus distance curve across the P-N junction is shown in the following figure.



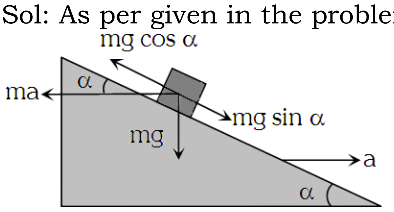
14) Ans: **C)** 24
Sol: Equivalent capacity between A and B i. e.
$C_{AB} = \frac{6 \times 4}{10} = 2.4\,\mu F$



As in series combination, charge remains constant. Therefore, charge across
$4\,\mu F$ or $6\,\mu F = 2.4 \times 10 = 24\,\mu C$

15) Ans: **B)** x and A
Sol: Given, $x = Ay + B\tan Cz$
By the dimensional homogeneity;
$[x] = [Ay] = [B] \Rightarrow \left[\frac{x}{A}\right] = [y] = \left[\frac{B}{A}\right]$
$[Cz] = [M^0L^0T^0] =$ Dimension less
thus, x and B; C and Z^{-1}; y and $\frac{B}{A}$ have the same dimension, but x and A have the different dimensions.

16) Ans: **D)** $g\tan\alpha$
Sol: As per given in the problem,



Assume, the mass of a block is m. It will remains stationary, if forces acting on it are in equilibrium means, $ma\cos\alpha = mg\sin\alpha \Rightarrow a = g\tan\alpha$
Where, ma= Pseudo force on block, mg = Weight.

17) Ans: **D)** 10%
Sol: Here, momentum $P = \sqrt{2mE}$.
Now, if m is constant, then
$\frac{P_2}{P_1} = \sqrt{\frac{E_2}{E_1}} = \sqrt{\frac{1.22\,E}{E}} \Rightarrow \frac{P_2}{P_1} = \sqrt{1.22} = 1.1$
$\Rightarrow P_2 = 1.1P_1 \Rightarrow P_2 = P_1 + 0.1P_1 = P_1 + 10\%$ of P_1
Therefore, the momentum will increase by 10%.

18) Ans: **C)** 90 kW
Sol: Here, Power $= \frac{\frac{1}{2}CV^2}{t}$
$\Rightarrow \text{Power} = \frac{1 \times 40 \times 10^{-6} \times (3000)^2}{2 \times 2 \times 10^{-3}} = 90\text{ kW}$

19) Ans: **B)** 6
Sol: As given, M =1 kg, R = 2 m.
For the disc, Moment of inertia
$= \frac{MR^2}{2} = \frac{1 \times 4}{2} = 2\ \text{kg m}^2$ (As given)
$\therefore$ Moment of inertia passing through the edge
$= I_0 + Md^2 = 2 + 1 \times 4 = 6\text{ kg m}^2$

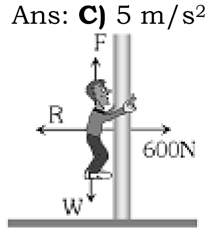
20) Ans: **B)** $\left(\frac{3v_0^2}{2\alpha}\right)^{\frac{1}{3}}$
Sol: As $a = \frac{dv}{dt} = \frac{dv}{dx}\frac{dx}{dt} = v\frac{dv}{dx} = -\alpha x^2$ (Given)
$\Rightarrow \int_{v_0}^{0} v\,dv = -\alpha\int_0^S x^2 dx \Rightarrow \left[\frac{v^2}{2}\right]_{v_0}^{0} = -\alpha\left[\frac{x^3}{3}\right]_0^S$
$\Rightarrow \frac{v_0^2}{2} = \frac{\alpha S^3}{3} \Rightarrow S = \left(\frac{3v_0^2}{2\alpha}\right)^{\frac{1}{3}}$

21) Ans: **D)** water rises upto the top of capillary tube and stays there without overflowing.
Sol: Water will not overflow but will change its radius of curvature.

22) Ans: **B)** B will be zero.
Sol: On applying Kirchhoff law,
$(2+2) = (0.1+0.3+0.2)i \Rightarrow i = \frac{20}{3}\text{A}$
$\therefore$ Potential difference across
$A = 2 - 0.1 \times \frac{20}{3} = \frac{4}{3}$ V (less than 2 V)
and Potential difference across $B = 2 - 0.3 \times \frac{20}{3} = 0$

23) Ans: **B)** 32 km
Sol: As we know, $g \propto \frac{GM}{r^2}$ $\therefore g \propto \frac{1}{r^2}$ or $r \propto \frac{1}{\sqrt{g}}$
$\therefore$ If g decreases by one percent, then r should increase by $\frac{1}{2}\%$ means $R = \frac{1}{2 \times 100} \times 6400 = 32\text{ km}$

24) Ans: **C)** 5 m/s²



Sol:
In this case, Net downward acceleration
$= \frac{\text{Weight - Friction force}}{\text{Mass}}$
$= \frac{(mg - \mu R)}{m} = \frac{60 \times 10 - 0.5 \times 600}{60} = \frac{300}{60} = 5\text{ m/s}^2$

25) Ans: **A)** a metal is kept in varying magnetic field
Sol: Eddy currents are produced when a metal is kept in a varying magnetic field.

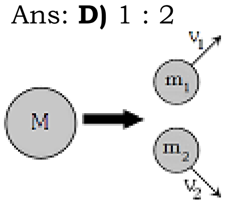
26) Ans: **A)** area of the bottom surface.
Sol: Since, $P = h\rho g$.

27) Ans: **B)** 14.14 A
Sol: Hot wire ammeter reads r. m. s. value of current. $\therefore$ Its peak value $= i_{rms} \times \sqrt{2} = 14.14$ amp

28) Ans: **A)** breaking point.

29) Ans: **A)** Slow neutron
Sol: Fast neutrons can escape from the reaction. In order to proceed the chain reaction, slow neutrons are the best.

30) Ans: **D)** 1 : 2



Sol:
According to conservation of momentum,

$m_1v_1 = m_2v_2 \quad \Rightarrow \frac{v_1}{v_2} = \frac{8}{1} = \frac{m_2}{m_1}$ ...... (i)

Also, from $r \propto A^{1/3}$

$$\frac{r_1}{r_2} = \left(\frac{A_1}{A_2}\right)^{1/3} = \left(\frac{1}{8}\right)^{1/3} = \frac{1}{2}$$

31) Ans: **C)** $\frac{P}{64}$
Sol: First, isothermal expansion

$$PV = P'(2V); P' = \frac{P}{2}$$

Then, adiabatic expansion

$$P'(2V)^{\gamma} = P_f(16V)^{\gamma}$$

(For adiabatic process $PV^{\gamma} = \text{constant}$)

$$\frac{P}{2}(2V)^{\frac{5}{3}} = P_f(16V)^{\frac{5}{3}}$$

$$P_f = \frac{P}{2}\left(\frac{2V}{16V}\right)^{\frac{5}{3}} = \frac{P}{2}\left(\frac{1}{8}\right)^{\frac{5}{3}} = \frac{P}{64}$$

33) Ans: **C)** $5.9\times10^{-6}\text{eV}$

Sol: Energy, $E = \frac{hc}{\lambda} = \frac{3\times10^{8}\times6.62\times10^{-34}}{0.21\times1.6\times10^{-19}}$

$$\Rightarrow E = 5.9\times10^{-6}\text{eV}$$

34) Ans: **B)** 2077.5 joules

Sol: Work done, $W = \frac{R}{\gamma-1}(T_1 - T_2)$

$$\Rightarrow W = \frac{8.31\times\{(273+27)-(273+127)\}}{1.4-1}$$

$= -2077.5$ joules

35) Ans: **C)** 4.2 cm
Sol: If displacement is y at any instant, then it is given that

$$U = \frac{1}{2}\times E \Rightarrow \frac{1}{2}m\omega^2y^2 = \frac{1}{2}\times\left(\frac{1}{2}m\omega^2a^2\right)$$

$$\Rightarrow y = \frac{a}{\sqrt{2}} = \frac{6}{\sqrt{2}} = 4.2\,\text{cm}$$

36) Ans: **B)** $\lambda_1 = 3.5\,\lambda_2$
Sol: The position of first minima = position of third maxima

$$\Rightarrow \frac{1\times\lambda_1 D}{d} = \frac{(2\times3+1)}{2}\frac{\lambda_2 D}{d} \quad \Rightarrow \lambda_1 = 3.5\,\lambda_2$$

37) Ans: **C)** b/a
Sol: As the spheres are joined by a wire i.e., they are at the same potential.

For same potential $\frac{kQ_1}{a_1} = \frac{kQ_2}{a_2} \Rightarrow \frac{Q_1}{Q_2} = \frac{a}{b}$

Further, the electric field at the surface of the sphere having radius R and charge Q is $\frac{kQ}{R^2}$.

$$\therefore \frac{E_1}{E_2} = \frac{kQ_1/a^2}{kQ_2/b_2} = \frac{Q_1}{Q_2}\times\frac{b^2}{a^2} = \frac{b}{a}.$$

38) Ans: **B)** source S_2 emits wave (2) and S_4 emits wave (4)
Sol: Two waves must have a constant phase relationship for interference. Equation '1' and '3' and '2' and '4' have a constant phase relationship of $\frac{\pi}{2}$ out of two choices. Only one S_2 emitting '2' and S_4 emitting '4' is given thus only (2) option is correct.

39) Ans: **A)** 0°, 180° and 90°
Sol: For 17 N both the vector should be parallel means angle between them should be zero.
For 7 N both the vectors should be anti-parallel means angle between them should be 180°.
For 13 N both the vectors should be perpendicular to each other means angle between them should be 90°.

40) Ans: **D)** $26.5\,\text{W/m}^2$
Sol: Given that, $E_0 = 100\,\text{V/m}$, $B_0 = 0.265\,\text{A/m}$.
$\therefore$ Maximum rate of energy flow, S = $E_0\times B_0$

$$\Rightarrow S = 100\times.265 = 26.5\,\frac{W}{m^2}$$

41) Ans: **D)** All given radiations travel at the same speed
Sol: In vacuum, all electromagnetic wave travel with the same speed $c\left(c = 3\times10^{8}\text{ m s}^{-1}\right)$.

42) Ans: **A)** 2700 m^3

Sol: As we have, $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \Rightarrow V_2 = \frac{P_1V_1}{T_1}\times\frac{T_2}{P_2}$

$$\Rightarrow V_2 = \frac{1500\times4\times270}{300\times2} = 2700\,\text{m}^3$$

43) Ans: **B)** 2 v

Sol: The r. m. s. velocity, $v_{rms} = \sqrt{\frac{3RT}{M}}$. Now as given in the problem, T will becomes 2 T and M will becomes $M/2$, therefore the value of v_{rms} will increase by $\sqrt{4}=2$ times means new root mean square velocity will be 2 v.

44) Ans: **B)** suddenly increases.
Sol: After a large reverse voltage in PN-junction diode, suddenly a huge current flows in the reverse direction. This is called Breakdown of PN-junction diode.

45) Ans: **A)** Velocity is perpendicular to $\vec{r}$ and acceleration is directed towards the origin.
Sol: Given, $\vec{r}=\cos\omega t\,\hat{x}+\sin\omega t\,\hat{y}$

$$\therefore\ \vec{v}=\frac{d\vec{r}}{dt}=-\omega\sin\omega t\,\hat{x}+\omega t\,\hat{y}$$

$$\vec{a}=\frac{d\vec{v}}{dt}=-\omega^2\cos\omega t\,\hat{x}-\omega^2\sin\omega t\,\hat{y}=-\omega^2\vec{r}$$

Since position vector $(\vec{r})$ is directed away from the origin, so, acceleration $(-\omega^2\vec{r})$ is directed towards the origin. Also,

$$\vec{r}\cdot\vec{v}=(\cos\omega t\,\hat{x}+\sin\omega t\,\hat{y})\cdot(-\omega\sin\omega t\,\hat{x}+\omega\cos\omega t\,\hat{y})$$
$$=-\omega\sin\omega t\cos\omega t+\omega\sin\omega t\cos\omega t=0$$
$$\Rightarrow \vec{r}\perp\vec{v}$$

46) Ans: **A)** 7
Sol: $l_1=0.516\,m$, $l_2=0.491\,m$, $T=20\,N$.
Mass per unit length, $\mu=0.001\,kg/m$

Frequency, $\upsilon=\frac{1}{2l}\sqrt{\frac{T}{\mu}}$

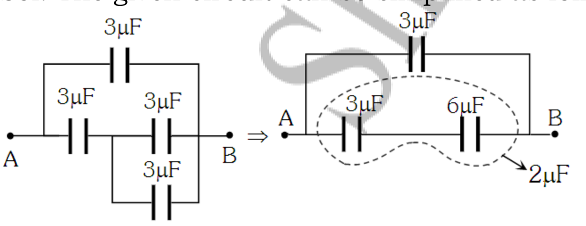
$$\upsilon_1=\frac{1}{2\times0.516}\sqrt{\frac{20}{0.001}}\,Hz=137\,Hz$$

$$\upsilon_2=\frac{1}{2\times0.491}\sqrt{\frac{20}{0.001}}\,Hz=144\,Hz$$

$\therefore$ Number of beats $=\upsilon_1-\upsilon_2=7\,Hz$

47) Ans: **D)** g is greater at the poles than at the equator.

48) Ans: **B)** $5\,\mu F$
Sol: The given circuit can be simplified as follows :



$\Rightarrow C_{AB}=5\,\mu F$

49) Ans: **A)** is the same at all points along the bar.

50) Ans: **C)** $\lambda_p\propto\lambda_e^2$
Sol: Wavelength of an electron of energy E is

$$\lambda_e=\frac{h}{\sqrt{2m_eE}}$$
...(i)
Wavelength of a photon of same energy E is

$$\lambda p=\frac{hc}{E}\ \text{ or }\ E=\frac{hc}{\lambda_p}$$
...(ii)
Squaring both sides of equation (i), we get

$$\lambda_e^2=\frac{h^2}{2m_eE}\ \text{ or }\ E=\frac{h^2}{2m_e\lambda_e^2}$$
...(iii)
Equating (ii) and (iii), we get

$$\frac{hc}{\lambda_p}=\frac{h^2}{2m_e\lambda_e^2}\ \text{ or }\ \lambda_p=\frac{2m_ec}{h}\lambda_e^2$$

$$\lambda_p\propto\lambda_e^2$$