PART : PHYSICS

1. In He^+ atom a photon emits due to transition of electron from orbit n = 4 to n = 1. Find corresponding transition in H-atom for same photon.

(1) $3 \rightarrow 1$ (2) $2 \rightarrow 1$ (3) $6 \rightarrow 4$ (4) $5 \rightarrow 3$

Ans. **(2)**

Sol. $E = -\frac{13.6\,eV}{n^2}z^2$

for helium z = 2

$$\Delta E = -13.6\left(\frac{1}{4}-\frac{1}{16}\right)2^2 = 13.6\left[1-\frac{1}{4}\right] = 13.6\left[\frac{3}{4}\right] = 10.2\ eV$$

For hydrogen

as for hydrogen, z = 1

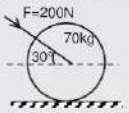
For n = 1 $E_1 = -13.6$

For n = 2 $E_2 = \frac{-13.6}{4} = -3.4$

$E_1 - E_2 = -10.2$ eV

So corresponding transition is from n = 2 to n = 1

2. Find the Normal reaction on the given sphere of mass 70 kg :

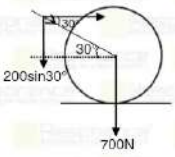


(1) 800N (2) 1000N (3) 1500N (4) 1400N

Ans. **(1)**

Sol. $N = 200\sin 30° + 700$

$N = 800$ Newton

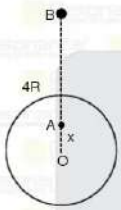


3. Find the value of x (distance of point from centre inside the earth) if gravity at x is 4 times of gravity at 4R (difference from centre of its earth) (R is radius of the earth)

(1) R/4 (2) R/8 (3) 2R/3 (4) 2R/3

Ans. **(1)**

Sol.



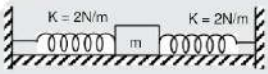
$4g_B = g_A$

$$4.\frac{GM}{(4R)^2} = \frac{GM}{R^3}r$$

$$\frac{1}{4R^2} = \frac{r}{R^3}$$

$$r = \frac{R}{4}$$

4. In given figure mass is 490 gm, then find number of oscillations in t = 14π sec.



(1) 22 (2) 20 (3) 15 (4) 32

Ans. **(2)**

Sol. $T = 2\pi\sqrt{\frac{M}{K_{eq}}}$

$$= 2\pi\sqrt{\frac{0.49}{4}} = \frac{22}{7} \times 0.7 = 0.7\,\pi$$

No. of oscillations = $\frac{14\pi}{0.7\pi} = 20$

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5. Speed of light in air is v. in another medium It is $V_{med} = 0.2$ V find refractive index of medium

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(1) 7 (2) 12 (3) 8 (4) 5

Ans. **(4)**

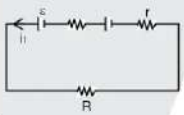
Sol. $\mu_{med} = \frac{C}{V} = \frac{V}{0.2V} = 5$

$\mu_{med} = 5$

6. If two batteries are connected is series and then parallel, the current in the circuit is same in both the cases then internal resistance of battery is : (external resistance is R)
(1) R (2) R/2 (3) 3R (4) R/4

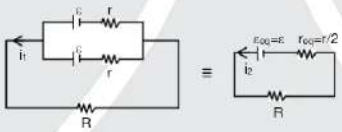
Ans. **(1)**

Sol. Let r is the internal resistance of battery.
In series



$i_1 = \frac{2\varepsilon}{2r + R}$ ...(1)

In parallel



$\varepsilon_{eq} = \frac{\varepsilon \times r + \varepsilon \times r}{r + r} = \varepsilon$; $r_{eq} = \frac{r \times r}{r + r} = \frac{r}{2}$

$i_2 = \frac{\varepsilon}{R + \frac{r}{2}} = \frac{2\varepsilon}{2R + r}$ ...(ii)

From equation (1) and (2)

Given $i_1 = i_2$

$\frac{2\varepsilon}{2r + R} = \frac{2\varepsilon}{2R + r}$

$2r + R = 2R + r$

$r = R$

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7. On increasing the temperature of a semiconductor :
(i) Number density of free charge carrier will increase

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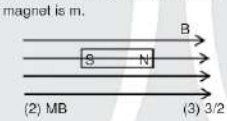
(i) Number density of free charge carrier will increase
(ii) Number density of free charge carrier will decrease
(iii) Resistivity of the semiconductor will increase
(iv) Resistivity of the semiconductor will decrease
The correct statements will be :
(1) only (iv) (2) only (i) (3) (i) and (iv) (4) (ii) and (iv)

Ans. **(3)**

Sol. If the temperature of a semiconductor is increased, number density of free charge carriers increases & resistivity decreases.

8. Find work required to rotate a magnet slowly from $\theta = 0$ to $\theta = 180°$ in an uniform magnetic field B. magnetic moment of magnet is m.



(1) 2 MB (2) MB (3) 3/2 MB (4) 2/3 MB

Ans. **(1)**

Sol. $\theta = 0 \rightarrow \theta = 180°$
$W_{is} = U\uparrow = U_f - U_i = (-MB\cos 180°) - (-MB\cos 0)$
$W_{is} = 2MB$

9. In a LCR alternating series circuit, the reactance of the capacitor and inductor are respectively X_C and X_L then which quantity will be non-dimensional

(1) RX_C (B) $\frac{R}{X_L X_C}$ (2) $\sqrt{X_C X_L}$ (4) $\frac{R}{\sqrt{X_C X_L}}$

Ans. **(4)**

Sol. Dimensions of both R & X are same so ratio of both will give dimension less quantity.

10. A lift is moving downwards with $a = 2\ m/s^2$ & $u = 2$ m/s. Find the kinetic energy of lift after it covers a distance of 6 m. Given, mass of light = 500 kg.
(1) 2 kJ (2) 4 kJ (3) 7 kJ (4) 9 kJ

Ans. **(3)**

Sol. $V = 2$ m/s $a = 2m/s^2$
at d = 6
Velocity $V^2 = u^2 + 2as$
$V = \sqrt{4 + 2 \times 2 \times 6}$
$V = \sqrt{28}$
Then $KE = \frac{1}{2}mv^2$
$= \frac{1}{2} \times 500 \times (28)^2 = \frac{1}{2} \times 500 \times 28 = 500 \times 14 = 7000$ J
K.E. = 7 kJ

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11. Elastic balls each of mass m are falling from a height h and colliding with the surface at the rate of 200 balls/sec. The average force acting on the roof will be :

(1) $200m\sqrt{2gh}$ (2) $400m\sqrt{2gh}$ (3) $100m\sqrt{2gh}$ (4) $300m\sqrt{2gh}$

Ans. (2)

Sol. Total momentum given to the roof will be = n (2 mV)

$$F = \frac{dp}{dt} = (2mV)\frac{dn}{dt} = 200$$

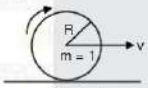
$$F = 2m\sqrt{2gh} \times 200 = 400m\sqrt{2gh}$$

12. A solid sphere of mass = 1kg is rolling (pure) with velocity v . If it's kinetic energy is $k = 7 \times 10^{-3}$ Joule. Find 'v' ?

(1) 15 cm/s (2) 18 cm/s (3) 10 cm/s (4) 5 cm/s

Ans. (3)

Sol.



$$K.E. = \frac{1}{2}I\omega^2 + \frac{1}{2}mv^2 = \frac{1}{2}\left(\frac{2}{5}\right)MR^2\omega^2 + \frac{1}{2}mv^2$$

$$K.E. = \frac{1}{5}mv^2 + \frac{1}{2}mv^2 \quad (\because v = R\omega)$$

$$\frac{(2+5)mv^2}{10} = KE \Rightarrow \frac{7}{10} \times 1 \times v^2 = 7 \times 10^{-3} \Rightarrow v^2 = \sqrt{10^{-2}} \Rightarrow v = \frac{1}{10} \text{ m/s} \Rightarrow v = 10 \text{ cm/s}$$

13. In Amplitude modulation, $A_c = 15 \sin(1000\pi t)$, $A_m = 10 \sin(4\lambda t)$. Determine the Range of frequency ?

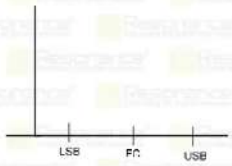
(1) 178Hz – 195Hz (2) 498Hz – 502Hz (3) 408Hz – 402Hz (4) 200Hz – 302Hz

Ans. (2)

Sol. $\omega_c = 1000\,\pi$

$$f_c = \frac{\omega_c}{2\pi} = \frac{1000\,\pi}{2\pi} = 500\text{Hz}$$

$$f_m = \frac{4\pi}{2\pi} = 2\text{Hz}$$



Range = 498Hz – 502Hz

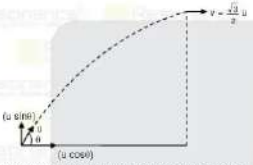
14. A particle is projected from ground with speed u at highest point of its Path speed is $\frac{\sqrt{3}u}{2}$. Find time of flight of the particle :

14. A particle is projected from ground with speed u at highest point of its Path speed is $\frac{\sqrt{3}u}{2}$. Find time of flight of the particle :

(1) $\frac{u}{g}$ (2) $\frac{\sqrt{3}u}{g}$ (3) $\frac{u}{2g}$ (4) $\frac{u}{\sqrt{3}g}$

Ans. (1)

Sol.



Velocity of particle at the highest point

$u\cos\theta = \frac{\sqrt{3}}{2}u$

$\cos\theta = \frac{\sqrt{3}}{2}$

$\theta = 30°$

$T = \frac{2u\sin\theta}{g} \Rightarrow \quad T = \frac{2u\sin30}{g} \Rightarrow T = \frac{u}{g}$

15. A source emits light of power 15 kW. Number of photons ejected per sec. from the source is 10^{16}. Find nature of emitted light :

(1) Ultra violet rays (2) X-rays (3) Infra rays (4) gamma rays

Ans. (4)

Sol. $E = \frac{hc}{\lambda}$

$E = \frac{nhc}{\lambda} = 15\text{kW}$

$\frac{nhc}{\lambda} = 15\times10^3 \Rightarrow \frac{10^{16}\times6.63\times10^{-34}\times3\times10^8}{\lambda} = 15\times10^3 \Rightarrow \lambda = \frac{6.63}{4}\times10^{-13}$

$= 1.32\times10^{-13} = 1.32\times10^{-7}\ \mu m$

16. Ration of C_P and C_V depends upon temperatures according to the following relation :

(1) $\gamma \propto T$ (2) $\gamma \propto 1/T$ (3) $\gamma \propto \sqrt{T}$ (4) $\gamma \propto T^0$

Ans. (4)

Sol. $\gamma = \frac{C_P}{C_V}$

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17. A wire has length 1 m at temperature 210°C. If the temperature of wire is reduced to 160° the wire get compressed. Now, If a block of mass 'm' gets hang to this wire then its length again extend to initial

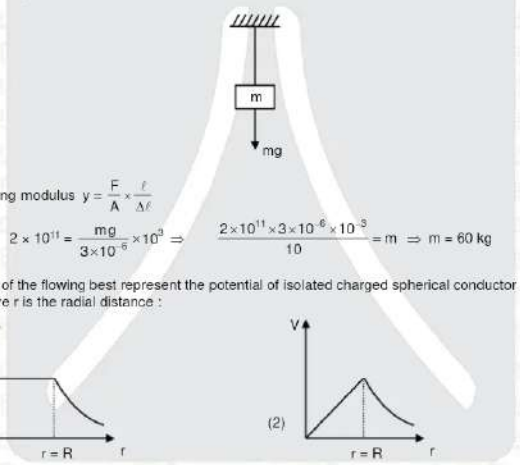
17. A wire has length 1 m at temperature 210°C. If the temperature of wire is reduced to 160° the wire get compressed. Now, If a block of mass 'm' gets hang to this wire then its length again extend to initial length. Find mass of block.
given, Area of wire = 3×10^{-6} m^2 ; Young modulus = 2×10^{11} N/m^2
$\alpha = 2 \times 10^{-5}$ /°C
(1) 20 kg (2) 60 kg (3) 70 kg (4) 80 kg

Ans. **(2)**

Sol. As

$$\frac{\Delta \ell}{\ell} = \alpha \Delta T \Rightarrow \frac{\Delta \ell}{\ell} = 2 \times 10^{-5} \times (210 - 160)$$

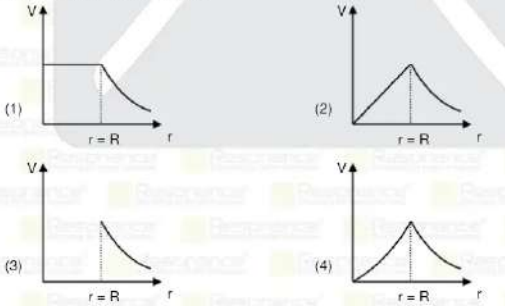
$$\frac{\Delta \ell}{\ell} = 2 \times 10^{-5} \times 50 = 10^{-3}$$



as young modulus $y = \frac{F}{A} \times \frac{\ell}{\Delta \ell}$

so, $2 \times 10^{11} = \frac{mg}{3 \times 10^{-6}} \times 10^{3} \Rightarrow \frac{2 \times 10^{11} \times 3 \times 10^{-6} \times 10^{-3}}{10} = m \Rightarrow m = 60$ kg

18. Which of the flowing best represent the potential of isolated charged spherical conductor as a function of r, where r is the radial distance :



Ans. **(1)**

Sol. $V_{in} = \frac{KQ}{R}$ & $V_{out} = \frac{KQ}{r}$

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19. If drift velocity of electron inside a wire is V_d. what will the new drift velocity if area of cross-section is doubled keeping the current constant?

(1) $2V_d$ (2) $\frac{V_d}{4}$ (3) $\frac{V_d}{2}$ (4) $\frac{V_d}{\sqrt{2}}$

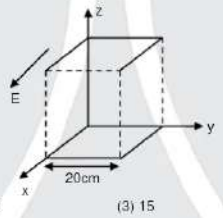
Ans. **(3)**

Sol. $I = neAV_d$.

$neAV_d = ne(2A)V'$

$\Rightarrow V' = \frac{V_d}{2}$

20. Electric field in a region is $4000\, x^2 \hat{i}$ N/c. the flux through the cube shown in figure is $\frac{P}{5}$ nm²/C. Find P?



(1) 32 (2) 60 (3) 15 (4) 100

Ans. **(1)**

Sol. $E = 4000 \times (0.2)^2$

$E = 160$ N/c

$\phi = \vec{E}.\vec{A} = 160 \times (0.2)^2$

$\phi = 6.4$

$P/5 = 6.4$

$P = 6.4 \times 5 = 32$

21. What will be the effect in resistance of semiconductor on increasing the temperature?

(1) increase (2) decrease (3) constant (4) None of these

Ans. **(2)**

Sol. Resistance will decrease

Temp. $\uparrow$ R $\downarrow$

22. **Assertion :** Wave nature of electron explains interference and diffraction.

Reason : Davission and Germer experiment explain the wave nature of electron.

(1) Both (A) and (R) are true and (R) is the correct explanation of (A)

(2) Both (A) and (R) true but (R) is NOT the correct explanation of (A)

(3) (A) is true but (R) is false.

(4) (A) is false but (R) is true.

Ans. **(1)**

Sol. Both are correct

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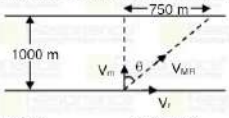
23. A man can swim with a speed of 4km/hr in still water. He tries to cross a river flowing with a speed of V_r in the shortest possible time and drifts 750 m away as shown. The width of river is 1000 m. Find V_r



(1) 2/5 km/hr (2) 2 km/hr (3) 3 km/hr (4) 3/2 km/hr

Ans. **(3)**

Sol. $\tan\theta = \frac{V_r}{V_m} = \frac{750}{1000} \Rightarrow V_r = \frac{75}{100} \times 4 \Rightarrow V_r = 3$ km/hr

24. Surface tension of water drop of radius r = 1 mm is 0.07 N/m. 1000 similar drops are combined to form a bigger drop. If u_1 is the surface energy of 1000 similar drops and u_2 is the surface energy of bigger drop. Find change in energy.

(1) 590 μJ (2) 672 μJ (3) 792 μJ (4) 829 μJ

Ans. **(3)**

Sol.

Using volume conservation

$1000 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3$

$R = 10\,r$

$R = 10 \times 1$ mm $= 10$ mm

as surface energy $U = S(4\pi r^2)$

when S is surface energy & r is radius

$U_1 = 0.07\,(4\pi \times (1 \times 10^{-3})^2) \times 1000$ $\quad U_2 = 0.07\,(4\pi\,(10 \times 10^{-3})^2)$

$U_1 - U_2 = 0.07 \times 4\pi\,[10^{-6} \times 10^3 - 10^{-4}]$

$0.07 \times 4\pi\,[10^{-3} - 10^{-4}] = 0.01 \times 4 \times \frac{22}{7} \times 10^{-3}\left[1 - \frac{1}{10}\right]$

$= 0.01 \times 4 \times 22 \times 10^{-3} \times \frac{9}{10} = 792 \times 10^{-6}\,J = 792\mu J$

25. A free neutron decays to a proton but a free proton does not decay to a neutron. This is because

(1) neutron is a composite particle made of a proton and an electron whereas proton is fundamental particle

(2) neutron is an uncharged particle whereas proton is a charged particle

(3) neutron has larger rest mass than the proton

(4) weak forces can operate in a neutron but not in a proton.

Ans. **(3)**