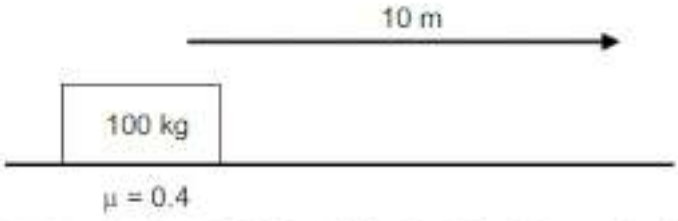
PART : PHYSICS

1. A particle is executing SHM with an amplitude A. Find the ratio of total energy and kinetic energy if it is at $\frac{A}{3}$ from mean position.

(1) $\frac{9}{8}$ (2) $\frac{5}{4}$ (3) $\frac{3}{5}$ (4) $\frac{1}{2}$

Ans. **(1)**

Sol. $$\frac{T.E.}{K.E} = \frac{\frac{1}{2}KA^2}{\frac{1}{2}K\left(A^2 - x^2\right)} = \frac{A^2}{A^2 - \frac{A^2}{9}} = \frac{1}{1-\frac{1}{9}} = \frac{1}{\frac{8}{9}} = \frac{9}{8}$$

2. 

Find work done by friction if block slides 10 m on horizontal plane

(1) 2000 J (2) – 3000 J (3) –4000 J (4) 1000 J

Ans. **(3)**

Sol. $F_k = \mu mg = (0.4)(100)(10) = 400$ N

$W_F = \vec{F}_k . \vec{r}$

$W_F = -(400)(10)$

$W_F = -4000$ J

3. If potential energy of particle is given by $U = 4x^2+y+z$ Find force on the particle in x-direction.

(1) $-8x\hat{i}+\hat{j}$ (2) $-2x\hat{i}+\hat{j}$ (3) $-8x\hat{i}$ (4) $8x\hat{i}$

Ans. **(3)**

Sol. $$\vec{F} = -\frac{\partial U}{\partial r}\hat{r} - \frac{\partial U}{\partial x}\hat{i} - \frac{\partial U}{\partial y}\hat{j} - \frac{\partial U}{\partial z}\hat{k}$$

$\vec{F} = -8x\hat{i} - 1\hat{j} - 1\hat{k}$

$\vec{F}_x = -8x\hat{i}$

4. Statement-I : A given capillary firstly inserted in hot water & then in cold water. Then hot water will rise more in capillary

Statement-II : In same case, hot water will rise less.

(1) Statement I and II correct

(2) Statement I and II both incorrect

(3) Statement I correct and II incorrect

(4) Statement I incorrect and II is correct

Ans. **(4)**

Sol. Statement –I Incorrect

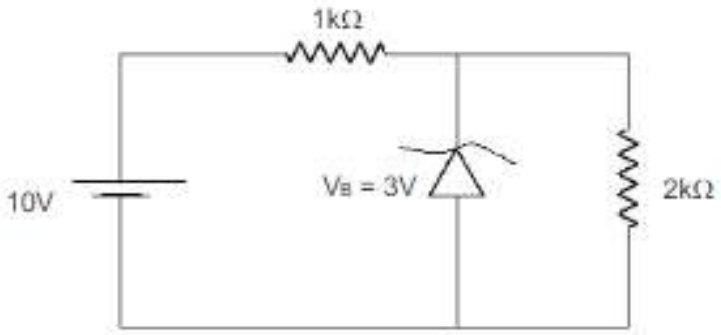
Statement-II Correct

$$h = \frac{2T\cos\theta}{\ell \times g}$$

T = Surface tension

With increase in temperature, surface tension of water decreases thus height of capillary rise will be less in hot water. [Considering thermal expansion of liquid and capillary is negligible]

5.

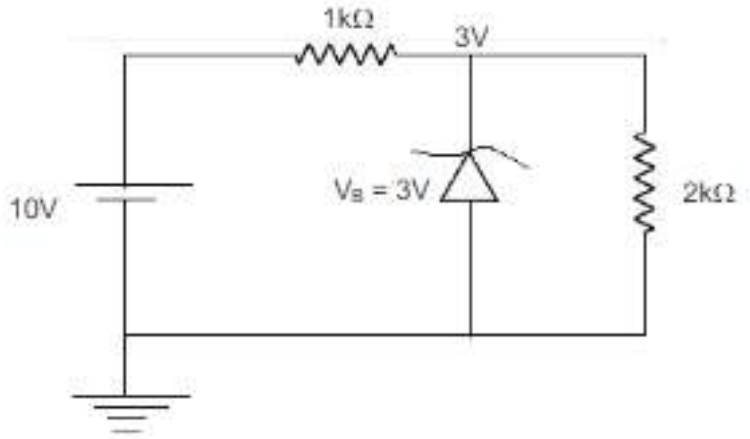


If breakdown voltage of zener diode is 3V then find the current flow in zener diode.

(1) 3mA (2) 5.5 mA (3) 4.5 mA (4) 3.5 mA

Ans. **(2)**

Sol.



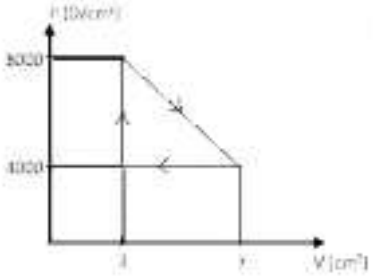
Volt drop across zener diode is 3V

Current in $2k\Omega = \frac{3}{2\times10^3} = 1.5$ mA

Current in $1k\Omega = \frac{10-3}{1\times10^3} = 7$mA

Current in Zener diode = (7 – 1.5) mA = 5.5 mA

6.



Find work done by gas in cyclic process

(1) 0.3 mJ (2) 0.6 mJ (3) 1 mJ (4) 0.8 mJ

Ans. **(4)**

Sol. Wg=Area enclosed in P–V diagram

$W_g = \frac{1}{2}(8000-4000)(7-3)\left(\frac{D}{cm^2}\times cm^3\right)$

W_g= 8000 D.cm

$W_g = 8000\ (10^{-5}) \times 10^{-2}$ N.m

W_g=0.8 mJ

7. An object is moving with an centripetal acceleration of constant magnitude in a curved path. If ratio of radius of curvature at two different point is given as 3:2. Then find ratio of speeds at those points

(1) 3 : 2 (2) 2 : 3 (3) $\sqrt{3}:\sqrt{2}$ (4) $\sqrt{2}:\sqrt{3}$

Ans. **(3)**

Sol. $a_c = \frac{v^2}{r}$

$$\frac{a_{c_1}}{a_{c_2}} = \left(\frac{v_1}{v_2}\right)^2\left(\frac{r_2}{r_1}\right)$$

$$\Rightarrow \quad 1 = \left(\frac{v_1}{v_2}\right)^2\left(\frac{2}{3}\right)\left[a_{c_1} = a_{c_2}\right]$$

$$\Rightarrow \quad \frac{v_1}{v_2} = \sqrt{\frac{3}{2}}$$

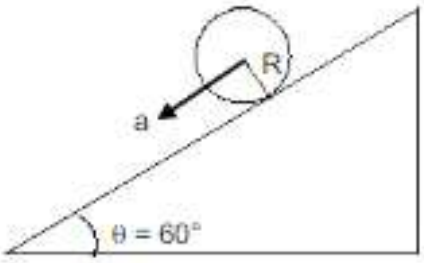
$$\Rightarrow \quad v_1 : v_2 = \sqrt{3} : \sqrt{2}$$

8. A solid cylinder is released from rest and the surface is sufficiently rough for pure rolling it rolls without sliding down the inclined plane of inclination $\theta = 60°$ from horizontal. Calculate the acceleration of centre of mass of the cylinder.

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

Ans. **(3)**

Sol.



$$a = \frac{g\sin\theta}{1 + \frac{I}{mR^2}}$$

For solid sphere, $I = \frac{mR^2}{2}$

$$a = \frac{2g}{3}\sin\theta = \frac{2g}{3}\sin(60°)$$

$$a = \frac{g}{\sqrt{3}}$$

9. De broglie wave length of e^- and proton are equal. The ratio of K.E. of electron and proton will be

(1) 1500 (2) 1836 (3) 1600 (4) 2000

Ans. **(2)**

Sol. $\lambda_e = \lambda_p$

$$\lambda = \frac{\lambda}{\sqrt{2m(k.E)}}$$

$$\frac{\lambda_e}{\lambda_p} = 1 = \frac{\lambda}{\sqrt{2m_e(k.E)_e}} \times \frac{\sqrt{2m_p(k.E)_p}}{\lambda}$$

$$\Rightarrow \frac{(k.E)_e}{(k.E)_p} = \frac{m_p}{m_e} = \frac{1836\, m_e}{m_e} = 1836$$

10. Value of gravitational acceleration is same at depth 'd' and height 'n' from the surface of earth find value of h. (radius of earth = R_e, considering h<<R).

(1) h =d (2) h = 2d (3) $h = \frac{d}{2}$ (4) $h = \frac{3d}{2}$

Ans. **(3)**

Sol. g very with height : $g\left(1-\frac{2h}{R}\right)$

g very with depth : $g\left(1-\frac{d}{R}\right)$

If g is same at both point then

$$g\left(1-\frac{2h}{R}\right) = g\left(1-\frac{d}{R}\right)$$

$$\left[h = \frac{d}{2}\right]$$

11. The voltage applied across the resistance R is (200 ± 5) Ω and current in resistance is (20 ± 0.2) A, then find the percent error in resistance.

(1) 3.5 % (2) 5% (3) 7% (4) 3%

Ans. **(1)**

Sol. V = RI

$$R = \frac{V}{I}$$

$$\frac{dR}{R} \times 100\% = \frac{dV}{V} \times 100\% + \frac{dI}{I} \times 100\%$$

$$= \frac{5}{200} \times 100\% + \frac{0.2}{20} \times 100\%$$

$$= 2.5\% + 1\% = 3.5\%$$

12. An electron is placed 1 meter away in front of uniformly charged sheet and now electron is released from rest and strikes after 1 second to charged sheet. If charge density of sheet $x\left(\frac{m\varepsilon_0}{e}\right)$ then value of x will be :

(1) 2 (2) 4 (3) 6 (4) 8

Ans. **(2)**

Sol. $\frac{1}{2}at^2 = 1$

$\frac{1}{2}a(1)^2 = 1$

$a = 2$

$\frac{eE}{m} = 2$

$\frac{e}{m}\frac{\sigma}{2\varepsilon_0} = 2$

$\sigma = \frac{4m\varepsilon_0}{e}$

Ans. 4

13. Reading of Galvanometer without shunt is 25 division, and with shunt is 5 division. Value of coil resistance of galvanometer is 24 Ω. Find value of shunt resistance of Galvanometer.

(1) 2Ω (2) 4Ω (3) 6Ω (4) 8Ω

Ans. **(3)**

Sol. $(i - i_g)s = i_gR_g$

$s = \frac{i_gR_g}{i - i_g} = \frac{5 \times 24}{20}$

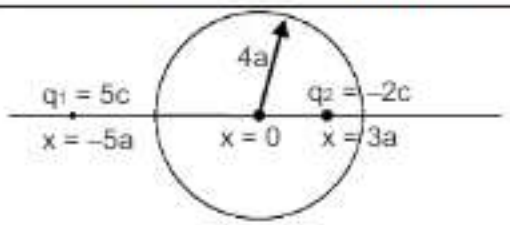
$s = 6\Omega$

14. There are two charges $q_1 = 5c$ & $q_2 = -2C$ located at $x = -5a$ & $x = 3a$ respectively. Find electric flux passing through a sphere of radius 4a. Centre of the sphere is at origin.

(1) $\frac{-2}{\epsilon_0}$ (2) $\frac{5}{\epsilon_0}$ (3) $\frac{3}{\epsilon_0}$ (4) 0

Ans. **(1)**

Sol.



Using Guess's law

$$0 = \frac{q_{in}}{\epsilon_0} = \frac{-2}{\epsilon_0}$$

15. Bio convex lens of Refractive Index 1.5 of focal length 20 cm in air which is now immersed in a liquid of Refractive Index 1.6. What will be the focal length of lens after immersing in liquid?

(1) 1.6 (2) 160 (3) –160 (4) –1.6

Sol. $\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$$\frac{1}{20} = \left(\frac{1.5}{1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad .....(1)$$

$$\frac{1}{f'} = \left(\frac{1.5}{1.6} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad .....(2)$$

Eq. (1) & (2)

$$\frac{f'}{20} = -8$$

$$f' = -160\,cm$$

16. In a L–C oscillating circuit If is given that C = 100μF & L = 6.4 mH if maximum voltage across capacitor is 12 volt then find maximum current in inductor.

(1) 1.5 A (2) 2A (3) 3.5 A (4) 4 A

Ans. **(1)**

Sol. Using conservation of energy.

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

$$\Rightarrow \quad i^2 = \frac{CV^2}{L} = \frac{100\times10^{-6}\times12\times12}{6.4\times10^{-3}}$$

$$\Rightarrow \quad i^2 = \frac{12\times12}{64}$$

$$\Rightarrow \quad i = \frac{12}{8} = \frac{3}{2} = 1.5\ A$$

17. Given current as function of time $I = i_0 + \beta t$

at $t = 0$, $i = i_0 = 20$, $\beta = 3$.

Find charge passing through in $t = 20s$.

(1) 3000 C (2) 2500 C (3) 1500 C (4) 1000 C

Ans. **(4)**

Sol. $Q = \int i\,dt \qquad \left[i = \frac{dq}{dt}\right]$

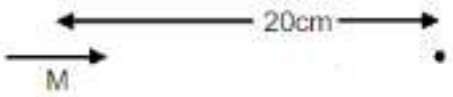
$= \int (i_0 + \beta t)dt$

$= \left[i_0 t + \frac{\beta t^2}{2}\right]_0^{20}$

$= 20(20) + (3)\frac{[20 \times 20]}{2}$

$= (400 + 600) = 1000$ C

18. Magnetic potential at a point 20 cm away from a magnet is 0.075 SI unit then magnetic moment at this point will be $x \times 10^4$ SI unit. Find the value of x.



(1) 2 (2) 3 (3) 4 (4) 5

Ans. **(2)**

Sol. $\frac{\mu_0 M}{4\pi r^2} = 0.075$

19. Match the following :

A.	$\oint \vec{B}.\vec{dA} = 0$	P.	Faraday & Lens's law
B.	$\oint \vec{E}.\vec{dA} = \frac{Q_{in}}{\epsilon_0}$	Q.	Gauss law of on magnetism
C.	$\oint \vec{B}.\vec{dl} = \mu_0 I_{enc}$	R.	Ampere's law
D.	$\oint \vec{E}.\vec{dl} = \frac{-d\phi_B}{dt}$	S.	gauss law of electrostatics

(1) (A – Q), (B – S), (C – R), (D – P)

(2) (A – S), (B – Q), (C – R), (D – P)

(3) (A – Q), (B – R), (C – S), (D – P)

(4) (A – Q), (B – S), (C – P), (D – R)

Ans. **(1)**

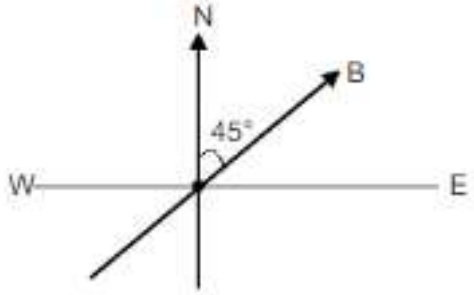
Sol. (A – Q), (B – S), (C – R), (D – P)

20. A square loop of side 0.1 m is in east west plane and magnetic field is along north east of 0.2 T. If magnetic field gradually becomes 0 in 10s, find EMF generated in loop?

(1) 0.10 mv (2) 0.14 mv (3) 0.16 mv (4) 0.18 mv

Ans. **(2)**

Sol.



$emf = \frac{\Delta d}{\Delta t}$ $\quad \therefore \Delta t = 10sec$

$\Delta\phi = BA\cos 45°$

$Emf = \frac{0.2\times10^{-2}}{10}\times\frac{1}{\sqrt{2}}$

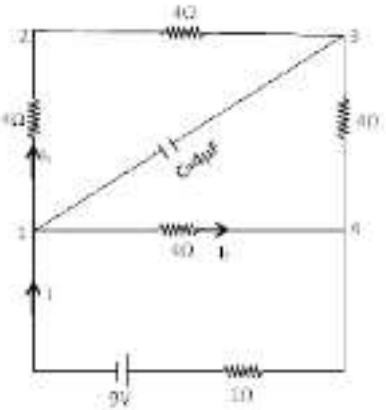
$= \sqrt{2}\times10^{-4}V$

$= 0.14$ mv

21. A wire of resistance 16Ω is bond to form square and a battery of EMF 9V and internal resistance 1Ω is connected across a side of square and 4μF capacitor is connected across one diagonal find energy stored in capacitor?

(1) 9 μJ (2) $\frac{81}{2}$ μ J (3) 27 μ J (4) $\frac{9}{2}$ μ J

Sol.



No current will pass through capacitor in full charging condition

$R_{eq} = \frac{12\times4}{16} = 3\Omega$

$I = \frac{9}{3+1} = \frac{9}{4}A$

$I_1 = I \times \frac{4}{(12+4)} = \frac{9}{16}A$

$\therefore V_1 - V = V_C = \frac{9}{16} \times 8 = \frac{9}{2}$ Volt

$U = \frac{1}{2}CV_C^2 = \frac{1}{2}(4)\left(\frac{9}{2}\right)^2$

$V = 40.5\ \mu J$

22. Find distance of image from the convex mirror of focal length 15 cm if magnification is $\frac{1}{2}$

(1) 15 cm (2) 7.5 cm (3) 30 cm (4) 45 cm

Ans. **(2)**

Sol. $f = 15$ cm

$m = \frac{1}{2}$

For magnetisation $\frac{1}{2}$ object should be virtual

$\therefore \quad m = -\frac{v}{u} = \frac{1}{2}$

Using, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} + \frac{1}{-2v} = \frac{-1}{15}$

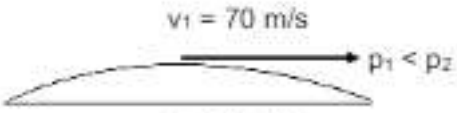
$v = -7.5$ cm

23. The area of aeroplane wing is 0.2 m^2 and the density of air it 1.2 kg/m^3 the airflow (velocity of air) above the wing is 70 m/s and below is 65 m/s find the lift fore

(1) 51 N (2) 81 N (3) 90 N (4) 85 N

Ans. **(2)**

Sol.



Area = 0.2 m^2

P = 1.2 kg/ m^3

$p_1 + \frac{1}{2}pv_1^2 = p_2 + \frac{1}{2}pv_2^2$

$(p_2 - p_1) = \frac{1}{2}p\left(v_1^2 - v_2^2\right)$

Life force = $(p_2 - p_1)A$

$= \frac{1}{2} \times 1.2\,(70^2 - 65^2) \times 0.2$

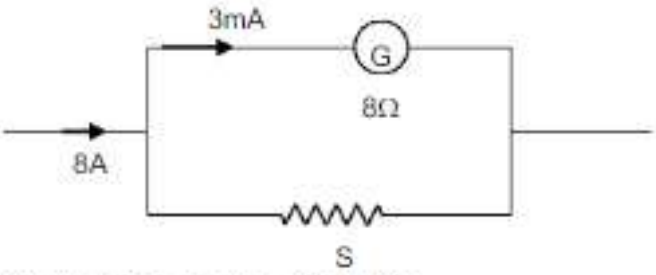
$f = 81$ N

24. A Galvanometer of resistance 8Ω is shunted with a resistance S. If full scale deflection current is 3mA and the maximum current pass through the Ammeter is 8A. Find the value of shunt.

(1) 3mΩ (2) 5mΩ (3) 7mΩ (4) 9mΩ

Ans. **(1)**

Sol.



$(3mA) \times 8\Omega = S \times (8 - 3 \times 10^{-3})A$

$\Rightarrow \quad \frac{24}{1000} = S(8)$

$S = 3m\Omega$

25. A particle is moving with constant acceleration along a straight line. From rest particle moves for a distance S_1 for time $t_1 = (P-1)$ s and a distance S_2 for time $t_2 = p$ sec. Find total time to travel distance $S_1 + S_2$.

(1) $t = \sqrt{\frac{(2S_1 + S_2)(4P-1)}{S_2 + S_1}}$ (2) $t = \sqrt{\frac{(S_1 + S_2)(2P-1)}{S_2 + S_1}}$

(3) $t = \sqrt{\frac{(2S_1 + S_2)(2P-1)}{S_2 - S_1}}$ (4) $t = \sqrt{\frac{(S_1 + S_2)(2P-1)}{S_2 - S_1}}$

Ans. **(4)**

Sol. distance travelled in P^{th} sec.

$S_2 - S_1 = u + \frac{a}{2}[2n-1]$

$S_2 - S_1 = 0 + \frac{a}{2}[2P-1]$

$a = \frac{2(S_2 - S_1)}{2P-1}$

time taken to travel $S_1 + S_2$ distance.

Using $s = S = ut + \frac{1}{2}at^2$

$S_1 + S_2 = \frac{1}{2}\left(\frac{2(S_2 - S_1)}{2P-1}\right)t^2$

$t = \sqrt{\frac{(S_1 + S_2)(2P-1)}{S_2 - S_1}}$

26. ${}^{6}_{3}Li + {}^{2}_{1}H \longrightarrow 2{}^{4}_{2}He + Q$

where

$m_{Li} = 6.015122$

$m_{H} = 2.014$

$m_{He} = 4.0026$

Find value of Q in MeV

(1) 22.24 (2) 20.34 (3) 18.26 (4) 25.25

Ans. **(1)**

Sol. $Q = \Delta mc^2$

$= [m_{Li} + m_{H} - 2m_{He}]C^2$ {m_e cancelled}

$= \{[6.015122 + 2.014] - 2\times4.0026\}\, C^2$

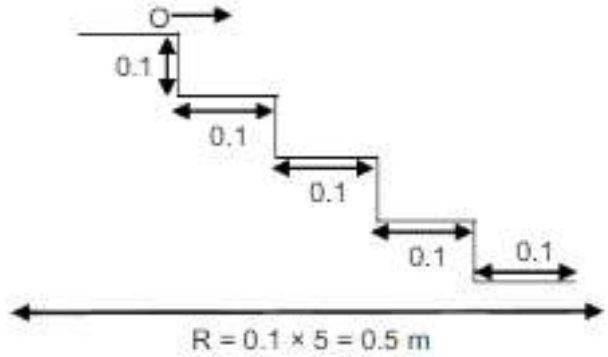
$= 22.24$ MeV

27. A ball is thrown horizontally from the top of the stairs of height and width both 0.1 m. Find the minimum velocity of ball such that it strikes on the fifth stair?

(1) 3.581 (2) 1.583 (3) 1.581 (4) 2.581

Ans. **(3)**

Sol.



$R = V \times T$

$T = \sqrt{\frac{2h}{g}}$

$T = \sqrt{\frac{2\times0.5}{10}} = \sqrt{\frac{1}{10}}$

$V = \frac{R}{T} = \frac{0.1\times5}{\sqrt{\frac{1}{10}}} = 0.5\sqrt{10}$

$V = 1.581$ m/s