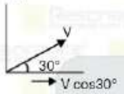
PART : PHYSICS

1. A particle is thrown at an angle of 30°. Find the ratio of kinetic energy at initial position that at the maximum height.

(1) 4 : 6 (2) 4 : 3 (3) 1 : 2 (4) 9 : 5

Ans. (2)

Sol.



Let initial velocity = v

Velocity at maximum height = $V\cos 30° = \frac{\sqrt{3}v}{2}$

$KE_1 = KE_{initial} = \frac{1}{2}mv^2$

$KE_2 = KE$ at $h_{max} = \frac{1}{2}m\left(\frac{\sqrt{3}v}{2}\right)^2 = \frac{3mv^2}{8}$

So, $KE_1 : KE_2$

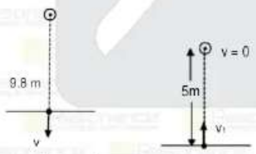
$\frac{1}{2}mv^2 : \frac{3}{8}mv^2$ 4 : 3 Ans.

2. A ball dropped from height 9.8 m and rebound to a height 5m. If time of contact was 0.2 sec., then find average acceleration during the time ball was in contact with the floor. ($g = 10\ m/s^2$)

(1) 120 m/s^2 (2) 60 m/s^2 (3) 100 m/s^2 (4) 50 m/s^2

Ans. (1)

Sol.



$v = \sqrt{2gh} = \sqrt{2 \times 10 \times 9.8} = 14\ m/s$

After collision ball rebound to height 5m

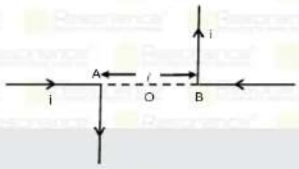
$0 = v_1^2 - 2 \times g \times 5$

$v_1 = \sqrt{2 \times g \times 5} = \sqrt{2 \times 10 \times 5} = 10\ m/s$

Average acceleration $= \frac{v_1 - (-v)}{t} = \frac{10 + 14}{0.2} = \frac{24}{0.2} = 120\ m/s^2$

3. Two long wires are kept in sample plane such that point O lies at middle of the line AB The magnetic

3. Two long wires are kept in sample plane such that point O lies at middle of the line AB The magnetic field at point O due to the current I flowing in both wires as shown is equal to



(1) $\frac{2\mu_0 i}{\pi\ell}$ (2) $\frac{\mu_0 i}{2\pi\ell}$ (3) $\frac{\mu_0 i}{4\pi\ell}$ (4) $\frac{\mu_0 i}{\pi\ell}$

Ans. (4)

Sol. $B_0 = \frac{\mu_0 i}{4\pi r} = B_1 + B_2$

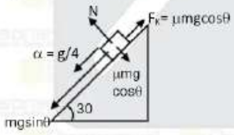
$$B_0 = \frac{\mu_0 i}{4\pi\frac{\ell}{2}} + \frac{\mu_0 i}{4\pi\frac{\ell}{2}} = \frac{\mu_0 i}{\pi\ell}$$

4. A block is sliding down an inclined plane of inclination 30º with an acceleration of g/4. Find the coefficient of friction between the block and inclined

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

Ans. (1)

Sol.



$mg\sin\theta - \mu gm\cos\theta = ma$

$$\frac{g}{2} - \frac{\mu g\sqrt{3}}{2} = \frac{g}{4}$$

$$\frac{1}{2} - \frac{\sqrt{3}\mu}{2} = \frac{1}{4}$$

$$\frac{1}{2} - \frac{1}{4} = \frac{\sqrt{3}}{2}\mu, \quad \mu = \frac{1}{2\sqrt{3}}$$

5. In a radioactive decay hlf life is 30 min. than find fraction of undecay substace after 90 min.

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

5. In a radioactive decay hlf life is 30 min. than find fraction of undecay substace after 90 min.

(1) $\frac{1}{6}$ (2) $\frac{1}{8}$ (3) $\frac{1}{3}$ (4) $\frac{1}{9}$

Ans. (2)

Sol. Half life of decay = 30 min.

Initial no. of nuclei = N_0

after 30 min. (1 half life) remaining nuclei = $\frac{N_0}{2}$

after 60 min. (2nd half life) remaining nuclei = $\frac{N_0}{4}$

after 90 min. (3rd half life) remaining nuclei = $\frac{N_0}{8}$

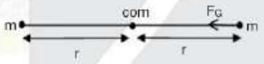
$$\frac{N}{N_0} = \frac{N_0}{8N_0} = \frac{1}{8}$$

6. Two equal masses (m) rotating about their com. The separation between the masses is 2r than find out their speed .

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

Ans. (1)

Sol.



Gravitational force will provide centripetal force.

$$\frac{Gmm}{(2r)^2} = \frac{mv^2}{r} \Rightarrow \frac{Gm}{4r} = V^2$$

$$V = \sqrt{\frac{Gm}{4r}}$$

7. A car is moving in a circular track of roiling 50 cm with coefficient of friction being 0.34 On this horizontal tack the maximum safe speed for turning is equal to : (g = 10 m/s²)

(1) 3 (2) 2 (3) 1.3 (4) 0.3

Ans. (3)

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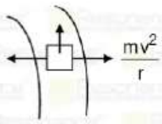
Sol.



For max speed, ring

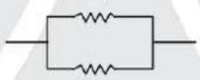
$\mu mg = \frac{mv^2}{r}$

$V = \sqrt{\mu gr}$

$V = \sqrt{0.34 \times 10 \times \frac{1}{2}}$

$V = 1.3$ m/s

8. Two resistance are connected in parallel as shown in the circuit. Find the ratio of power dissipated in R_1 to R_2



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

Ans. (1)

Sol. ∵ Resentence are in parallel.

Potential difference a/c then are same

$\frac{P_1}{P_2} = \frac{V^2/R_1}{V^2/R_2} = \frac{R_2}{R_1} = \frac{3R}{R} = \frac{3}{1}$

n $P_1 : P_2 = 3 : 1$

9. A solid sphere is doing pure rolling. Its kinetic energy is 2240 J and mass of the sphere is 2 kg Determine the velocity of centre of sphere in m/s

(1) 20 (2) 40 (3) 25 (4) 35

Ans. (2)

Sol. $KE = \frac{1}{2} I_{cm}\omega^2 + \frac{1}{2}mv^2$

$= \frac{1}{2} \times \frac{2}{5} mR^2 \times \frac{v^2}{R^2} + \frac{1}{2}mv^2$

$\Rightarrow \frac{mv^2}{5} + \frac{mv^2}{2} \Rightarrow \frac{7}{10}mv^2$

$\frac{7}{10} \times 2 \times v^2 = 2240$

$v^2 = \frac{22400}{14}$

$v = 40$ m/s

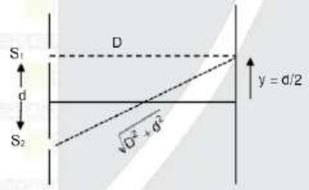
10. In Young's double slit experiment, $\lambda = 800$ nm $y = \frac{d}{2}$ {1st minima} and D = 5 cm Here D >> d

Find d {distance between slits}

(1) 2×10^{-6} m (2) 6×10^{-4} m (3) 2×10^{-4} m (4) 4×10^{-4} m

Ans. (3)

Sol.



Path difference, $\Delta x = \sqrt{D^2 + d^2} - D$

$\frac{\lambda}{2} = \sqrt{D^2 + d^2} - D$

$\frac{\lambda}{2} = D\left[1 + \frac{d^2}{2D^2} - 1\right]$

(Binomial expansion)

$\frac{\lambda}{2} = \frac{d^2}{2D}$

$d = \sqrt{D_0\lambda}$

$d = \sqrt{5 \times 10^{-2} \times 800 \times 10^{-9}}$

$d = 2 \times 10^{-4}$ m

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11. A soap bubble initially have radius 3.5 cm. If the radius increase to 7 cm given surface tension $= 2 \times 10^{-2}$ N/m find out the work done in this process? $\left(\text{use } \pi = \frac{22}{7}\right)$

(1) 18.48×10^{-4} J (2) 0.72×10^{-4} J (3) 0.56×10^{-4} J (4) 0.96×10^{-4} J

Ans. (1)

Sol. The energy for soap bubble is given by $U = S \times 8\pi R^2$

When 'S' is surface tension R is radius

$\Delta U = S \times 8\pi\left(R_2^2 - R_1^2\right)$

$\Delta U = 2 \times 10^{-2}$ N/m $\times 8\pi(7^2 - (3.5)^2) \times 10^{-4}$

$= \frac{16\pi \times 10^{-2}(49 - 12.25)}{10^4} = 588\pi \times 10^{-6}$

$= 588 \times \frac{22}{7} \times 10^{-6}$

$\Delta U = 1848 \times 10^{-6}$ J

$= 18.48 \times 10^{-4}$ J

12. Height of both the transmitter tower and the receiver tower is 80 m. each and the radius of the earth is 6400 Km. The maximum distance between the transmitter and receiver tower, so that line of sight communication can be done successfully will be:-

(1) 32 Km. (2) 64 Km. (3) 16 Km. (4) 128 Km.

Ans. (2)

Sol. $d_{max} = \sqrt{2Rh_t} + \sqrt{2Rh_r}$

$d_{max} = \sqrt{2 \times 6400 \times 10^3 \times 80} + \sqrt{2 \times 6400 \times 10^3 \times 80}$

$d_{max} = 64$ Km.

13. For light emitting diode, consider the following statements:-

(I) The diode is connected in forward bias.

(II) The diode is connected in reverse bias.

(III) The energy of emitted photons is approximately equal to (Slightly less than E_g) the forbidden energy gap (E_g)

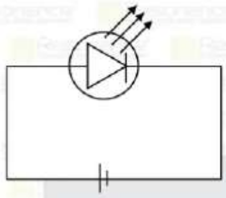
(IV) The photons are emitted due to recombination.

The correct statements are :-

(1) Only (II), (III) (2) Only (I) (3) (II), (III), (IV) (4) (I), (III), (IV)

Ans. (4)

Sol.

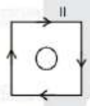


14. A square loop of side L and a circular loop of radius a are placed concentrically and in the same plane. IF L >> r then the mutual inductance. between then will be:-

(1) $\frac{\sqrt{2}\mu r^2}{L}$ (2) $\frac{2\sqrt{2}\mu r^2}{L}$ (3) $\frac{\mu r^2}{2\sqrt{2}L}$ (4) $\frac{4\sqrt{2}\mu i r^2}{L}$

Ans. (2)

Sol.



$$B_1 = \frac{\mu_0 i_1}{4\pi\left(\frac{L}{2}\right)}(\text{Sin}45^\circ + \text{Sin}45^\circ)\times 4$$

$$B_1 = \frac{2\sqrt{2}\mu_0 i_1}{\pi L}$$

$$\phi_{21} = \left(\frac{2\sqrt{2}\mu_0 i_1}{\pi L}\right)(\pi r^2)$$

$$\phi_{21} = \left(\frac{2\sqrt{2}\mu_0 \pi r^2}{\pi L}\right) i_1$$

$$M_{21} = \frac{2\sqrt{2}\mu_0 r^2}{L}$$

15. Match the following

(I) Pressure Gradient	(P) $M^1L^1T^{-3}A^{-1}$
(II) Electric Field	(Q) L^2T^{-2}
(III) Latent heat	(R) $ML^{-2}T^{-2}$
(IV) Energy density	(S) $M^1L^{-1}T^{-2}$

(1) I→P, II→R, II→Q, IV→S
(2) I→Q, II→P, II→R, IV→R
(3) I→S, II→R, II→P, IV→Q
(4) I→R, II→P, II→Q, IV→S

Ans. (4)

Sol. $\frac{dP}{dx} = \frac{f}{A.L}$

$= \frac{MLT^{-2}}{L^3} = M^1L^{-2}T^{-2}$

$E = \frac{F}{q} = \frac{MLT^{-2}}{AT} = M^1L^1T^{-3}A^{-1}$

$L = \frac{\text{Heat}}{\text{mass}} = \frac{\text{energy}}{\text{mass}} = \frac{ML^2T^{-2}}{M} = L^2T^{-2}$

$U_d = \frac{\text{Energy}}{\text{volume}} = \frac{ML^2T^{-2}}{L^3} = ML^{-1}T^{-2}$

16. If the smallest wavelength of lyman series is λ then wavelength radiated by He^+ ion when electron jumps from 2nd excited state to first excited state.

(1) $\frac{9\lambda}{5}$
(2) $\frac{4\lambda}{5}$
(3) $\frac{3\lambda}{5}$
(4) $\frac{6\lambda}{5}$

Ans. (1)

Sol. $\frac{1}{\lambda} = Rz^2\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$

For H–atom , lyman series $n_f = 1$, $n_i = 2, 3, 4, \ldots\ldots\infty$, &

For smallest wavelength $n_i = \infty$

$\frac{1}{\lambda} = R\left(\frac{1}{1}\right) \Rightarrow R = \frac{1}{\lambda}$

For He^+, $\frac{1}{\lambda'} = R(2)^2\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$

$n_f = 2;\quad n_i = 3$

$\frac{1}{\lambda'} = R \times 4\left(\frac{1}{4} - \frac{1}{9}\right) \Rightarrow \frac{1}{\lambda'} = 4R\left(\frac{5}{36}\right) = \left(\frac{5R}{9}\right)$

$\lambda' = \frac{9}{5R} = \frac{9\lambda}{5}$

17. For a given decay find z?

$$^{236}_{92}X \xrightarrow{\alpha-\text{decay}} \xrightarrow{\alpha-\text{decay}} \xrightarrow{\beta\ \text{decay}} {}^{A}_{z}Y$$

(1) 96 (2) 94 (3) 89 (4) 90

Ans. (3)

Sol. During α–decay atomic number reduced by 2 & mass no. by 4. and in β decay A remain same but z increase by 1.

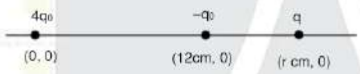
$$^{236}_{92}X \longrightarrow {}^{232}_{90}X + {}^{4}_{2}He \longrightarrow {}^{228}_{88}Q + {}^{4}_{2}He \longrightarrow {}^{228}_{89}Y + {}^{0}_{-1}\beta$$

18. A charge of $4q_0$ is kept at origin and an another charge of $-q_0$ is kept at x = 12 cm. Where the third charge q should be placed, so that the all the charges are in equilibrium.

(1) 18 cm (2) 20 cm (3) 27 cm (4) 24 cm

Ans. (4)

Sol. As all charges are in equilibrium $\therefore$ force on q = 0



In equilibrium, $\dfrac{K(4q_0)(q)}{(r\times10^{-2})^2} = \dfrac{K(q_0)(q)}{[(r-12)\times10^{-2}]^2}$

$$\frac{4}{r^2} = \frac{1}{(r-12)^2}$$

$$\frac{2}{r} = \frac{1}{r-12}$$

$$2r - 24 = r$$

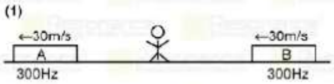
$$r = 24 \text{ cm}$$

19. An observer is standing on platform. A train A is leaving the station with speed 30m/s emitting a sound of frequency 300Hz. Another train B is arriving to the station with speed 30m/s emitting a sound of frequency 330Hz. Find the beat frequency as observed by man.

(1) 55 Hz (2) 42 Hz (3) 60 Hz (4) 30 Hz

Ans. (1)

Sol.



Apparent frequency $f = \left(\dfrac{V \pm V_0}{V \pm V_s}\right) f_0$

(for leaving train) $f_A = \left(\frac{V}{V+V_s}\right) f_0$ $[V_0 = 0]$

$$f_A = \left(\frac{330}{330+30}\right) \times 330 = 275 \text{Hz}$$

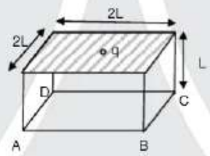
(for leaving train) $f_B = \left(\frac{V}{V-V_s}\right) \times f_0$

$$= \left(\frac{330}{330-30}\right) \times 300 = 330 \text{Hz}$$

Beat frequency $= f_B - f_A$

$= 330 - 275 = 55$ Hz

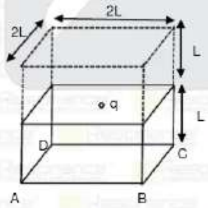
20. A cuboid of dimension 2L × 2L × L. A charge q is placed at centre of surface with area $4L^2$. Flux through opposite side is?



(1) $\frac{6q}{\varepsilon_0}$ (2) $\frac{q}{6\varepsilon_0}$ (3) $\frac{q}{18\varepsilon_0}$ (4) $\frac{q}{\varepsilon_0}$

Ans. (2)

Sol. We can put similar cuboid on above this cupboard to make symmetry about charge



Flux through this whole cube $= \frac{q}{\varepsilon_0}$

As total faces are 6, so flux through ABCD is $\frac{q}{6\varepsilon_0}$

21. Two interfering waves of same wavelength 8 cm and equal frequency having amplitude each of 8 cm. The resulting wave also have amplitude 8 cm. Find the phase angle between interfering waves

(1) 90° (2) 150° (3) 60° (4) 120°

Ans. (4)

Sol. $A_1 = 8$ cm.

$A_2 = 8$ cm

$A = 8$ cm

$A^2 = A_1^2 + A_2^2 + 2A_1A_2\cos\phi$

$64 = 64 + 64 + 2 \times 64 \cos\phi$.

$64 = 2 \times 64\ (2 + \cos\phi)$

$\cos\phi = -1/2$ $\phi = 120°$

22. **S_1 :** dQ is heat supplied to the system. dU is change in internal energy and dW is work done on the system then according to first Law of thermodynamics. $dQ = dU - dW$

S_2 : First law of thermodynamics is based on conservation of energy.

(1) S_1 is true, S_2 is true and S_2 is correct explanation of S_1

(2) S_1 is true, S_2 is true and S_2 is not correct explanation of S_1

(3) S_1 is false S_2 is true

(4) S_1 and S_2 both false

Ans. (1)

Sol. S_1 is true, S_2 true S_2 true is correct explanation of S_1

23. Threshold wavelength of a metal surface is 5500 A°. Light from the following bulbs is incident on the metal surface.

(I) 10 watt infra-red bulb.

(II) 75 watt infra-red bulb.

(III) 10 watt violet bulb.

(IV) 75 watt ultra-violet bulb.

Which of the following bulbs will be able to eject the electrons?

(1) Only I and II

(2) Only III and IV

(3) Only II and IV

(4) I, II, III, IV All

Ans. (2)

Sol. $\lambda_{th} = 550$nm, So to eject electrons, the wavelength of light should be $\lambda < \lambda_{th}$

$\lambda < 550$nm So ultra-violet and violet light will be able to eject the electrons.

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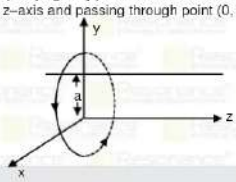
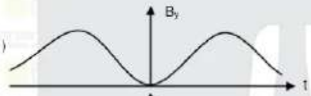
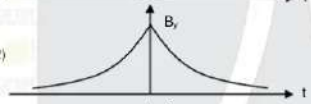
24. A current carrying circular loop is lying in xy plane and its centre is at origin. The y–component of magnetic field on a line parallel to the z–axis and passing through point (0, a, 0) will be



(1)



(2)



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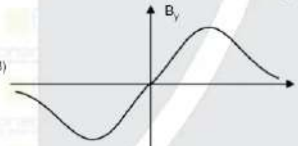

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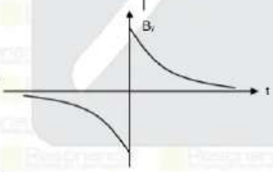
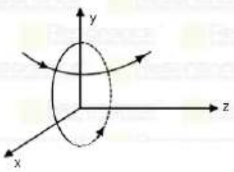
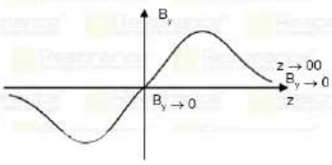


Ans. (3)

Sol.





25. Air is filled in a tyre at temperature 27°C. Its pressure is 270 KPa. If the temperature is raised to 36°C find out the final pressure. (assuming volume constant).

(1) 270 KPa (2) 265 KPa (3) 278 KPa (4) 300 KPa

Ans. (3)

Sol. $PV = nRT$ (ideal gas equation)

For constant volume

$P \propto T$

$$\frac{P_1}{P_2} = \frac{T_1}{T_2}$$

$$\frac{270\text{KPa}}{P_2} = \frac{(273+27)\text{K}}{(273+36)\text{K}}$$

$$P_2 = (270\text{KPa})\left(\frac{309}{300}\right) \approx 278\text{KPa}$$