NEET(UG)–2018 TEST PAPER WITH ANSWER & SOLUTION
(HELD ON SUNDAY 06th MAY, 2018)

PHYSICS

1. An em wave is propagating in a medium with a velocity $\vec{V} = V\hat{i}$. The instantaneous oscillating electric field of this em wave is along +y axis. Then the direction of oscillating magnetic field of the em wave will be along :-
(1) –z direction
(2) +z direction
(3) –y direction
(4) –x direction

Ans. (2)

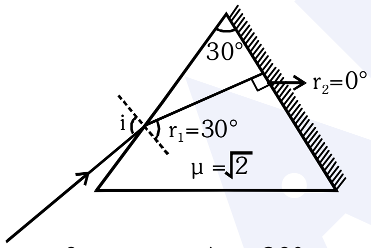
Sol. $\hat{V} = \hat{E} \times \hat{B}$, $\hat{i} = \hat{j} \times \hat{k}$

$\therefore$ $\hat{B} = \hat{k}$, +z direction

2. The refractive index of the material of a prism is $\sqrt{2}$ and the angle of the prism is 30°. One of the two refracting surfaces of the prism is made a mirror inwards, by silver coating. A beam of monochromatic light entering the prism from the other face will retrace its path (after reflection from the silvered surface) if its angle of incidence on the prism is :-
(1) 60° (2) 45° (3) 30° (4) zero

Ans. (2)

Sol.



$r_2 = 0$, $r_1 = A = 30°$

$\sin i = \sqrt{2}\sin 30° = \sqrt{2} \times \frac{1}{2} = \frac{1}{\sqrt{2}}$

$\angle i = 45°$

3. The magnetic potential energy stored in a certain inductor is 25 mJ, when the current in the inductor is 60 mA. This inductor is of inductance :-
(1) 0.138 H (2) 138.88 H
(3) 1.389 H (4) 13.89 H

Ans. (4)

Sol. $PE = \frac{1}{2}LI^2$

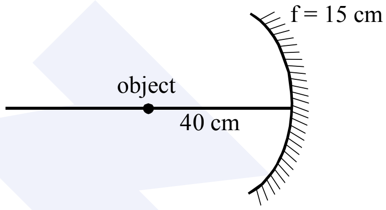
$25 \times 10^{-3} = \frac{1}{2}L(60 \times 10^{-3})^2$

$L = 13.89$ H

4. An object is placed at a distance of 40 cm from a concave mirror of focal length 15 cm. If the object is displaced through a distance of 20 cm towards the mirror, the displacement of the image will be:-
(1) 30 cm away from the mirror
(2) 36 cm away from the mirror
(3) 30 cm towards the mirror
(4) 36 cm towards the mirror

Ans. (2)

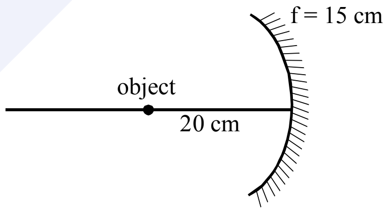
Sol. (i)



0

$v_1 = \frac{uf}{u-f} = \frac{(-40)(-15)}{-40+15} = \frac{600}{-25} = -24\text{cm}$

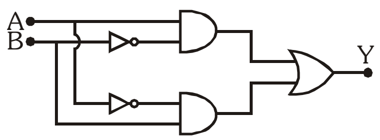
(ii)



$v_2 = \frac{uf}{u-f} = \frac{(-20)(-15)}{-20+15} = -60$ cm

Displacement of image = $v_2 - v_1$ = –36 cm
= 36 cm away from the mirror

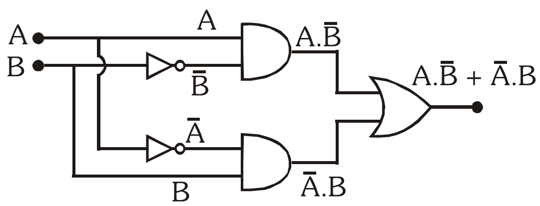
5. In the combination of the following gates the output Y can be written in terms of inputs A and B as :-



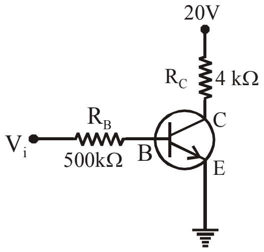
(1) $\overline{A.B}$ (2) $A.\bar{B} + \bar{A}.B$
(3) $\overline{A.B} + A.B$ (4) $\overline{A+B}$

Ans. (2)

Sol.



6. In the circuit shown in the figure, the input voltage V_i is 20 V, V_{BE} = 0 and V_{CE} = 0. The values of I_B, I_C and β are given by :-



(1) I_B = 40 μA, I_C = 10 mA, β = 250
(2) I_B = 25 μA, I_C = 5 mA, β = 200
(3) I_B = 20 μA, I_C = 5 mA, β = 250
(4) I_B = 40 μA, I_C = 5 mA, β = 125

Ans. (4)

Sol. $V_i = I_B R_B + V_{BE}$

$20 = I_B \times (500 \times 10^3) + 0$

$$I_B = \frac{20}{500\times10^3} = 40\mu A$$

$$V_{CC} = I_C R_C + V_{CE}$$

$20 = I_C \times (4 \times 10^3) + 0$

$I_C = 5 \times 10^{-3} = 5$ mA

$$\beta = \frac{I_C}{I_B} = \frac{5\times10^{-3}}{40\times10^{-6}} = 125$$

7. In a p-n junction diode, change in temperature due to heating :-
(1) affects only reverse resistance
(2) affects only forward resistance
(3) does not affect resistance of p-n junction
(4) affects the overall V – I characteristics of p-n junction

Ans. (4)

Sol. Affects the overall V – I characteristics of p-n junction

8. A small sphere of radius 'r' falls from rest in a viscous liquid. As a result, heat is produced due to viscous force. The rate of production of heat when the sphere attains its terminal velocity, is proportional to :-
(1) r^3 (2) r^2 (3) r^5 (4) r^4

Ans. (3)

Sol. Rate of heat produced

$$\frac{dQ}{dt} = F_v \times V_T \qquad \because V_T = \frac{2r^2}{9\eta}(\rho-\sigma)g$$

$= 6\pi\eta r V_T \times V_T \qquad \therefore V_T \propto r^2$

$$\frac{dQ}{dt} \propto rV_T^2 \qquad \because V_T \propto r^2$$

$$\frac{dQ}{dt} \propto r^5$$

9. A sample of 0.1 g of water at 100°C and normal pressure (1.013×10^5 Nm^{-2}) requires 54 cal of heat energy to convert to steam at 100°C. If the volume of the steam produced is 167.1 cc, the change in internal energy of the sample, is :-
(1) 104.3 J (2) 208.7 J
(3) 42.2 J (4) 84.5 J

Ans. (2)

Sol. ΔQ = 54 cal = 54 × 4.18 joule = 225.72 joule

$\Delta W = P[V_{steam} - V_{water}]$ [For water 0.1 gram=0.1 cc]

$= 1.013 \times 10^5[167.1 \times 10^{-6} - 0.1 \times 10^{-6}]$ joule

$= 1.013 \times 167 \times 10^{-1} = 16.917$ joule

By FLOT

$\Rightarrow \Delta U = \Delta Q - \Delta W = 225.72 - 16.917$

$\Delta U = 208.8$ joule

10. Two wires are made of the same material and have the same volume. The first wire has cross-sectional area A and the second wire has cross-sectional area 3A. If the length of the first wire is increased by Δl on applying a force F, how much force is needed to stretch the second wire by the same amount ?
(1) 9F (2) 6F (3) 4F (4) F

Ans. (1)

Sol. $$Y = \frac{F\ell}{A\Delta\ell}$$

$\because V = A\ell$ so $\ell = \frac{V}{A}$

$$F = \frac{YA\Delta\ell}{\ell} = \frac{YA^2\Delta\ell}{V}$$

$$\frac{F_1}{F_2} = \left(\frac{A_1}{A_2}\right)^2 \Rightarrow \frac{F}{F_2} = \left(\frac{A}{3A}\right)^2 = \frac{1}{9}$$

$F_2 = 9F$

11. The power radiated by a black body is P and it radiates maximum energy at wavelength λ_0. If the temperature of the black body is now changed so that it radiates maximum energy at wavelength $\frac{3}{4}\lambda_0$, the power radiated by it becomes nP. The value of n is :-
(1) $\frac{3}{4}$ (2) $\frac{4}{3}$ (3) $\frac{256}{81}$ (4) $\frac{81}{256}$

Ans. (3)

Sol. $P = \sigma A T^4 \Rightarrow P \propto T^4$

According to Wein's law $T \propto \frac{1}{\lambda_m}$

$$\Rightarrow P \propto \left(\frac{1}{\lambda_m}\right)^4 \Rightarrow \frac{P_2}{P_1} = \left(\frac{\lambda_{m_1}}{\lambda_{m_2}}\right)^4$$

$$\Rightarrow \frac{P_2}{P_1} = \left(\frac{\lambda_0}{\frac{3}{4}\lambda_0}\right)^4 \Rightarrow \frac{nP}{P} = \frac{256}{81} \Rightarrow n = \frac{256}{81}$$

12. A set of 'n' equal resistors, of value 'R' each, are connected in series to a battery of emf 'E' and internal resistance 'R'. The current drawn is I. Now, the 'n' resistors are connected in parallel to the same battery. Then the current drawn from battery becomes 10 I. The value of 'n' is :-

(1) 10 (2) 11
(3) 20 (4) 9

Ans. (1)

Sol. $I = \dfrac{E}{nR + R}$ ..... (1)

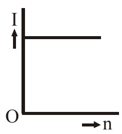
$10I = \dfrac{E}{\frac{R}{n} + R} = \dfrac{nE}{R + nR}$ .....(2)

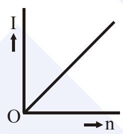
From (1) & (2),

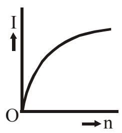
$n\dfrac{E}{R + nR} = 10\left(\dfrac{E}{nR + R}\right)$

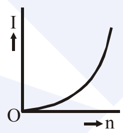
n = 10

13. A battery consists of a variable number 'n' of identical cells (having internal resistance 'r' each) which are connected in series. The terminals of the battery are short-circuited and the current I is measured. Which of the graphs shows the correct relationship between I and n ?

(1) 

(2) 

(3) 

(4) 

Ans. (1)

Sol. $I = \dfrac{nE}{nr} = \dfrac{E}{r} = \text{constant}$

14. A carbon resistor (47 ± 4.7) kΩ is to be marked with rings of different colours for its identification. The colour code sequence will be :-

(1) Violet – Yellow – Orange – Silver
(2) Yellow – Violet – Orange – Silver
(3) Yellow – Green – Violet – Gold
(4) Green – Orange – Violet – Gold

Ans. (2)

Sol. $R = (47 \pm 4.7) \times 10^3$

$R = 47 \times 10^3 \pm 10\% \,\Omega$

As per color code, 3 - Orange, 4 - Yellow, 7 - Violet, 10% - Silver

15. Which one of the following statements is ***incorrect*** ?

(1) Rolling friction is smaller than sliding friction
(2) Limiting value of static friction is directly proportional to normal reactions
(3) Frictional force opposes the relative motion
(4) Coefficient of sliding friction has dimensions of length

Ans. (4)

Sol. Coefficient of sliding friction has no dimension

16. A moving block having mass m, collides with another stationary block having mass 4m. The lighter block comes to rest after collision. When the initial velocity of the lighter block is v, then the value of coefficient of resistitution (e) will be :-

(1) 0.5 (2) 0.25
(3) 0.8 (4) 0.4

Ans. (2)

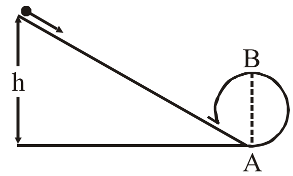
Sol. By conservation of linear momentum

$mv = 4mv' \Rightarrow v' = \dfrac{v}{4}$

coefficient of restitution (e) = $\dfrac{\text{Velocity of separation}}{\text{Velocity of approach}}$

$= \dfrac{\frac{v}{4} - 0}{v - 0} = \dfrac{1}{4} = 0.25$

17. A body initially at rest and sliding along a frictionless track from a height h (as shown in the figure) just completes a vertical circle of diameter AB = D. The height h is equal to :-



(1) $\dfrac{3}{2}D$ (2) D (3) $\dfrac{7}{5}D$ (4) $\dfrac{5}{4}D$

Ans. (4)

Sol. To complete a vertical circle, speed at A should be

$v_A = \sqrt{5gR}$

using energy conservation

$mgh = \dfrac{1}{2}mv_A^2$

$h = \dfrac{1}{2}\dfrac{v_A^2}{g} = \dfrac{1}{2}\dfrac{5g}{g}\dfrac{D}{2}$ $\left(R = \dfrac{D}{2}\right)$

$h = \dfrac{5D}{4}$

18. Three objects, A : (a solid sphere), B : (a thin circular disk) and C = (a circular ring), each have the same mass M and radius R. They all spin with the same angular speed ω about their own symmetry axes. The amounts of work (W) required to bring them to rest, would satisfy the relation :-

(1) $W_C > W_B > W_A$ (2) $W_A > W_B > W_C$
(3) $W_B > W_A > W_C$ (4) $W_A > W_C > W_B$

Ans. (1)

Sol. W = loss in KE = $\frac{1}{2}I\omega^2$

$I_A = \frac{2}{5}MR^2 = 0.4MR^2$

$I_B = \frac{1}{2}MR^2 = 0.5MR^2$

$I_C = MR^2$

$\therefore$ $W_C > W_B > W_A$

19. A tuning fork is used to produce resonance in a glass tube. The length of the air column in this tube can be adjusted by a variable piston. At room temperature of 27°C two successiv resonances are produced at 20 cm and 73 cm column length. If the frequency of the tuning fork is 320 Hz, the velocity of sound in air at 27°C is :-

(1) 330 m/s (2) 339 m/s
(3) 350 m/s (4) 300 m/s

Ans. (2)

Sol. $V = 2f(\ell_2 - \ell_1)$

$= 2(320) \times (0.73 - 0.20)$

$= (640) \times (0.53) = 339.2$ m/s

20. An electron falls from rest through a vertical distance h in a uniform and vertically upward directed electric field E. The direction of electrical field is now reversed, keeping its magnitude the same. A proton is allowed to fall from rest in through the same vertical distance h. The time fall of the electron, in comparison to the time fall of the proton is :-

(1) smaller (2) 5 times greater
(3) 10 times greater (4) equal

Ans. (1)

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

$h = 0 + \frac{1}{2}\left(\frac{qE}{m}\right)t^2 \Rightarrow t = \sqrt{\frac{2hm}{qE}} \Rightarrow t \propto \sqrt{m}$

as mass of proton is heavier than electron, hence electron will take less time.

21. A pendulum is hung from the roof of a sufficiently high building and is moving freely to and fro like a simple harmonic oscillator. The acceleration of the bob of the pendulum is 20 m/s^2 at a distance of 5 m from the mean position. The time period of oscillation is :-

(1) 2π s (2) π s
(3) 2 s (4) 1 s

Ans. (2)

Sol. $|a| = \omega^2 x$

$20 = \omega^2 5 \Rightarrow \omega^2 = 4 \Rightarrow \omega = 2 \Rightarrow \frac{2\pi}{T} = 2$

T = π sec

22. The electrostatic force between the metal plates of an isolated parallel plate capacitor C having a charge Q and area A, is :-

(1) independent of the distance between the plates.
(2) linearly proportional to the distance between the plates
(3) proportional to the square root of the distance between the plates.
(4) inversely proportional to the distance between the plates.

Ans. (1)

Sol. F = QE

$F = Q\frac{\sigma}{2\epsilon_0} = \frac{Q^2}{2A\epsilon_0}$

$\therefore$ Electrostatic force is independent of distance between plates

23. An electron of mass m with an initial velocity $\vec{V} = V_0\hat{i}(V_0 > 0)$ enters an electric field $\vec{E} = -E_0\hat{i}$ (E_0 = constant >0) at t = 0. If λ_0 is its de-Broglie wavelength initially, then its de-Broglie wavelength at time t is :-

(1) $\frac{\lambda_0}{\left(1 + \frac{eE_0}{mV_0}t\right)}$ (2) $\lambda_0\left(1 + \frac{eE_0}{mV_0}t\right)$

(3) $\lambda_0 t$ (4) λ_0

Ans. (1)

Sol. $\vec{V} = V_0\hat{i}$

$\vec{E} = -E_0\hat{i}$

$$\vec{a} = \frac{\vec{F}}{m} = \frac{q\vec{E}}{m} = \frac{(-e)(-E_0)\hat{i}}{m}$$

$$\boxed{\vec{a} = \frac{eE_0}{m}\hat{i}}$$

V = u + at

$$\boxed{V = V_0 + \frac{eE_0}{m}t}$$

$$\lambda = \frac{h}{mv}$$

$$= \frac{h}{m\left[V_0 + \frac{eE_0 t}{m}\right]} = \frac{h}{mV_0\left[1 + \frac{eE_0 t}{mV_0}\right]} = \frac{\lambda_0}{1 + \frac{eE_0 t}{mV_0}}$$

24. For a radioactive material, half-life is 10 minutes. If initially there are 600 number of nuclei, the time taken (in minutes) for the disintegration of 450 nuclei is :-

(1) 20 (2) 10

(3) 30 (4) 15

Ans. (1)

Sol. $N_0 = 600$, $N' = 450$

$N = N_0 - N'$

$$\boxed{N = 150}$$

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/T_H} \Rightarrow \frac{150}{600} = \left(\frac{1}{2}\right)^{t/10}$$

$$\Rightarrow \frac{1}{4} = \left(\frac{1}{2}\right)^{t/10} \Rightarrow \left(\frac{1}{2}\right)^2 = \left(\frac{1}{2}\right)^{t/10}$$

$$2 = \frac{t}{10} \Rightarrow t = 20 \text{ min}$$

25. When the light of frequency $2\nu_0$ (where ν_0 is threshold frequency), is incident on a metal plate, the maximum velocity of electrons emitted is v_1. When the frequency of the incident radiation is increased to $5\nu_0$, the maximum velocity of electrons emitted from the same plate is v_2. The ratio of v_1 to v_2 is :-

(1) 1 : 2 (2) 1 : 4

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

Ans. (1)

Sol. From Einstein's equation of PEE

$$\frac{1}{2}mv_1^2 = 2h\nu_0 - h\nu_0 \quad \text{or} \quad \frac{1}{2}mv_1^2 = h\nu_0 \quad ...(1)$$

$$\frac{1}{2}mv_2^2 = 5h\nu_0 - h\nu_0 \quad \text{or} \quad \frac{1}{2}mv_2^2 = 4h\nu_0 \quad ...(2)$$

(1) ÷ (2)

$$\frac{v_1}{v_2} = \sqrt{\frac{1}{4}} = \frac{1}{2}$$

26. the ratio of kinetic energy to the total energy of an electron in a Bohr orbit of the hydrogen atom, is :-

(1) 1 : 1 (2) 1 : –1

(3) 2 : –1 (4) 1 : –2

Ans. (2)

Sol. $E_{total} = -KE$

$$\frac{KE}{E_{Total}} = \frac{1}{-1}$$

27. The moment of the force, $\vec{F} = 4\hat{i} + 5\hat{j} - 6\hat{k}$ at (2, 0, –3), about the point (2, –2, –2), is given by:-

(1) $-8\hat{i} - 4\hat{j} - 7\hat{k}$

(2) $-4\hat{i} - \hat{j} - 8\hat{k}$

(3) $-7\hat{i} - 8\hat{j} - 4\hat{k}$

(4) $-7\hat{i} - 4\hat{j} - 8\hat{k}$

Ans. (4)

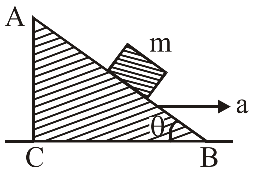
Sol. $\vec{F} = 4\hat{i} + 5\hat{j} - 6\hat{k}$

$$\vec{r} = (2-2)\hat{i} + (0-(-2))\hat{j} + (-3-(-2))\hat{k} \;=\; 2\hat{j} - 1\hat{k}$$

$$\vec{r} \times \vec{F} = (2\hat{j} - 1\hat{k}) \times (4\hat{i} + 5\hat{j} - 6\hat{k})$$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 2 & -1 \\ 4 & 5 & -6 \end{vmatrix} = -7\hat{i} - 4\hat{j} - 8\hat{k}$$

28. A block of mass m is placed on a smooth inclined wedge ABC of inclination θ as shown in the figure. The wedge is given an acceleration 'a' towards the right. The relation between a and θ for the block to remain stationary on the wedge is :-

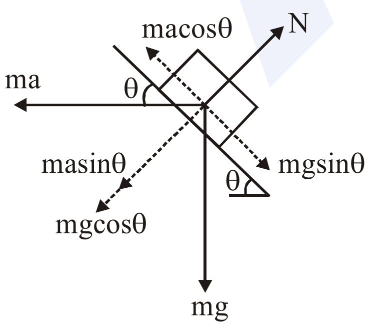


(1) $a = \dfrac{g}{\operatorname{cosec}\theta}$ (2) $a = \dfrac{g}{\sin\theta}$

(3) $a = g\cos\theta$ (4) $a = g\tan\theta$

Ans. **(4)**

Sol. Using pseudo force



$ma\cos\theta = mg\sin\theta$

$\boxed{a = g\tan\theta}$

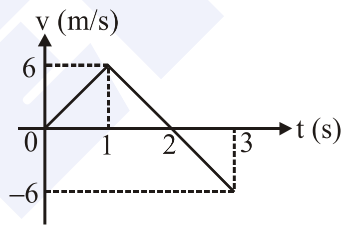
29. A toy car with charge q moves on a frictionless horizontal plane surface under the influence of a uniform electric field $\vec{E}$. Due to the force $q\vec{E}$, its velocity increases from 0 to 6 m/s in one second duration. At that instant the direction of the field is reversed. The car continues to move for two more seconds under the influence of this field. The average velocity and the average speed of the toy car between 0 to 3 seconds are respectively :-

(1) 2 m/s, 4 m/s (2) 1 m/s, 3 m/s

(3) 1 m/s, 3.5 m/s (4) 1.5 m/s, 3 m/s

Ans. **(2)**

Sol. $0 < t < 1s$: velocity increases from 0 to 6 m/s
$1 < t < 2s$: velocity decreases from 6 to 0 m/s but car continues to move forward
$2 < t < 3s$: since field strength is same ⇒ same acceleration ∴ car's velocity increases from 0 to −6 m/s



Distance travelled in first second

$$S = \left(\frac{u+v}{2}\right)t = \left(\frac{0+6}{2}\right)(1) = 3m$$

Distance = 9 m so average speed = $\dfrac{9m}{3s} = 3m/s$

Displacement = 3m so average velocity = $\dfrac{3m}{3s}$ = 1 m/s

30. A student measured the diameter of a small steel ball using a screw gauge of least count 0.001 cm. The main scale reading is 5 mm and zero of circular scale division coincides with 25 divisions above the reference level. If screw gauge has a zero error of – 0.004 cm, the correct diameter of the ball is :-

(1) 0.521 cm (2) 0.525 cm

(3) 0.053 cm (4) 0.529 cm

Ans. **(4)**

Sol. Reading of screw gauge
= MSR + VSR × LC + zero error
= 0.5 cm + 25 × 0.001 cm + 0.004 cm
= 0.529 cm

31. Unpolarised light is incident from air on a plane surface of a material of refractive index 'μ'. At a particular angle of incidence 'i', it is found that the reflected and refracted rays are perpendicular to each other. Which of the following options is correct for this situation ?

(1) Reflected light is polarised with its electric vector parallel to the plane of incidence

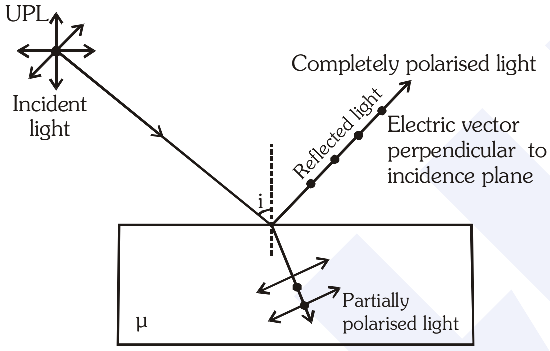
(2) Reflected light is polarised with its electric vector perpendicular to the plane of incidence

(3) $i = \sin^{-1}\left(\frac{1}{\mu}\right)$

(4) $i = \tan^{-1}\left(\frac{1}{\mu}\right)$

Ans. **(2)**

Sol.



32. In Young's double slit experiment the separation d between the slits is 2 mm, the wavelength λ of the light used is 5896 Å and distance D between the screen and slits is 100 cm. It is found that the angular width of the fringes is 0.20°. To increase the fringe angular width to 0.21° (with same λ and D) the separation between the slits needs to be changed to :-

(1) 1.8 mm (2) 1.9 mm
(3) 2.1 mm (4) 1.7 mm

Ans. **(2)**

Sol. $\theta = \frac{\lambda}{d}$, $\frac{\theta_1}{\theta_2} = \frac{d_2}{d_1}$

$$\frac{0.20}{0.21} = \frac{d_2}{2} \Rightarrow d_2 = \frac{0.20}{0.21} \times 2 = 1.9 \text{ mm}$$

33. An astronomical refracting telescope will have large angular magnification and high angular resolution, when it has an objective lens of :-

(1) small focal length and large diameter
(2) large focal length and small diameter
(3) large focal length and large diameter
(4) small focal length and small diameter

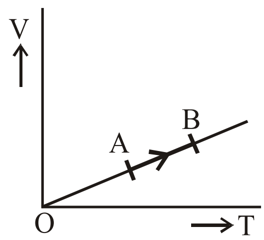
Ans. **(3)**

Sol. For astronomical refracting telescope

- Angular magnification is more for large focal length of objective lens $\left(M.P. = \frac{f_0}{f_e}\right)$
- Resolving power $= \frac{d}{1.22\,\lambda}$

Resolving power is high for large diameter.

34. The volume (V) of a monatomic gas varies with its temperature (T), as shown in the graph. The ratio of work done by the gas, to the heat absorbed by it, when it undergoes a change from state A to state B, is :-



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

Ans. **(1)**

Sol. $V \propto T$

isobaric process

$W = P\Delta V = \mu R\Delta T$

$\Delta Q = \mu C_P \Delta T$

for mono atomic gas f = 3

$$C_P = \left(\frac{f}{2}R + R\right) = \frac{5}{2}R$$

So $\frac{W}{\Delta Q} = \frac{\mu R\Delta T}{\mu C_P \Delta T} = \frac{2}{5}$

35. The fundamental frequency in an open organ pipe is equal to the third harmonic of a closed organ pipe. If the length of the closed organ pipe is 20 cm, the length of the open organ pipe is :-

(1) 13.2 cm (2) 8 cm

(3) 12.5 cm (4) 16 cm

Ans. (1)

Sol. $f_{oop} = 3f_{cop}$

$$\frac{V}{2\ell_{oop}} = \frac{3V}{4\ell_{cop}}$$

$$\ell_{oop} = \frac{2}{3} \times \ell_{cop} = \frac{2}{3} \times 20 = 13.3 \text{ cm}$$

36. The efficiency of an ideal heat engine working between the freezing point and boiling point of water, is :-

(1) 26.8% (2) 20%

(3) 6.25% (4) 12.5%

Ans. (1)

Sol. $\eta = \frac{T_1 - T_2}{T_1} \times 100$

$T_1 = 373$, $T_2 = 273$

$$\eta = \frac{100}{373} \times 100 = 26.8\%$$

37. At what temperature will the rms speed of oxygen molecules become just sufficient for escaping from the Earth's atmosphere ?

(Given :

Mass of oxygen molecule (m) = 2.76×10^{-26} kg

Boltzmann's constant $k_B = 1.38 \times 10^{-23}$ J K^{-1}) :-

(1) 2.508×10^4 K

(2) 8.360×10^4 K

(3) 5.016×10^4 K

(4) 1.254×10^4 K

Ans. (2)

Sol. $V_{es} = V_{rms}$

$$11.2 \times 10^3 = \sqrt{\frac{3kT}{m}} \Rightarrow T = \frac{(11.2 \times 10^3)^2 m}{3k}$$

Putting value of m and k

$T = 8.360 \times 10^4$ k

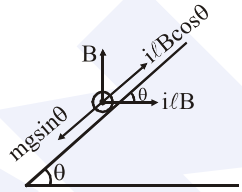
38. A metallic rod of mass per unit length 0.5 kg m^{-1} is lying horizontally on a smooth inclined plane which makes an angle of 30° with the horizontal. The rod is not allowed to slide down by flowing a current through it when a magnetic field of induction 0.25T is acting on it in the vertical direction. The current flowing in the rod to keep is stationary is

(1) 7.14 A (2) 5.98 A

(3) 14.76 A (4) 11.32 A

Ans. (4)

Sol.



$i\ell B \cos\theta = mg\sin\theta$

$$i = \frac{mg}{\ell B}\tan\theta = \left(\frac{m}{\ell}\right)\frac{g\tan\theta}{B}$$

$$i = 0.5 \times \frac{9.8}{0.25} \times \frac{1}{\sqrt{3}} = 11.3 \text{ amp.}$$

39. An inductor 20 mH, a capacitor 100 μF and a resistor 50 Ω are connected in series across a source of emf, V = 10 sin 314 t. The power loss in the circuit is

(1) 0.79 W (2) 0.43 W

(3) 2.74 W (4) 1.13 W

Ans. (1)

Sol. $V_0 = 10V$, $\omega = 314$ rad/s

$P = V_{rms}\, i_{rms} \cos\phi$

$$= V_{rms}\left(\frac{V_{rms}}{Z}\right)\left(\frac{R}{Z}\right) = \frac{(V_{rms})^2 R}{Z^2}$$

$X_L = \omega L = (314)(20 \times 10^{-3}) = 6.280$

$$X_C = \frac{1}{\omega C} = \frac{1}{314 \times 100 \times 10^{-6}} = 31.84\Omega$$

$R = 50\Omega$

$$Z = \sqrt{(X_C - X_L)^2 + R^2}$$

$$= \sqrt{(31.84 - 6.28)^2 + (50)^2} = 56\Omega$$

$$\Rightarrow P = \frac{\left(\frac{10}{\Omega}\right)^2 \times 50}{(56)^2} = 0.79 \text{ W}$$

40. A thin diamagnetic rod is placed vertically between the poles of an electromagnet. When the current in the electromagnet is switched on, then the diamagnetic rod is pushed up, out of the horizontal magnetic field. Hence the rod gains gravitational potential energy. The work required to do this comes from

(1) the current source
(2) the magnetic field
(3) the lattice structure of the material of the rod
(4) the induced electric field due to the changing magnetic field

Ans. (1)

Sol. When current source is switched on, magnetic field sets up between poles on electromagnet.
Diamagnetic material, due to its tendency to move from stronger to weaker field, is thus repelled out.

41. Current sensitivity of a moving coil galvanometer is 5 div/mA and its voltage sensitivity (angular deflection per unit voltage applied) is 20 div/V. The resistance of the galvanometer is

(1) 40 Ω (2) 25 Ω (3) 250 Ω (4) 500 Ω

Ans. (3)

Sol. $\frac{\theta}{i}=\frac{50}{10^{-3}}=5000$, $\frac{\theta}{V}=20$

$\Rightarrow \frac{\theta/i}{\theta/V}=\frac{5000}{10}=250 \Rightarrow \frac{V}{i}=R=250\Omega$

42. If the mass of the Sun were ten times smaller and the universal gravitational constant were ten time larger in magnitude, which of the following is ***not*** correct ?

(1) Raindrops will fall faster
(2) Walking on the ground would become more difficult
(3) Time period of a simple pendulum on the Earth would decrease
(4) 'g' on the Earth will not change

Ans. (4)

Sol. $m_s' = \frac{m_s}{10}$ & G' = 10 G

$$g_E=\frac{G'M_E}{R^2}=\frac{10GM_E}{R^2}=10g$$

∴ Raindrops will fall faster, Walking on the ground would become more difficult, Time period of a simple pendulum on the earth would decrease.

43. A solid sphere is in rolling motion. In rolling motion a body possesses translational kinetic energy (K_t) as well as rotational kinetic energy (K_r) simultaneously. The ratio K_t : (K_t + K_r) for the sphere is

(1) 7 : 10 (2) 5 : 7
(3) 10 : 7 (4) 2 : 5

Ans. (2)

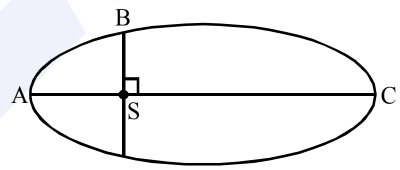
Sol. If I_{cn} = nMR^2

$I_{solid}=\frac{2}{5}mR^2$ $n=\frac{2}{5}$

$$\frac{K.E_{Rot}}{K.E_{Total}}=\frac{n}{n+1}$$

$$\frac{K.E_{Trans}}{K.E_{Total}}=\frac{1}{n+1}=\frac{1}{\frac{2}{5}+1}=\frac{5}{7}$$

44. The kinetic energies of a planet in an elliptical orbit about the Sun, at positions A, B and C are K_A, K_B and K_C respectively. AC is the major axis and SB is perpendicular to AC at the position of the Sun S as shown in the figure. Then



(1) $K_A < K_B < K_C$ (2) $K_A > K_B > K_C$
(3) $K_B < K_A < K_C$ (4) $K_B > K_A > K_C$

Ans. (2)

Sol. L = muv = Iω = constant

$$KE=\frac{L^2}{2I}$$

$I_A < I_B < I_C$

$KE_A > KE_B > KE_C$

45. A solid sphere is rotating freely about its symmetry axis in free space. The radius of the sphere is increased keeping its mass same. Which of the following physical quantities would remain constant for the sphere ?

(1) Angular velocity
(2) Moment of inertia
(3) Rotational kinetic energy
(4) Angular momentum

Ans. (4)

Sol. I = $\frac{2}{5}mR^2$

$\tau_{ext}=0 \Rightarrow$ L = constant