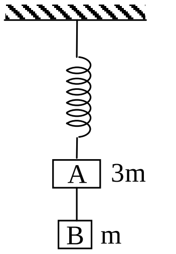
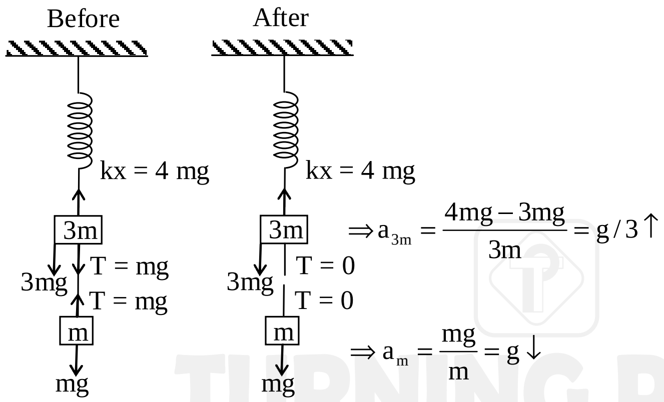
91. Two blocks A and B of masses 3m and m respectively are connected by a massless and inextensible string. The whole system is suspended by a massless spring as shown in figure. The magnitudes of acceleration of A and B immediately after the string is cut, are respectively.



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

Sol. [2]



92. The acceleration due to gravity at a height 1 km above the earth is the same as at a depth d below the surface of earth. Then:

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

Sol. [4]

Outside the earth, $g = g_0\left(1 - \frac{2h}{R}\right)$

Inside the earth, $g = g_0\left(1 - \frac{d}{R}\right)$

for same value of g, $\frac{2h}{R} = \frac{d}{R}$

$\Rightarrow \; d = 2h = 2\text{km}$

93. A particle executes linear simple harmonic motion with an amplitude of 3 cm. When the particle is at 2 cm from the mean position, the magnitude of its velocity is equal to that of its acceleration. Then its time period in seconds is:

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

Sol. [3]

At distance x from mean position,

$\omega\sqrt{A^2 - x^2} = \omega^2 x$

$\Rightarrow A^2 - x^2 = \omega^2 x^2$

$\Rightarrow \omega = \sqrt{\frac{A^2 - x^2}{x^2}} = \sqrt{\frac{3^2 - 2^2}{2^2}} = \frac{\sqrt{5}}{2}$

$\Rightarrow T = \frac{2\pi}{\omega} = \frac{4\pi}{\sqrt{5}}\text{sec}$

94. The resistance of a wire is 'R' ohm. If it is melted and stretched to 'n' times its original length, its new resistance will be:

(1) nR (2) $\frac{R}{n}$ (3) n^2R (4) $\frac{R}{n^2}$

Sol. [3]

Volume of wire remain same, thus $A = \frac{V}{\ell}$

Or, $R = \frac{\ell}{A}\rho = \rho\frac{\ell^2}{V}$

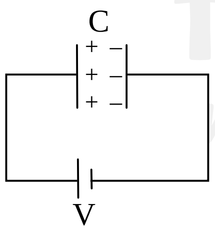
$\Rightarrow R \propto \ell^2$ or $R' = n^2R$

95. A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of resulting system:

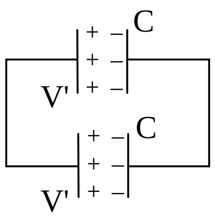
(1) increases by a factor of 4
(2) decreases by a factor of 2
(3) remains the same
(4) increase by a factor of 2

Sol. [2]

Initial energy of system, $U_i = \frac{1}{2}CV^2$



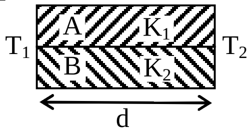
when another capacitor is connected in parallel,



$V' = \frac{CV + 0}{C + C} = \frac{V}{2}$

final energy of system, $U_f = \frac{1}{2}(2C)V'^2 = \frac{1}{4}CV^2$

96. Two rods A and B of different materials are welded together as shown in figure. Their thermal conductivities are K_1 and K_2. The thermal conductivity of the composite rod will be:



(1) $\frac{K_1 + K_2}{2}$ (2) $\frac{3(K_1 + K_2)}{2}$ (3) $K_1 + K_2$ (4) $2(K_1 + K_2)$

Sol. [1]

Since rods are in parallel, then

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\Rightarrow \frac{K(2A)}{d} = \frac{K_1 A}{d} + \frac{K_2 A}{d}$$

$$\Rightarrow K = \frac{K_1 + K_2}{2}$$

97. The two nearest harmonics of a tube closed at one end and open at other end are 220 Hz and 260 Hz. What is the fundamental frequency of the system.

(1) 10 Hz (2) 20 Hz (3) 30 Hz (4) 40 Hz

Sol. [2]

For closed organ pipe, difference in successive frequencies is equals to twice of fundamental frequency. Then, $2f_0 = 40 \Rightarrow f_0 = 20\text{Hz}$

98. The bulk modulus of a spherical object is 'B'. If it is subjected to uniform pressure 'p', the fractional decrease in radius is:

(1) $\frac{P}{B}$ (2) $\frac{B}{3p}$ (3) $\frac{3p}{B}$ (4) $\frac{P}{3B}$

Sol. [4]

Since, $B = \frac{\Delta P}{-\Delta V / V}$ or $\frac{-\Delta V}{V} = \frac{\Delta P}{B} = \frac{P}{B}$

$$\because \quad -\frac{\Delta r}{r} = -\frac{1}{3}\frac{\Delta V}{V} = \frac{P}{3B}$$

99. A physical quantity of the dimensions of length that can be formed out of c, G and $\frac{e^2}{4\pi \epsilon_0}$ is

[c is velocity of light, G is universal constant of gravitation and e is charge]:

(1) $\frac{1}{c^2}\left[G\frac{e^2}{4\pi \epsilon_0}\right]^{1/2}$ (2) $c^2\left[G\frac{e^2}{4\pi \epsilon_0}\right]^{1/2}$ (3) $\frac{1}{c^2}\left[\frac{e^2}{G4\pi \epsilon_0}\right]^{1/2}$ (4) $\frac{1}{c}G\frac{e^2}{4\pi \epsilon_0}$

Sol. [1]

$$L = K[c]^p[G]^q\left[\frac{e^2}{4\pi\varepsilon_0}\right]^r$$

$$\Rightarrow \quad M^0L^1T^0 = \left[L^1T^{-1}\right]^p\left[M^{-1}L^3T^{-2}\right]^q\left[M^1L^3T^{-2}\right]^r$$

$\Rightarrow \quad -q + r = 0 \quad \Rightarrow \quad q = r$

$\quad p + 3q + 3r = 1 \quad \Rightarrow \quad 6q = -p + 1$

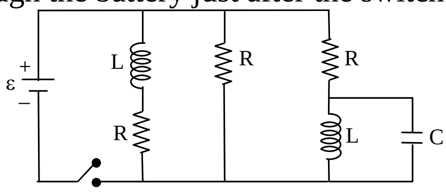
and $\quad -p - 2q - 2r = 0 \Rightarrow \quad p = -4q$

By solving them, $p = -2$, $q = \dfrac{1}{2}$ and $r = \dfrac{1}{2}$

Thus, $L = K\dfrac{1}{C^2}\sqrt{\dfrac{Ge^2}{4\pi\varepsilon_0}}$

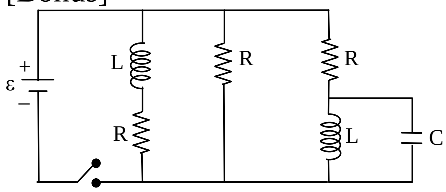
where K is a dimensionless constant

100. Figure shows a circuit that contains three identical resistors with resistance R = 9.0 Ω each, two identical inductors with inductance L = 2.0 mH each, and an ideal battery with emf ε = 18 V. The current 'i' through the battery just after the switch closed is....

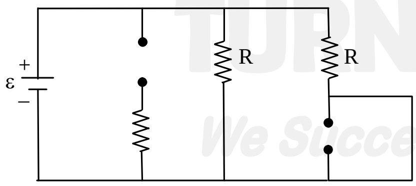


(1) 2 mA (2) 0.2 A (3) 2 A (4) 0 ampere

Sol. [Bonus]



when switch is closed, inductor provides infinite resistance and capacitor provides zero resistance.



Thus, current through battery, $I = \dfrac{\varepsilon}{R/2} = \dfrac{2E}{R} = 4A$

101. One end of string of length *l* is connected to a particle of mass 'm' and the other end is connected to a small peg on a smooth horizontal table. If the particle moves in circle with speed 'υ', the net force on the particle (directed towards center) will be (T represents the tension in the string)

(1) T (2) $T + \dfrac{m\upsilon^2}{\ell}$ (3) $T - \dfrac{m\upsilon^2}{\ell}$ (4) Zero

Sol. [1]

Net force on the particle = $T = \dfrac{mv^2}{\ell}$

102. The photoelectric threshold wavelength of silver is 3250×10^{-10} m. The velocity of the electron ejected from a silver surface by ultraviolet light of wavelength 2536×10^{-10} m is: (Given $h = 4.14 \times 10^{-15}$ eVs and $c = 3 \times 10^{8}\ ms^{-1}$)

(1) $\approx 6\times10^5\ ms^{-1}$ (2) $\approx 0.6\times10^6\ ms^{-1}$ (3) $\approx 61\times10^3\ ms^{-1}$ (4) $\approx 0.3\times10^6\ ms^{-1}$

Sol. [1], [2]

$$\phi = \frac{hc}{\lambda_0} = \frac{12400}{3250} = 3.81 \text{ eV}$$

Kinetic energy of electrons,

$$K = \frac{hc}{\lambda} - \phi$$

$$= \frac{12400}{2536} - 3.31 = 1.08 \text{ eV} = 1.73 \times 10^{-19} \text{ J}$$

$$\Rightarrow \quad V = \sqrt{\frac{2 \times 1.73 \times 10^{-19}}{9.1 \times 10^{-31}}} = 0.6 \times 10^{6} \text{ m/s} = 6 \times 10^{5} \text{ m/s}$$

103. Radioactive material 'A' has decay constant '8 λ' and material 'B' has decay constant 'λ'. Initially they have same number of nuclei. After what time, the ratio of number of nuclei of material 'B' to that 'A' will be $\frac{1}{e}$?

(1) $\frac{1}{\lambda}$ (2) $\frac{1}{7\lambda}$ (3) $\frac{1}{8\lambda}$ (4) $\frac{1}{9\lambda}$

Sol. [2]

After time t, $N_A = N_0 e^{-\lambda_A t}$

& $N_B = N_0 e^{-\lambda_B t}$

Since, $\frac{N_B}{N_A} = e$

$$\Rightarrow \quad \frac{e^{-\lambda_B t}}{e^{-\lambda_A t}} = e$$

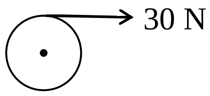
$$\Rightarrow \quad (\lambda_A - \lambda_B)t = 1$$

$$\Rightarrow \quad t = \frac{1}{\lambda_A - \lambda_B} = \frac{1}{7\lambda}$$

104. A rope is would around a hollow cylinder of mass 3 kg and radius 40 cm. What is the angular acceleration of the cylinder if the rope is pulled with a force of 30 N?

(1) 25 m/s^2 (B) 0.25 rad/s^2 (C) 25 rad/s^2 (D) 5 m/s^2

Sol. [3]

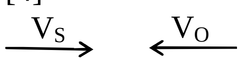


$$\alpha = \frac{\tau}{I} = \frac{FR}{mR^2} = \frac{F}{mR} = \frac{30}{3 \times 0.4} = 25 \text{ rad/s}^2$$

105. Two cars moving in opposite directions approach each other with speed of 22 m/s and 16.5 m/s respectively. The driver of the first car blows a horn having a frequency 400 Hz. The frequency heard by the driver of the second car is [velocity of sound 340 m/s]:

(1) 350 Hz (2) 361 Hz (3) 411 Hz (4) 448 Hz

Sol. [4]



$$f' = f\left[\frac{V + V_O}{V - V_S}\right] = 400\left[\frac{340 + 16.5}{340 - 22}\right]$$

$$= 400 \times \frac{356.5}{318} = 448\,\text{Hz}$$

106. A 250 - Turn rectangular coil of length 2.1 cm and width 1.25 cm carries a current of 85 μA and subjected to a magnetic field of strength 0.85 T. Work done for rotating the coil by 180° against the torque is:

(1) 9.1 μJ (2) 4.55 μJ (3) 2.3 μJ (4) 1.15 μJ

Sol. [1]

$$W = MB(\cos 0° - \cos 180°) = 2\,MB$$

$$= 2(NBIA) = 2 \times 250 \times 0.85 \times 85 \times 10^{-6} \times 2.1 \times 1.25 \times 10^{-4}$$

$$= 9.48 \times 10^{-6}\,\text{J} = 9.5\mu\text{J}$$

107. A long solenoid of diameter 0.1 m has 2×10^4 turns per meter. At the centre of the solenoid, a coil of 100 turns and radius 0.01 m is placed with its axis coinciding with the solenoid axis. The current in the solenoid reduces at a constant rate to 0A from 4A in 0.05 s. If the resistance of the coil is $10\,\pi^2\Omega$, the total charge flowing through the coil during this time is:

(1) 32 π μC (2) 16 μC (3) 32 μC (4) 16 π μC

Sol. [3]

Magnetic field inside the solenoid, $B = \mu_0 nI$

$$= 4\pi \times 10^{-7} \times 2 \times 10^4 \times I = 8\pi \times 10^{-3} \times I$$

Charge flowing through the ring,

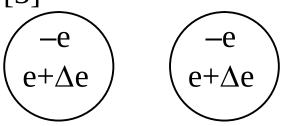
$$\Delta q = \frac{\Delta\phi}{R} = \frac{N(B_1 - B_2)\pi r^2}{R}$$

$$= \frac{100 \times 8\pi \times 10^{-3}(4-0) \times \pi \times 10^{-4}}{10\pi^2} = 32\,\mu\text{C}$$

108. Suppose the charge of a proton and an electron differ slightly. One of them is –e, the other is (e + Δe). If the net of electrostatic force and gravitational force between two hydrogen atoms placed at a distance d (much greater than atomic size) apart is zero, then Δe is of the order of [Given mass of hydrogen $m_h = 1.67 \times 10^{-27}$ kg]

(1) 10^{-20} C (2) 10^{-23} C (3) 10^{-37} C (4) 10^{-47} C

Sol. [3]



$$-\frac{2Ke(e+\Delta e)}{r^2} + \frac{Ke^2}{r^2} + \frac{K(e+\Delta e)^2}{r^2} = \frac{Gm^2}{r^2}$$

$$\Rightarrow \quad Ke^2\left[-2\left(1+\frac{\Delta e}{e}\right)+1+\left(1+\frac{\Delta e}{e}\right)^2\right] = Gm^2$$

$$\Rightarrow \quad Ke^2\left[-2-2\frac{\Delta e}{e}+1+1+\left(\frac{\Delta e}{e}\right)^2+\frac{2\Delta e}{e}\right] = Gm^2$$

$$\Rightarrow \quad Ke^2 \times \frac{\Delta e^2}{e^2} = Gm^2$$

$\Rightarrow \quad \Delta e = \sqrt{\frac{Gm^2}{K}} = \sqrt{\frac{6.67\times10^{-11}\times\left(6.67\times10^{-27}\right)^2}{9\times10^9}} = 5.7\times10^{-37}C$

109. Two astronauts are floating in gravitational free space after having lost contact with their spaceship. The two will:
(1) keep floating at the same distance between them
(2) move towards each other
(3) move away from each other
(4) will become stationary

Sol. [1]
They have same velocity when separates from spaceship, thus distance will remain same.

110. The ratio of wavelengths of the last line of Balmer series and the last line of Lyman series is:
(1) 2 (2) 1 (3) 4 (4) 0.5

Sol. [3]
Last line of Balmer series, $\frac{1}{\lambda_1} = R\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right)$

Last line of Lyman series, $\frac{1}{\lambda_2} = R\left(\frac{1}{1^2} - \frac{1}{\infty^2}\right)$

$\Rightarrow \frac{\lambda_1}{\lambda_2} = 4$

111. The de-Broglie wavelength of a neutron in thermal equilibrium with heavy water at a temperature T (Kelvin) and mass m, is:
(1) $\frac{h}{\sqrt{mkT}}$ (2) $\frac{h}{\sqrt{3mkT}}$ (3) $\frac{2h}{\sqrt{3mkT}}$ (4) $\frac{2h}{\sqrt{mkT}}$

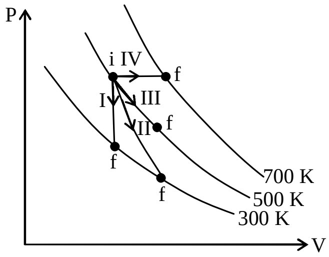
Sol. [2]
$\lambda = \frac{\lambda}{\sqrt{2m(KE)}} = \frac{\lambda}{\sqrt{2m\left(\frac{3}{2}KT\right)}} = \frac{\lambda}{\sqrt{3mKT}}$

112. A thin prism having refracting angle 10° is made of glass of refractive index 1.42. This prism is combined with another thin prism of glass of refractive index 1.7. This combination produces dispersion without deviation. The refracting angle of second prism should be:
(1) 4° (2) 6° (3) 8° (4) 10°

Sol. [2]
for dispersion without deviation,
$(\mu - 1)A + (\mu' - 1)A' = 0$

$\Rightarrow \quad A' = -\left(\frac{\mu - 1}{\mu' - 1}\right)A = \frac{0.42}{0.7}\times10° = 6°$

113. Thermodynamic processes are indicated in the following diagram.



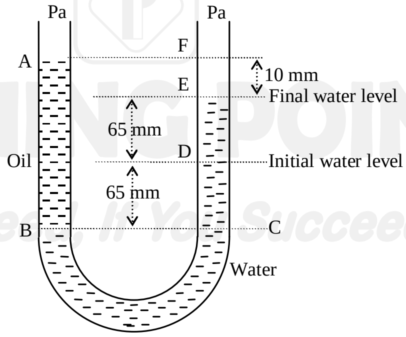
Match the following :

	Column-1		Column-2
P.	Process I	a.	Adiabatic
Q.	Process II	b.	Isobaric
R.	Process III	c.	Isochoric
S.	Process IV	d	Isothermal

(1) $P \to a, Q \to c, R \to d, S \to b$
(2) $P \to c, Q \to a, R \to d, S \to b$
(3) $P \to c, Q \to d, R \to b, S \to a$
(4) $P \to d, Q \to b, R \to a, S \to c$

Sol. [2]
Theory based

114. A U tube with both ends open to the atmosphere, is partially filled with water. Oil, which is immiscible with water, is poured into one side until it stands at a distance of 10 mm above the water level on the other side. Meanwhile the water rises by 65 mm from its original level (see diagram). The density of the oil is:



(1) $650\,kg\,m^{-3}$ (2) $425\,kg\,m^{-3}$ (3) $800\,kg\,m^{-3}$ (4) $928\,kg\,m^{-3}$

Sol. [4]
Pressure at B = Pressure at C

$$P_0 + \rho_0 g(140) = P_0 + \rho_w g(130)$$

$$\Rightarrow \rho_0 = \frac{13}{14} \times 1000 = 928\,kg/m^3$$

115. A spring of force constant k is cut into lengths of ratio 1 : 2 : 3. They are connected in series and the new force constant is k'. Then they are connected in parallel and force constant is k". Then k' : k" is:

(1) 1 : 6 (2) 1 : 9 (3) 1 : 11 (4) 1 : 14

Sol. [3]

$$K'(6L) = K_1(L) = K_2(2L) = K_3(3L)$$

$$\Rightarrow \quad K_1 = 6K', K_2 = 3K' \;\&\; K_3 = 2K'$$

when connected in parallel,

$$K'' = K_1 + K_2 + K_3 = 11K'$$

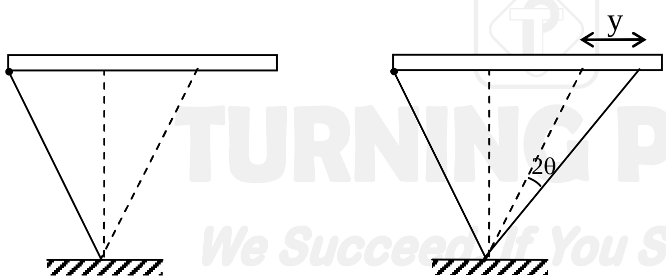
$\Rightarrow \quad \frac{K'}{K''} = \frac{1}{11}$

116. Which of the following statements are correct?
(a) Centre of mass of a body always coincides with the centre of gravity of the body.
(b) Centre of mass of a body is the point at which the total gravitational torque on the body is zero.
(c) A couple on a body produce both translational and rotational motion in a body.
(d) Mechanical advantage greater than one means that small effort can be used to lift a large load.
(1) (b) and (d) (2) (a) and (b) (3) (b) and (c) (4) (c) and (d)

Sol. [1]
Theory based

117. A beam of light from a source L is incident normally on a plane mirror fixed at a certain distance x from the source. The beam is reflected back as a spot on a scale placed just above the source L. When the mirror is rotated through a small angle θ, the spot of the light is found to move throught a distance y on the scale. The angle θ is given by:
(1) $\frac{y}{2x}$ (2) $\frac{y}{x}$ (3) $\frac{x}{2y}$ (4) $\frac{x}{y}$

Sol. [1]



Reflected beam rotates by angle 2θ, when mirror is rotated by angle θ.

Since, $2\theta = \frac{y}{x} \Rightarrow \theta = \frac{y}{2x}$

118. A gas mixture consists of 2 moles of O_2 and 4 moles of Ar at temperature T. Neglecting all vibrational modes, the total internal energy of the system is:
(1) 4 RT (2) 15 RT (3) 9 RT (4) 11 RT

Sol. [4]

Since, $E = \frac{f}{2}nRT$

$$E = \frac{5}{2}(2)(R)T + \frac{3}{2}(4)(R)T$$
$$= 11RT$$

119. Consider a drop of rain water having mass 1 g falling from a height of 1 km. It hits the ground with a speed of 50 m/s. Take 'g' constant with a value 10 m/s^2. The work done by the (i) gravitational force and the (ii) resistive force of air is:
(1) (i) –10 J (ii) –8.25 J (2) (i) 1.25 J (ii) –8.25 J
(3) (i) 100 J (ii) 8.75 J (4) (i) 10 J (ii) –8.75J

Sol. [4]

Work done by gravity,

$w_g = mgh = 10^{-3} \times 10 \times 10^3 = 10J$

by work energy theorem,

$w_g + w_R = \frac{1}{2}mv^2$

$\Rightarrow \quad w_R = \frac{1}{2}(10^{-3})(50)^2 - 10$

$= 1.25 - 10 = -8.75\,J$

120. A carnot engine having an efficiency of $\frac{1}{10}$ as heat engine, is used as a refrigerator. If the work done on the system is 10 J, the amount of energy absorbed from the reservoir at lower temperature is:

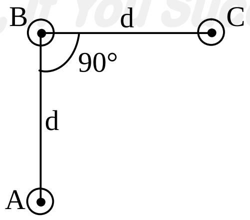
(1) 1 J (2) 90 J (3) 99 J (4) 100 J

Sol. [2]

Since, $\beta = \frac{1-\eta}{\eta} = \frac{1-\frac{1}{10}}{\frac{1}{10}} = 9$

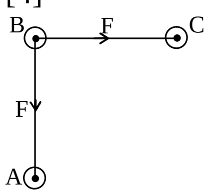
$\beta = \frac{Q_2}{\text{work done}} \Rightarrow 9 = \frac{Q_2}{10} \Rightarrow Q_2 = 90\,J$

121. An arrangement of three parallel straight wires placed perpendicular to plane of paper carrying same current 'I' along the same direction is shown in Fig. Magnitude of force per unit length on the middle wire 'B' is given by:



(1) $\frac{\mu_0 i^2}{2\pi d}$ (2) $\frac{2\mu_0 i^2}{\pi d}$ (3) $\frac{\sqrt{2}\mu_0 i^2}{\pi d}$ (4) $\frac{\mu_0 i^2}{\sqrt{2}\pi d}$

Sol. [4]



$F_{total} = \sqrt{2}\,F$

$= \sqrt{2}\,\frac{\mu_0 I^2}{2\pi d}$

$= \frac{\mu_0 I^2}{\sqrt{2}\pi d}$

122. The x and y coordinates of the particle at any time are $x = 5t - 2t^2$ and $y = 10t$ respectively, where x and y are in meters and t in seconds. The acceleration of the particle at t = 2s is:
(1) 0 (2) 5 m/s^2 (3) –4 m/s^2 (4) –8 m/s^2

Sol. [3]

$$\vec{V} = \frac{dx}{dt}\hat{i} + \frac{dy}{dt}\hat{j} = (5-4t)\hat{i} + 10\hat{j}$$

and $\vec{a} = \frac{d\vec{v}}{dt} = -4\hat{i}$

or $|\vec{a}| = 4\,m/s^2$

123. The ratio of resolving powers of an optical microscope for two wavelengths λ_1 = 4000 Å and λ_2 = 6000 Å is:
(1) 8 : 27 (2) 9 : 4 (3) 3 : 2 (4) 16 : 81

Sol. [3]

Resolving power of microscope $\propto \lambda$

the ratio of resolving power = $\frac{\lambda_2}{\lambda_1} = \frac{6000}{4000} = \frac{3}{2}$

124. Preeti reached the metro station and found that the escalator was not working. She walked up the stationary escalator in time t_1. On other days, if she remains stationary on the moving escalator, then the escalator takes her up in time t_2. The time taken by her to walk up on the moving escalator will be:
(1) $\frac{t_1 + t_2}{2}$ (2) $\frac{t_1 t_2}{t_2 - t_1}$ (3) $\frac{t_1 t_2}{t_2 + t_1}$ (4) $t_1 - t_2$

Sol. [3]

When escalator is not working

$V_1 = \frac{d}{t_1}$ ...(1)

when she stand and escalator in moving.

$V_2 = \frac{d}{t_2}$ ...(2)

when they both moves upward

$(V_2 + V_1) = \frac{d}{t'}$ ...(3)

from eq. (1), (2) and (3)

$\Rightarrow \frac{d}{t_2} + \frac{d}{t_1} = \frac{d}{t'}$

$\Rightarrow t' = \frac{t_1 t_2}{t_2 + t_1}$

125. A spherical black body with a radius of 12 cm radiates 450 watt power at 500 K. If the radius were halved and the temperature doubled, the power radiated in watt would be :
(1) 225 (2) 450 (3) 1000 (4) 1800

Sol. [4]

As power $\propto T^4 \times r^2$

$$\frac{P_1}{P_2} = \frac{T_1^4 r_1^2}{T_2^4 r_2^2}$$

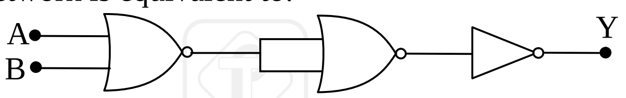
$$\therefore \quad \frac{450}{P_2} = \frac{T^4 r^2}{(2T)^4 \left(\frac{r}{2}\right)^2}$$

$$P_2 = 1800 \, \text{watt}$$

126. A potentiometer is an accurate and versatile device to make electrical measurements of E.M.F. because the method involves:
(1) cells
(2) potential gradients
(3) a condition of no current flow through the galvanometer
(4) a combination of cells, galvanometer and resistances

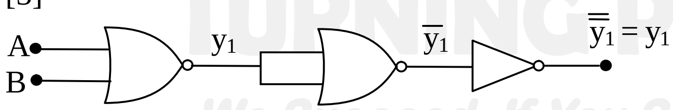
Sol. [3]
Conceptual

127. The given electrical network is equivalent to:



(1) AND gate (2) OR gate (3) NOR gate (4) NOT gate

Sol. [3]



$y_1 = \overline{A + B}$

128. In a common emitter transistor amplifier the audio signal voltage across the collector is 3 V. The resistance of collector is 3 KΩ. If current gain is 100 and the base resistance is 2 kΩ, the voltage and power gain of the amplifier is:
(1) 200 and 1000 (2) 15 and 200 (3) 150 and 15000 (4) 20 and 2000

Sol. [3]

Voltage gain $A_v = \frac{\beta R_C}{R_B}$

$$A_v = 100 \times \left(\frac{3}{2}\right) = 150$$

Power gain = Voltage gain × Current gain

$$= \frac{\beta R_C}{R_B} \times \beta$$

$$= 10000 \times \frac{3}{2} = 15000$$

129. Two discs of same moment of inertia rotating about their regular axis passing through centre and perpendicular to the plane of disc with angular velocities ω_1 and ω_2. They are brought

into contact face to face coinciding the axis of rotation. The expression for loss of energy during this process is:

(1) $\frac{1}{2}I(\omega_1+\omega_2)^2$ (2) $\frac{1}{4}I(\omega_1-\omega_2)^2$ (3) $I(\omega_1-\omega_2)^2$ (4) $\frac{1}{8}I(\omega_1-\omega_2)^2$

Sol. [2]

As angular momentum in conserved therefore

$L_i = L_f$

$I\omega_1 + I\omega_2 = 2I\omega'$

$\therefore \quad \omega' = \frac{\omega_1+\omega_2}{2}$

Intial KE is $\frac{1}{2}I\omega_1^2 + \frac{1}{2}I\omega_2^2$

Final KE is $\frac{1}{2}(2I)\left(\frac{\omega_1+\omega_2}{2}\right)^2$

loss = intial KE – final KE

$= \frac{1}{2}I(\omega_1^2+\omega_2^2) - I\left(\frac{\omega_1+\omega_2}{2}\right)^2$

$= \frac{1}{4}I(\omega_1-\omega_2)^2$

130. Young's double slit experiment is first performed in air and then in a medium other than air. It is found that 8^{th} bright fringe in the medium lies where 5^{th} dark fringe lies in air. The refractive index of the medium is nearly:

(1) 1.25 (2) 1.59 (3) 1.69 (4) 1.78

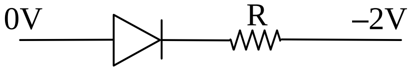
Sol. [4]

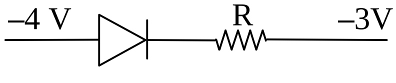
$8\beta_m = \frac{9}{2}\beta_a$

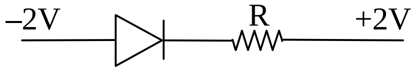
$\Rightarrow \quad 8 \times \frac{\lambda_m D}{d} = \frac{9}{2}\cdot\frac{\lambda_a D}{d}$

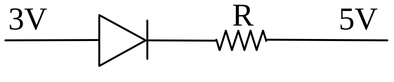
$\Rightarrow \quad \frac{\lambda_a}{\lambda_m} = \frac{16}{9} \quad \text{or} \quad \mu = \frac{\lambda_a}{\lambda_m} = \frac{16}{9} = 1.78$

131. Which one of the following represents forward bias diode?

(1)


(2)


(3)


(2)


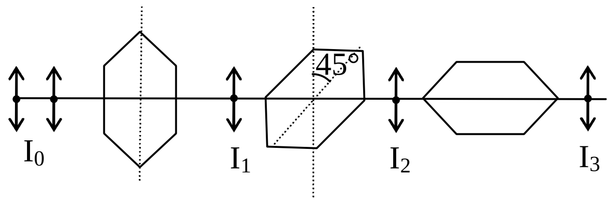
Sol. [3]

Zero volt is higher potential than –2 volt.

132. Two Polaroids P_1 and P_2 are placed with their axis perpendicular to each other. Unpolarised light I_0 is incident on P_1. A third polaroid P_3 is kept in between P_1 and P_2 such that its axis makes an angle 45° with that of P_1. The intensity of transmitted light through P_2 is :

(1) $\frac{I_0}{2}$ (2) $\frac{I_0}{4}$ (3) $\frac{I_0}{8}$ (4) $\frac{I_0}{16}$

Sol. [3]



$I_1 = \frac{I_0}{2}$ & $I_2 = I_1 \cos^2 45° = \frac{I_0}{4}$

and $I_3 = I_2 \cos^2 45° = \frac{I_0}{8}$

133. In an electromagnetic wave in free space that root mean square value of the electric field is $E_{rms} = 6$V/m. The peak value of the magnetic field is:
(1) 1.41×10^{-8} T (2) 2.83×10^{-8} T (3) 0.70×10^{-8} T (4) 4.23×10^{-8} T

Sol. [2]

$$B_{rms} = \frac{E_{rms}}{C} = \frac{6}{3\times10^8} = 2\times10^{-8}\,T$$

$$B_0 = \sqrt{2}\,B_{rms} = 2.83\times10^{-8}\,T$$

134. If θ_1 and θ_2 be the apparent angles of dip observed in two vertical planes at right angles to each other, then the true angle of dip θ is given by:
(1) $\cot^2\theta = \cot^2\theta_1 + \cot^2\theta_2$ (2) $\tan^2\theta = \tan^2\theta_1 + \tan^2\theta_2$
(3) $\cot^2\theta = \cot^2\theta_1 - \cot^2\theta_2$ (4) $\tan^2\theta = \tan^2\theta_1 - \tan^2\theta_2$

Sol. [1]

$$\tan\theta_1 = \frac{\tan\theta}{\cos\alpha} \;\&\; \tan\theta_2 = \frac{\tan\theta}{\cos(90-\alpha)}$$

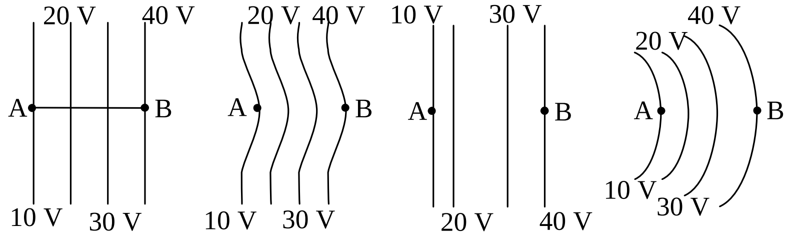
where, θ is actual dip angle

$\Rightarrow \cos^2\alpha + \sin^2\alpha = 1$

$\Rightarrow \frac{\tan^2\theta}{\tan^2\theta_1} + \frac{\tan^2\theta}{\tan^2\theta_2} = 1$

$\Rightarrow \cot^2\theta_1 + \cot^2\theta_2 = \cot^2\theta$

135. The diagrams below show regions of equipotentials



A positive charge is moved from A to B in each diagram.
(1) Maximum work is required to move q in figure (c)

(2) In all the four cases the work done is the same
(3) Minimum work is required to move q in figure (a)
(4) Maximum work is required to move q in figure (b)

Sol. [2]

Since, $W = q\,\Delta V = q(V_B - V_A) = q(40-10) = 30q$

work done is same in all the four cases.