JEE MAIN

QUESTION PAPER WITH SOLUTION

38000+
SELECTIONS SINCE 2007

PHYSICS

29th June 2022 | Shift - 1

MOTION®

JEE (Main+Advanced) | NEET | NTSE | Olympiads | Boards

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NEET / AIIMS

- AIR-1 TO 10 — 25 TIMES
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JEE MAIN+ADVANCED

- AIR-1 TO 10 — 8 TIMES
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NATION'S BEST SELECTION
PERCENTAGE (%) RATIO

STUDENT QUALIFIED IN NEET

2021	3296 / 3411 = 93.12%
2020	2663 / 2843 = 93.66%
2019	2041 / 2212 = 92.27%

STUDENT QUALIFIED IN JEE ADVANCED

2021	1256 / 2994 = 41.95%
2020	994 / 2538 = 39.16%
2019	769 / 2105 = 36.53%

STUDENT QUALIFIED IN JEE MAIN

2021	2994 / 4087 = 73.25%
2020	2538 / 3554 = 71.44%
2019	2288 / 3316 = 68.99%

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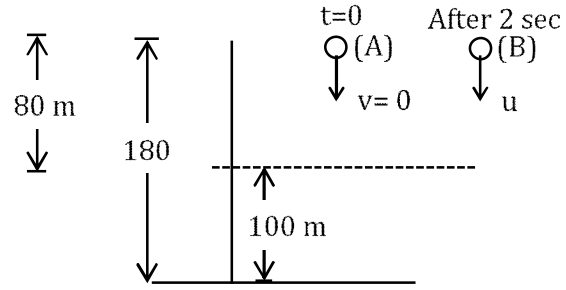
NITIN VIJAY (NV Sir)
Founder & CEO

SECTION - A

1. Two balls A and B are placed at the top of 180 m tall tower. Ball A is released from the top at t = 0 s. Ball B is thrown vertically down with an initial velocity 'u' at t = 2 s. After a certain time, both balls meet 100 m above the ground. Find the value of 'u' in ms^{-1}. [use g = 10 ms^{-2}] :

(A) 10 (B) 15 (C) 20 (D) 30

Sol. **(D)**



For A ball.

$s = ut + \frac{1}{2}at_A^2$ $a = g = 10\ m/s^2$

$80 = \frac{1}{2}(10)t_A^2$

$t_A = 4$ sec

For B

$t_B = t_A - 2sec$ $v_B = 0$

$t_B = 2sec.$ $s = 80$ m

$s = u_B t_B + \frac{1}{2}at_B^2$

$80 = 2u + \frac{1}{2}g(2)^2$

$\boxed{u = 30\ m/s}$

2. A body of mass M at rest explodes into three pieces, in the ratio of masses 1: 1: 2. Two smaller pieces fly off perpendicular to each other with velocities of 30 ms^{-1} and 40 ms^{-1} respectively. The velocity of the third piece will be:

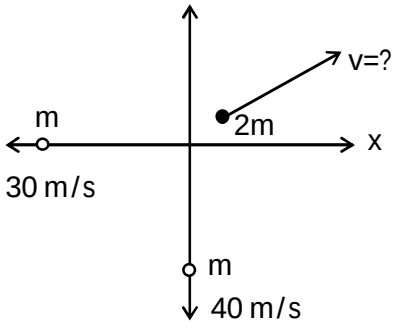
(A) 15 ms^{-1} (B) 25 ms^{-1} (C) 35 ms^{-1} (D) 50 ms^{-1}

Sol. **(B)**

Ratio of masses = 1 : 1 : 2

i.e. m : m : 2 m

From conservation of momentum



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$\vec{P}_i = \vec{P}_f$

$0 = (-30i - 40j)m + 2mv$

$v = \frac{30i+40j}{2} = 15i + 20j\ m/s$

$|v| = 25\ m/s$

3. The activity of a radioactive material is 2.56×10^{-3}Ci. If the half life of the material is 5 days, after how many days the activity will become 2×10^{-5}Ci ?

(A) 30 days (B) 35 days (C) 40 days (D) 25 days

Sol. **(B)**

$A_0 = 2.56 \times 10^{-3}$

$A = 2 \times 10^{-5}$

Half life = 5 day

Total times = ?

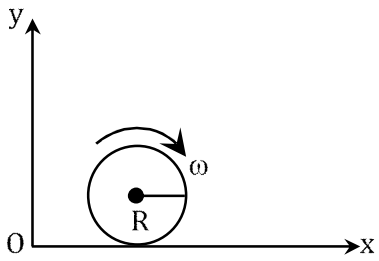
$\therefore\ A = A_0 e^{-\lambda t}$

$2.56 \times 10^{-3} e^{-\lambda t} = 2 \times 10^{-5}$

$\frac{\ln 2}{5}(t) = \ln(128)$

$t = \frac{5\ln(128)}{\ln(2)} = 5 \times \log_3 128 = 5 \times 7 = 35$ days

4. A spherical shell of 1 kg mass and radius R is rolling with angular speed ω on horizontal plane (as shown in figure). The magnitude of angular momentum of the shell about the origin O is $\frac{a}{3}R^2\omega$. The value of a will be :



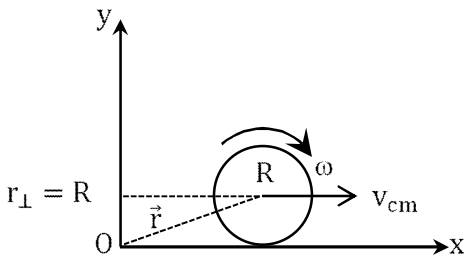
(A) 2 (B) 3 (C) 5 (D) 4

Sol. **(C)**

Mass of sphere = 1 kg

Radius = R

$\vec{L}$ about O = $\frac{a}{3}R^2\omega$



$\vec{L} = \vec{L}_{cm} + m(\vec{r} \times \vec{v}_{cm})$

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$\vec{L} = I_{cm}\omega + m(\vec{r} \times \vec{v}_{cm})$

$= \left(\frac{2}{3}mR^2\right)\omega + mRv_{cm}$

$\vec{L} = \frac{2}{3}mR^2\omega + mR^2\omega \quad (v_{cm} = R\omega)$

$\vec{L} = \frac{5}{3}mR^2\omega$

$\vec{L} = \frac{a}{3}mR^2\omega = \frac{5}{3}mR^2\omega$

$\therefore a = 5$

5. A cylinder of fixed capacity of 44.8 litres contains helium gas at standard temperature and pressure. The amount of heat needed to raise the temperature of gas in the cylinder by 20.0°C will be : (Given gas constant R = $8.3JK^{-1} - mol^{-1}$)

(A) 249 J (B) 415 J (C) 498 J (D) 830 J

Sol. **(C)**

Given

22.4 L volume of gas = 1 mole

$\Rightarrow 44.8\ L_{(He)} = 2$ mole

n = no. of mole = 2

$C_v = \frac{3}{2}R$ (He) → monoatomic

$\therefore \Delta Q = nC_V\Delta T$

$= 2 \times \frac{3}{2}R \times 20 = 60 \times 8.3$

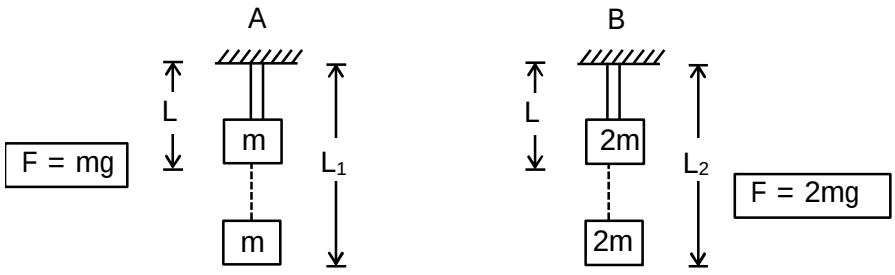
= 498 J

ΔQ = 498 J

6. A wire of length L is hanging from a fixed support. The length changes to L_1 and L_2 when masses 1 kg and 2 kg are suspended respectively from its free end. Then the value of L is equal to :

(A) $\sqrt{L_1 L_2}$ (B) $\frac{L_1+L_2}{2}$ (C) $2L_1 - L_2$ (D) $3L_1 - 2L_2$

Sol. **(C)**



$\Delta L = (L_1 - L)$ $\Delta L = (L_2 - L)$

$F = \frac{YA}{L}\Delta L$

$\boxed{F = K\Delta L}$

For (A)

$mg = K(L_1 - L)$ ...(i)

For (B)

$2mg = K(L_2 - L)$ ...(ii)

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From Eq. $\frac{(ii)}{(i)}$

$$\frac{2}{1} = \frac{L_2 - L}{L_1 - L}$$

$$\boxed{L = 2L_1 - L_2}$$

7. Given below are two statements : one is labelled as Assertion **A** and the other is labelled as Reason **R**.

Assertion A : The photoelectric effect does not takes place, if the energy of the incident radiation is less than the work function of a metal.

Reason R : Kinetic energy of the photoelectrons is zero, if the energy of the incident radiation is equal to the work function of a metal.

In the light of the above statements, choose the most appropriate answer from the options given below.

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

(B) Both **A** and **R** are correct but **R** is not the correct explanation of **A**

(C) **A** is correct but **R** is not correct

(D) **A** is not correct but **R** is correct

Sol. **(A)**

R is not correct explanation of A because R is not considering when energy of incident radiation is less than work function of metal, then also kinetic energy of photoelectrons is zero.

8. A particle of mass 500gm is moving in a straight line with velocity $v = bx^{5/2}$. The work done by the net force during its displacement from x = 0 to x = 4 m is : (Take $b = 0.25\ m^{-3/2}\ s^{-1}$).

(A) 2 J (B) 4 J (C) 8 J (D) 16 J

Sol. **(D)**

$v = bx^{5/2}$

$m = 0.5\ kg = ½\ kg$ $\quad (b = 0.25\ m^{-3/2}S^{-1})$

$W = \Delta K$

$W = \frac{1}{2}m\left(v_{(x=4)}^2 - v_{x=0}^2\right)$ $\quad \because v_{x=0}^2 = 0$

$= \frac{1}{2}mb^2(4)^5$ $\quad \because v_{(x=4)}^2 = \left(b(4)^{5/2}\right)^2$

$\because\ v_{x=4}^2 = b^2(4)^5$

$W = \frac{1}{2}mb^2(4)^5 = \frac{1}{2} \times \frac{1}{2} \times (0.25)^2 \times 4^5 = \frac{1}{2} \times \frac{1}{2} \times \left(\frac{1}{4}\right)^2 \times 4^5$

$= (4)^2 = 16$ J

9. A charge particle moves along circular path in a uniform magnetic field in a cyclotron. The kinetic energy of the charge particle increases to 4 times its initial value. What will be the ratio of new radius to the original radius of circular path of the charge particle

(A) 1 : 1 (B) 1 : 2 (C) 2 : 1 (D) 1 : 4

Sol. **(C)**

$K.E_{(f)} = 4\ K.E_{(i)}$

$r = \frac{mv}{qB} = \frac{\sqrt{2mK}}{qB}$

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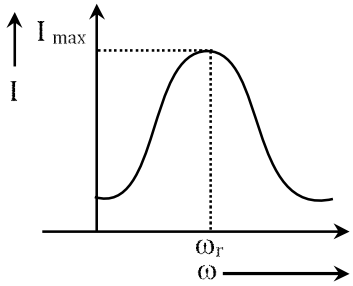
$$\frac{r_i}{r_f} = \frac{\sqrt{K_i}}{\sqrt{K_f}} = \frac{\sqrt{K}}{\sqrt{4K}} = \frac{1}{2}$$

$$\therefore \frac{r_f}{r_i} = \frac{2}{1}$$

10. For a series LCR circuit, I vs ω curve is shown :



(a) To the left of ω_r, the circuit is mainly capacitive.

(b) To the left of ω_r, the circuit is mainly inductive.

(c) At ω_r, impedance of the circuit is equal to the resistance of the circuit.

(d) At ω_r, impedance of the circuit is 0 .

Choose the most appropriate answer from the options given below :

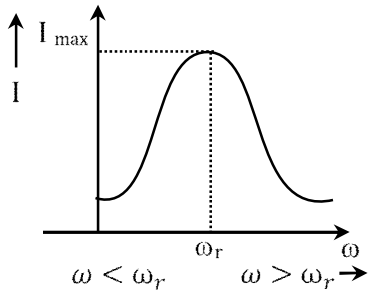
(A) (a) and (d) only

(B) (b) and (d) only

(C) (a) and (c) only

(D) (b) and (c) only

Sol. **(C)**



At resonance in LCR

Z = R = (min)

Z = Impedance

$\omega < \omega_r$

$\omega L < \frac{1}{\sqrt{LC}}$

$\omega L < \frac{1}{\omega C}$

$\boxed{X_L < X_C}$

Capacitive

$\omega > \omega_r$

$\omega L > \frac{1}{\sqrt{LC}}$

$\omega L > \frac{1}{\omega C}$

$\boxed{X_L > X_C}$

Inductive

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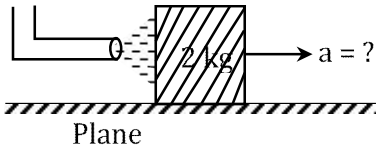
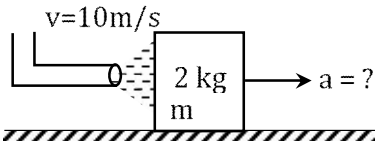
11. A block of metal weighing 2 kg is resting on a frictionless plane (as shown in figure). It is struck by a jet releasing water at a rate of $1 kgs^{-1}$ and at a speed of $10\ ms^{-1}$. Then, the initial acceleration of the block, in ms^{-2}, will be :



(A) 3 (B) 6 (C) 5 (D) 4

Sol. **(C)**

$\frac{dm}{dt} = 1kg/s$



$F = \frac{vdm}{dt} = 10 \times 1$

$F = 10\ N$

$a = \frac{F}{m} = \frac{10}{2} = 5\ m/s^2$

12. In van dar Wall equation $\left[P + \frac{a}{V^2}\right][V - b] = RT$; P is pressure, V is volume, R is universal gas constant and T is temperature. The ratio of constants $\frac{a}{b}$ is dimensionally equal to:

(A) $\frac{P}{V}$ (B) $\frac{V}{P}$ (C) PV (D) PV^3

Sol. **(C)**

$\left[P + \frac{a}{V^2}\right][V - b] = RT$

Dimensionally $[P] = \left[\frac{a}{V^2}\right]$ $[V] = [b]$

$\therefore a = PV^2$ $\frac{a}{b} = \frac{PV^2}{V} = PV$

13. Two vectors $\vec{A}$ and $\vec{B}$ have equal magnitudes. If magnitude of $\vec{A} + \vec{B}$ is equal to two times the magnitude of $\vec{A} - \vec{B}$, then the angle between $\vec{A}$ and $\vec{B}$ will be :

(A) $\sin^{-1}\left(\frac{3}{5}\right)$ (B) $\sin^{-1}\left(\frac{1}{3}\right)$ (C) $\cos^{-1}\left(\frac{3}{5}\right)$ (D) $\cos^{-1}\left(\frac{1}{3}\right)$

Sol. **(C)**

$|\vec{A}| = |\vec{B}| = A$

$|\vec{A} + \vec{B}| = 2(|\vec{A} - \vec{B}|)$

$A^2 + A^2 + 2A^2\cos\theta = 4(A^2 + A^2 - 2A^2\cos\theta)$

$2A^2(1 + \cos\theta) = 2A^2(4 - 4\cos\theta)$

$5\cos\theta = 3$

$\cos\theta = \frac{3}{5}$, $\theta = \cos^{-1}\left(\frac{3}{5}\right)$

14. The escape velocity of a body on a planet ' A' is $12 kms^{-1}$. The escape velocity of the body on another planet ' B ', whose density is four times and radius is half of the planet ' A ', is :

(A) $12 kms^{-1}$ (B) $24 kms^{-1}$ (C) $36 kms^{-1}$ (D) $6 kms^{-1}$

Sol. **(A)**

$v_{e_{(A)}} = 12\frac{km}{s}$

$r_B = \frac{1}{2}r_A$

$\text{Density}_{(B)} = 4(\text{Density})_A$

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$\rho_B = 4\rho_A$

$v_e = \sqrt{\frac{2GM}{R}} = \sqrt{\frac{2G\frac{4}{3}\pi R^3\rho}{R}}$

$v_e = R\sqrt{\rho}$

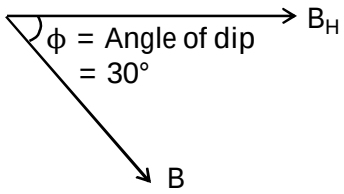
$\therefore \frac{v_{e(B)}}{v_{e(A)}} = \frac{r_B}{r_A}\sqrt{\frac{\rho_B}{\rho_A}} = \frac{1}{2}\sqrt{4} = \frac{1}{2} \times 2 = 1$

$\therefore v_{e(B)} = v_{e(A)} = 12$ km/s

15. At a certain place the angle of dip is 30° and the horizontal component of earth's magnetic field is 0.5G. The earth's total magnetic field (in G), at that certain place, is :

(A) $\frac{1}{\sqrt{3}}$ (B) $\frac{1}{2}$ (C) $\sqrt{3}$ (D) 1

Sol. **(A)**



$B_H = 0.50G$

$\phi = 30°$

$B_H = B\cos\phi$

$B = \frac{B_H}{\cos\phi} = \frac{0.5}{\cos 30^o} = \frac{0.5}{\frac{\sqrt{3}}{2}} = \frac{1}{\sqrt{3}}$

$\boxed{B = \frac{1}{\sqrt{3}}}$

16. A longitudinal wave is represented by $x = 10\sin 2\pi\left(nt - \frac{x}{\lambda}\right)$ cm. The maximum particle velocity will be four times the wave velocity if the determined value of wavelength is equal to :

(A) 2π (B) 5π (C) π (D) $\frac{5\pi}{2}$

Sol. **(B)**

$y = 10\sin 2\pi\left(nt - \frac{x}{\lambda}\right)$ cm

Given ;

Maximum particle velocity = 4 × velocity of wave

$v_p(max) = A\omega = 10(2\pi n)$

$v_{wave} = \frac{\omega}{K} = \frac{2\pi n}{\frac{2\pi}{\lambda}} = \frac{2\pi n\lambda}{2\pi} = n\lambda$

$10(2\pi n) = 4(n\lambda)$

$\frac{20\pi}{4} = \lambda \quad \boxed{\lambda = 5\pi}$

17. A parallel plate capacitor filled with a medium of dielectric constant 10, is connected across a battery and is charged. The dielectric slab is replaced by another slab of dielectric constant 15. Then the energy of capacitor will :

(A) increase by 50% (B) decrease by 15% (C) increase by 25% (D) increase by 33%

Sol. **(A)**

$K_1 = 10 \qquad K_2 = 15$

$U_i = \frac{1}{2}(K_1C)V^2 \qquad U_f = \left(\frac{1}{2}K_2C\right)V^2$

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$U_i = \frac{1}{2}10CV^2$ $U_f = \frac{1}{2}15CV^2$

$\frac{\Delta U}{U_i} = \frac{U_f - U_i}{U_i} = \frac{5}{10}$ $\frac{\Delta U}{U_i} \times 100 = \frac{5}{10} \times 100$

$\therefore$ 50% increases

18. A positive charge particle of 100 mg is thrown in opposite direction to a uniform electric field of strength $1 \times 10^5 NC^{-1}$. If the charge on the particle is 40 μC and the initial velocity is 200 ms^{-1}, how much distance it will travel before coming to the rest momentarily :

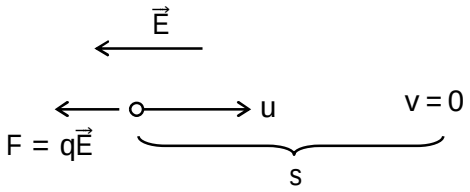
(A) 1 m (B) 5 m (C) 10 m (D) 0.5 m

Sol. **(D)**

$u = 200$ m/s, $q = 40 \times 10^{-6}$C

$E = 1 \times 10^5 \frac{N}{C}$

$m = 100$ mg $= 0.1$ kg



$\therefore a = \frac{F}{m} = \frac{qE}{m}$

III equation of motion

$v^2 = u^2 + 2as$ $\therefore -u^2 = -2as$

$u^2 = 2as$

$\therefore s = \frac{u^2}{2a} = \frac{u^2}{\frac{2qE}{m}} = \frac{u^2 m}{2q E}$

$s = \frac{(200 \times 200) \times 0.1}{2 \times 40 \times 10^{-6} \times 10^5} = 0.5$ m

19. Using Young's double slit experiment, a monochromatic light of wavelength 5000Å produces fringes of fringe width 0.5 mm. If another monochromatic light of wavelength 6000Å is used and the separation between the slits is doubled, then the new fringe width will be :

(A) 0.5 mm (B) 1.0 mm (C) 0.6 mm (D) 0.3 mm

Sol. **(D)**

$\beta = \frac{\lambda D}{d}$ d = dist. Between slits

$\lambda_1 = 5000$ Å β = frige width

$\lambda_2 = 6000$ Å D = Distance between centre of slits and screen

$\beta_1 = 0.5$ mm

$d_2 = 2d_1$

$\therefore \frac{\beta_1}{\beta_2} = \frac{\lambda_1}{\lambda_2} \times \frac{d_2}{d_1} = \frac{5}{6} \times 2 = \frac{10}{6}$

$\frac{0.5}{\beta_2} = \frac{5}{6} \times 2$ $\beta_2 = \frac{30}{100} = 0.3$ mm

$\beta_2 = 0.3$ mm

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20. Only 2% of the optical source frequency is the available channel bandwidth for an optical communicating system operating at 1000 nm. If an audio signal requires a bandwidth of 8 kHz, how many channels can be accommodated for transmission :

(A) 375×10^7 (B) 75×10^7

(C) 375×10^8 (D) 75×10^9

Sol. **(B)**

$\lambda = 1000$ nm — 2% of source frequency available

$c = 3 \times 10^8$ m/s — Bandwidth of each channel= 8KHz

$\therefore f = \frac{c}{\lambda} = \frac{3\times10^8}{10\times10^{-7}}$

$= \frac{3}{10} \times 10^{15} = 3 \times 10^{14}$ Hz

$\therefore$ 2% of $f = \frac{2}{100} \times 3 \times 10^{14}$ Hz

$= 6 \times 10^{12}$ Hz

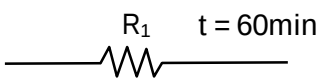
No. of channel $= \frac{\text{Banwidth}}{\text{frequency of chanel}} = \frac{6\times10^{12}}{8\times10^3} = \frac{3}{4} \times 10^9$

$= 0.75 \times 10^9 = 75 \times 10^7$

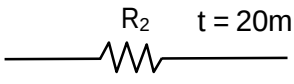
SECTION - B

21. Two coils require 20 minutes and 60 minutes respectively to produce same amount of heat energy when connected separately to the same source. If they are connected in parallel arrangement to the same source; the time required to produce same amount of heat by the combination of coils, will be _____min.

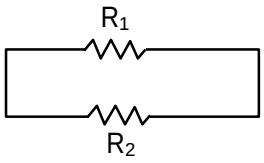
Sol. **(15)**



$H = P \times t = \frac{V^2}{R_1} \times 60$



$H = \frac{V^2}{R_2} \times 20$



Same heat produced

$\frac{V^2}{R_{net}} \times t = H$

$H = \left(\frac{V^2}{R_1} + \frac{V^2}{R_2}\right) t$

$H = \left(\frac{H}{60} + \frac{H}{20}\right) t$

$\frac{60 \times 20}{80} = t$ $\quad t = 15$ min

22. The intensity of the light from a bulb incident on a surface is 0.22 W/m^2. The amplitude of the magnetic field in this light-wave is _____ $\times 10^{-9}$T

(Given : Permittivity of vacuum $\epsilon_0 = 8.85 \times 10^{-12} C^2\, N^{-1} - m^{-2}$, speed of light in vacuum $c = 3 \times 10^8$ ms^{-1})

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Sol. **(43)**

$I = \frac{B_0^2 c}{2\mu_0}$ $\qquad$ $I = 0.22\ w/m^2,$

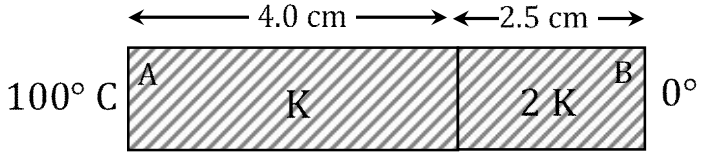
$B_0 = \sqrt{\frac{2\mu_0 I}{c}}$ $\qquad$ $c = 3 \times 10^8\ m/sec$

$\epsilon_0 = 8.85 \times 10^{-12} C^2 N^{-2}$

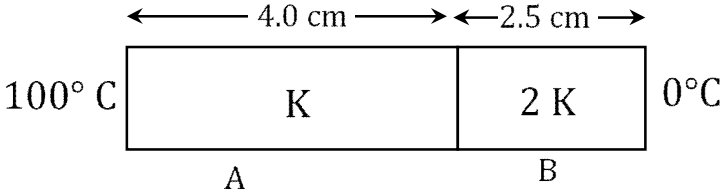
$B_0 = \sqrt{\frac{2\times 4\pi \times 10^{-7} \times 0.22}{3\times 10^8}} = 4.3 \times 10^{-8}$

$B_0 = 43 \times 10^{-9} T$

23. As per the given figure, two plates A and B of thermal conductivity K and 2 K are joined together to form a compound plate. The thickness of plates are 4.0 cm and 2.5 cm respectively and the area of cross-section is 120 cm^2 for each plate. The equivalent thermal conductivity of the compound plate is $\left(1 + \frac{5}{\alpha}\right) K$, then the value of α will be _____ .



Sol. **(21)**



Area of cross section = 120 cm^2

Equivalent thermal conductivity

$\left(1 + \frac{5}{\alpha}\right) K$

$R_{eq} = R_1 + R_2 \qquad R = \frac{L}{kA}$

$\frac{1}{K_{eq}} \frac{(L_1+L_2)}{A} = \frac{L_1}{K_1 A} + \frac{L_2}{K_2 A}$

$\frac{L_1+L_2}{K_{eq}} = \frac{L_1}{K_1} + \frac{L_2}{K_2} \quad \Rightarrow \frac{4+2.5}{K_{eq}} = \frac{4}{K} + \frac{2.5}{2K}$

$\frac{6.5}{K_{eq}} = \frac{10.5}{2K}$

$K_{eq} = \frac{65\times 2}{105} = \frac{130}{105} = \frac{26}{21}$

$K_{eq} = \frac{26}{21} = \left(1 + \frac{5}{21}\right) K$

$\frac{1+5}{\alpha} = 1 + \frac{5}{21}$

$\alpha = 21$

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24. A body is performing simple harmonic with an amplitude of 10 cm. The velocity of the body was tripled by air Jet when it is at 5 cm from its mean position. The new amplitude of vibration is $\sqrt{x}$ cm. The value of x is _____ .

Sol. **(700)**

$v^2 = \omega^2(A^2 - x^2)$ A = 10 cm Given

$v^2 = \omega^2\left(A^2 - \left(\frac{A}{2}\right)^2\right)$ ....(i) x = 5cm = $\frac{A}{2}$

$(3v)^2 = \omega^2\left(A'^2 - \left(\frac{A}{2}\right)^2\right)$ ....(ii)

Equation (ii) divided by (i)

$9 = \frac{4A'^2 - A^2}{4A^2 - A^2}$ A = $\sqrt{x}$ cm

$9(3A^2) = 4A'^2 - A^2$

$28A^2 = 4A'^2$

$A' = \sqrt{7}\,A$

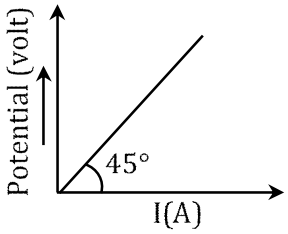
$A' = 10\sqrt{7}$

$\boxed{A' = \sqrt{700}\text{ cm}}$

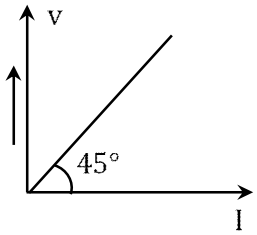
On comparison of A′ whith $\sqrt{x}$

$\boxed{x = 700\text{ cm}}$

25. The variation of applied potential and current flowing through a given wire is shown in figure. The length of wire is 31.4 cm. The diameter of wire is measured as 2.4 cm. The resistivity of the given wire is measured as $x \times 10^{-3}\Omega$cm. The value of x is_____ .
[Take $\pi = 3.14$]



Sol. **(144)**



Diameter = 2.4 cm

Radius = 1.2 cm

$\ell = 31.4\ cm$

$\rho = x \times 10^{-3}\Omega - cm$

$\tan\theta$ = slope = resistance

$R = 1\ \Omega$

$R = \rho\frac{\ell}{A}$

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$\therefore \quad \rho = \frac{RA}{\ell} = \frac{1\times3.14\times(1.2)^2\times10^{-4}}{31.4\times10^{-2}} = \frac{144\times10^{-2}}{10\times100}$

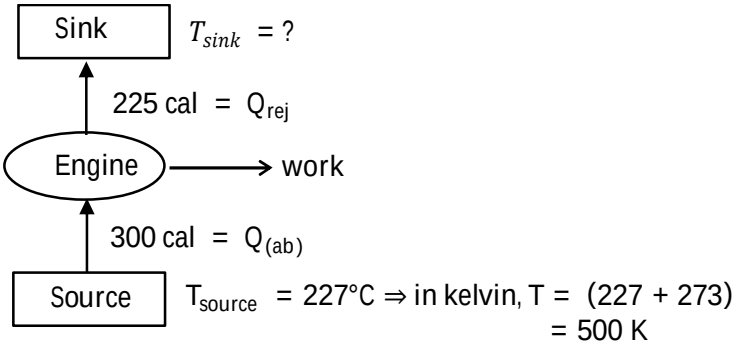
$\rho = 144 \times 10^{-5}\ \Omega m$

$= 144 \times 10^{-3}\ \Omega cm$

$\therefore x = 144$

26. 300 cal. of heat is given to a heat engine and it rejects 225 cal. of heat. If source temperature is $227°C$, then the temperature of sink will be ____ $°C$

Sol. **(102)**



$\frac{Q_{rej}}{Q_{ab}} = \frac{T_{sink}}{T_{source}}$

$\frac{225}{300} = \frac{T_{sink}}{500}$

$T_{sink} = \frac{5}{3} \times 225$

$= 375\ K$

$\boxed{T_{sink} = 102°C}$

27. $\sqrt{d_1}$ and $\sqrt{d_2}$ are the impact parameters corresponding to scattering angles 60° and 90° respectively, when an α particle is approaching a gold nucleus. For $d_1 = xd_2$, the value of x will be_____

Sol. **(3)**

$\boxed{\text{Impact parameters} \propto \cot\left(\frac{\theta}{2}\right)}$

where $\sqrt{d_1}$, $\sqrt{d_2}$ are impact parameterss

$\theta_1 = 60°,\ \theta_2 = 90°$

$\frac{d_1}{d_2} = \frac{\cot^2 30°}{\cot^2 45°}$

$\Rightarrow d_1 = 3d_2$

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28. A transistor is used in an amplifier circuit in common emitter mode. If the base current changes by $100\mu A$, it brings a change of 10 mA in collector current. If the load resistance is $2k\Omega$ and input resistance is $1k\Omega$, the value of power gain is $x \times 10^4$. The value of x is_____ .

Sol. **(2)**

Δi_b = change in base current = $100\mu A$

Δi_c = change in collector current = 10mA

R_L = load resistance = $2K\Omega$

$R_i = 1K\Omega$

$\beta = \frac{\Delta i_c}{\Delta i_b} = \frac{10\times10^{-3}}{100\times10^{-6}} = 100$

$R_g = \frac{R_L}{R_i} = \frac{2k}{1k} = 2$

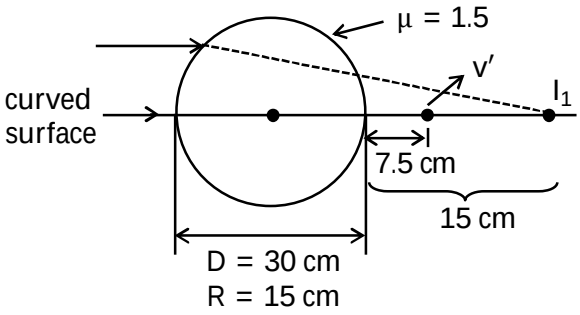
$P_{gain} = \beta^2 (R_g) = (100)^2 \times 2 = 2 \times 2 \times 10^4$

$P_a = 2 \times 10^4$

$\therefore$ $\boxed{x = 2}$

29. A parallel beam of light is allowed to fall on a transparent spherical globe of diameter 30 cm and refractive index 1.5. The distance from the centre of the globe at which the beam of light can converge is ____mm.

Sol. **(225)**



I[st] refraction

$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2-\mu_1}{R}$

$\mu_2 = 1.5$; μ_1 = air = 1

$\frac{1.5}{v} - \frac{1}{\infty} = \frac{0.5}{15}$

$\boxed{v = 45 \text{ cm}}$

2nd surface refraction

$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2-\mu_1}{R}$

$\mu_2 = 1$; $\mu_1 = 1.5$

$\frac{1}{v'} - \frac{1.5}{15} = \frac{0.5}{15}$

$\boxed{v' = 7.5 \text{ cm}}$

$\therefore$ distance from centre of globe at which light rays convergen = (R + 7.5)cm

= (15 + 7.5)cm

= 22.5 cm

= 225 mm

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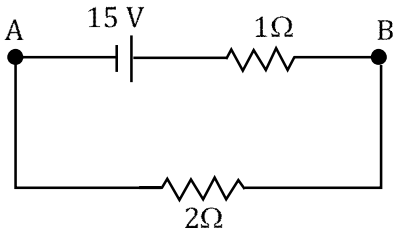
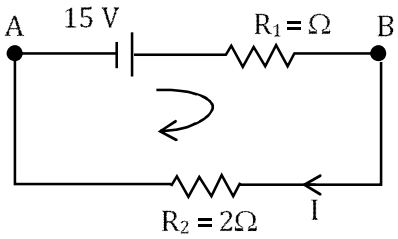
30. For the network shown below, the value of $V_B - V_A$ is _____V.



Sol. **(10)**



$I = \frac{E}{R_1+R_2}$ $\therefore I = \frac{15}{2+1} = 5A$

Applying KVL

$V_A + 15V - IR_1 - V_B = 0$

$V_A + 15 - 5(1) - V_B = 0$, $V_A - V_B = -10$

$\therefore \boxed{V_B - V_A = 10\ V}$

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>95 | 20%
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