FINAL JEE–MAIN EXAMINATION – JULY, 2022

(Held On Wednesday 27th July, 2022) **TIME : 9 : 00 AM to 12 : 00 NOON**

PHYSICS

TEST PAPER WITH SOLUTION

SECTION-A

1. A torque meter is calibrated to reference standards of mass, length and time each with 5% accuracy. After calibration, the measured torque with this torque meter will have net accuracy of :

(A) 15% (B) 25% (C) 75% (D) 5%

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. Dimensional formula for Torque

$[\tau] = [ML^2T^{-2}]$

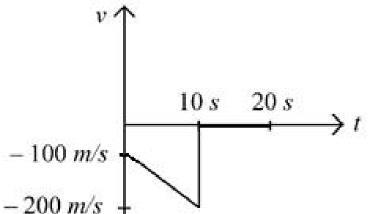
Now

Percentage error in torque = % τ = % M + 2 % L 2 % T

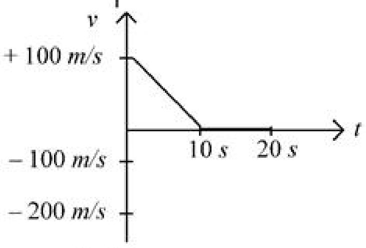
% τ = 25%

2. A bullet is shot vertically downwards with an initial velocity of 100 m/s from a certain height. Within 10 s, the bullet reaches the ground and instantaneously comes to rest due to the perfectly inelastic collision. The velocity-time curve for total time t = 20 s will be : (Take $g = 10\ m/s^2$)

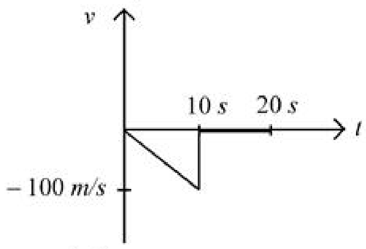
(A)



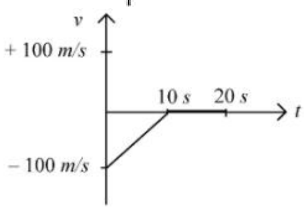
(B)



(C)



(D)



Official Ans. by NTA (A)

Allen Ans. (A)

Sol. V = –100 –10t

3. Sand is being dropped from a stationary dropper at a rate of 0.5 kgs^{-1} on a conveyor belt moving with a velocity of 5 ms^{-1}. The power needed to keep belt moving with the same velocity will be :

(A) 1.25 W (B) 2.5 W

(C) 6.25 W (D) 12.5 W

Official Ans. by NTA (D)

Allen Ans. (D)

Sol. Thrust = λV_{rel}

= 2.5 N

Now, Power =F × V = 12.5 W

4. A bag is gently dropped on a conveyor belt moving at a speed of 2 m/s. The coefficient of friction between the conveyor belt and bag is 0.4 Initially, the bag slips on the belt before it stops due to friction. The distance travelled by the bag on the belt during slipping motion is : [Take $g = 10\ m/s^{-2}$]

(A) 2 m (B) 0.5 m

(C) 3.2 m (D) 0.8 ms

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. In frame of belt

$a = \mu g = 4\ m/s^2$, v = 2m/s , u = 0

$v^2 = u^2 + 2as$

$\Rightarrow$ s = 0.5 m

5. Two cylindrical vessels of equal cross-sectional area 16 cm^2 contain water upto heights 100 cm and 150 cm respectively. The vessels are interconnected so that the water levels in them become equal. The work done by the force of gravity during the process, is [Take density of water = $10^3\ kg/m^3$ and $g = 10\ ms^{-2}$]

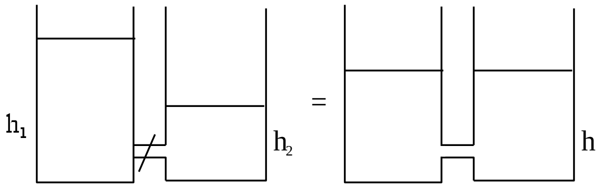
(A) 0.25 J (B) 1 J

(C) 8 J (D) 12 J

Official Ans. by NTA (B)

Allen Ans. (B)

Sol.



$$h = \frac{h_1 + h_2}{2}$$

Now,

$W = U_i - U_f$

$$W = (\rho A h_1)\ g\ \frac{h_1}{2} + (\rho\ A h_2) g \frac{h_2}{2} - \rho\ A(h_1+h_2)g$$

$$\left(\frac{h_1 + h_2}{4}\right)$$

$$W = \frac{\rho A g}{2}\left[h_1^2 + h_2^2 - \frac{(h_1 + h_2)^2}{2}\right]$$

W = 1 J

6. Two satellites A and B having masses in the ratio 4:3 are revolving in circular orbits of radii 3r and 4 r respectively around the earth. The ratio of total mechanical energy of A to B is :

(A) 9 : 16 (B) 16 : 9

(C) 1 : 1 (D) 4 : 3

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. Given that $\frac{m_1}{m_2} = \frac{4}{3}$, $\frac{r_1}{r_2} = \frac{3}{4}$

$$\text{Now TE} = \frac{1}{2}mv^2 + \left(\frac{-GMm}{r}\right)$$

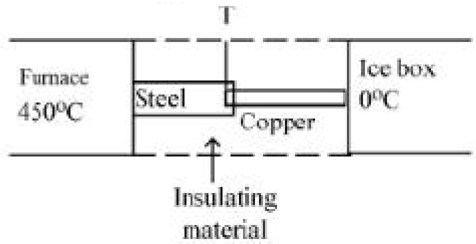
$$\text{but } \frac{mv^2}{r} = \frac{GMm}{r^2} \Rightarrow mv^2 = \frac{GMm}{r}$$

$$\Rightarrow \text{TE} = -\frac{GMm}{2r} \propto \frac{m}{r}$$

$$\frac{TE_1}{TE_2} = \frac{m_1}{m_2}\cdot\frac{r_2}{r_1} = \frac{4}{3}\times\frac{4}{3} = \frac{16}{9}$$

7. If K_1 and K_2 are the thermal conductivities L_1 and L_2 are the lengths and A_1 and A_2 are the cross sectional areas of steel and copper rods respectively such that $\frac{K_2}{K_1} = 9, \frac{A_1}{A_2} = 2, \frac{L_1}{L_2} = 2$.

Then, for the arrangement as shown in the figure. The value of temperature T of the steel – copper junction in the steady state will be :



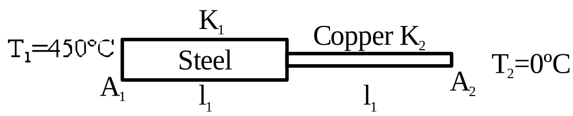
(A) 18ºC (B) 14 ºC

(C) 45 ºC (D) 150 ºC

Official Ans. by NTA (C)

Allen Ans. (C)

Sol.



$$\frac{d\theta}{dt} = \frac{K_1A_1}{l_1}(T_1 - T) = \frac{K_2A_2}{l_2}(T - T_2)$$

$$\Rightarrow \frac{450 - T}{T - 0} = \frac{K_2A_2l_1}{K_1A_1l_2} = 9\times\frac{1}{2}\times 2$$

$$\Rightarrow 450 - T = 9T \Rightarrow T = 45^\circ C$$

8. Read the following statements :

A. When small temperature difference between a liquid and its surrounding is doubled the rate of loss of heat of the liquid becomes twice.

B. Two bodies P and Q having equal surface areas are maintained at temperature 10ºC and 20 ºC. The thermal radiation emitted in a given time by P and Q are in the ratio 1 : 1.15

C. A carnot Engine working between 100 K and 400 K has an efficiency of 75%

D. When small temperature difference between a liquid and its surrounding is quadrupled, the rate of loss of heat of the liquid becomes twice.

Choose the correct answer from the options given below :

(A) A, B, C only (B) A, B only

(C) A, C only (D) B, C, D only

Official Ans. by NTA (A)

Allen Ans. (A)

Sol. Heat Transfer

A. by Newton's low of colling $\frac{d\theta}{dt} = \propto \Delta T$

B. $H = \frac{d\theta}{dt} = \sigma e A T^4 \Rightarrow \frac{H_P}{H_Q} = \left(\frac{T_P}{T_Q}\right)^4 = \left(\frac{283}{293}\right)^4$

$H_P : H_Q = 1\,(1.03)^4 = 1 : (1.03)^4 = 1 : 1.15$

$\Rightarrow$ B is correct

C. $\eta = 1 - \frac{100}{400} = \frac{3}{4} = 75\%$

D. is wrong as $\frac{d\theta}{dt} \propto \Delta T$

9. Same gas is filled in two vessels of the same volume at the same temperature. If the ratio of the number of molecules is 1:4, then

A. The r.m.s. velocity of gas molecules in two vessels will be the same.

B. The ratio of pressure in these vessels will be 1 : 4

C. The ratio of pressure will be 1 : 1

D. The r.m.s. velocity of gas molecules in two vessels will be in the ratio of 1 : 4

(A) A and C only (B) B and D only

(C) A and B only (D) C and D only

Official Ans. by NTA (C)

Allen Ans. (C)

Sol. **KTG**

A. $V_{Rms} = \sqrt{\frac{3RT}{M_w}} \Rightarrow V_{Rms}$ is same

B. $\frac{P_1}{P_2} = \frac{N_1}{N_2} \Rightarrow$ B is correct

Ans [A & B only are correct]

10. Two identical positive charges Q each are fixed at a distance of '2a' apart from each other. Another point charge q_0 with mass 'm' is placed at midpoint between two fixed charges. For a small displacement along the line joining the fixed charges, the charge q_0 executes SHM. The time period of oscillation of charge q_0 will be :

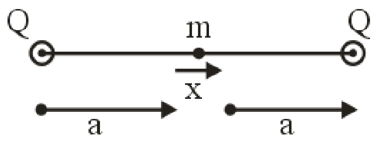
(A) $\sqrt{\frac{4\pi^3\varepsilon_0 m a^3}{q_0 Q}}$ (B) $\sqrt{\frac{q_0 Q}{4\pi^3\varepsilon_0 m a^3}}$

(C) $\sqrt{\frac{2\pi^2\varepsilon_0 m a^3}{q_0 Q}}$ (D) $\sqrt{\frac{8\pi^3\varepsilon_0 m a^3}{q_0 Q}}$

Official Ans. by NTA (A)

Allen Ans. (A)

Sol. **Electrostatics**



$F = m\,acc^n = \frac{KQq_0}{(a-x)^2} - \frac{KQq_0}{(a+x)^2}$

$m\,acc^n = \frac{KQq_0[2a][2x]}{(a^2-x^2)^2}$

$\Rightarrow acc^n \approx \left(\frac{4kQq_0}{ma^3}\right)x$

$T = 2\pi\sqrt{\frac{\pi\varepsilon_0 m a^3}{Qq_0}}$

$T = \sqrt{\frac{4\pi^3\varepsilon_0 m a^3}{Qq_0}}$

11. Two sources of equal emfs are connected in series. This combination is connected to an external resistance R. The internal resistances of the two sources are r_1 and r_2 ($r_1 > r_2$). If the potential difference across the source of internal resistance r_1 is zero then the value of R will be

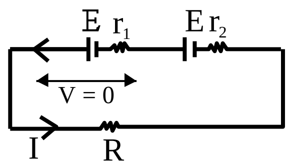
(A) $r_1 - r_2$ (B) $\frac{r_1 r_2}{r_1 + r_2}$

(C) $\frac{r_1 + r_2}{2}$ (D) $r_2 - r_1$

Official Ans. by NTA (A)

Allen Ans. (A)

Sol.



$I = \frac{2E}{r_1 + r_2 + R}$

$IR = E - Ir_2$

$I(R + r_2) = E$

$I = \frac{E}{R + r_2}$

$\frac{2E}{r_1 + r_2 + R} = \frac{E}{R + r_2}$

$2R + 2r_2 = r_1 + r_2 + R$

$R = r_1 - r_2$

12. Two bar magnets oscillate in a horizontal plane in earth's magnetic field with time periods of 3 s and 4 s respectively. If their moments of inertia are in the ratio of 3 : 2 then the ratio of their magnetic moments will e :

(A) 2 : 1 (B) 8 : 3

(C) 1 : 3 (D) 27 : 16

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. $T = 2\pi\sqrt{\frac{I}{MB_H}}$

$$\frac{T_1}{T_2} = \frac{2\pi\sqrt{\frac{I_1}{M_1B_H}}}{2\pi\sqrt{\frac{I_2}{M_2B_H}}} = \frac{3}{4}$$

$$\sqrt{\frac{I_1}{I_2}\times\frac{M_2}{M_1}} = \frac{3}{4}$$

$$\sqrt{\frac{I_1}{I_2}}\times\sqrt{\frac{M_2}{M_1}} = \frac{3}{4}$$

$$\sqrt{\frac{3}{2}}\times\sqrt{\frac{M_2}{M_1}} = \frac{3}{4}$$

$$\frac{3}{2}\times\frac{M_2}{M_1} = \frac{9}{16}$$

$$\frac{M_1}{M_2} = \frac{8}{3}$$

13. A magnet hung at 45° with magnetic meridian makes an angle of 60° with the horizontal. The actual value of the angle of dip is

(A) $\tan^{-1}\left(\sqrt{\frac{3}{2}}\right)$ (B) $\tan^{-1}\left(\sqrt{6}\right)$

(C) $\tan^{-1}\left(\sqrt{\frac{2}{3}}\right)$ (D) $\tan^{-1}\left(\sqrt{\frac{1}{2}}\right)$

Official Ans. by NTA (A)

Allen Ans. (A)

Sol. $\tan\theta' = \frac{\tan\theta}{\cos\alpha}$

$\theta' = 60°$

$\alpha = 45°$

$$\sqrt{3} = \frac{\tan\theta}{\frac{1}{\sqrt{2}}}$$

$$\tan\theta = \sqrt{\frac{3}{2}}$$

$$\theta = \tan^{-1}\sqrt{\frac{3}{2}}$$

14. A direct current of 4 A and an alternating current of peak value 4 A flow through resistance of 3 Ω and 2 Ω respectively. The ratio of heat produced in the two resistances in same interval of time will be :

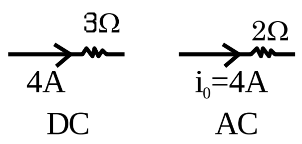
(A) 3 : 2 (B) 3 : 1

(C) 3 : 4 (D) 4 : 3

Official Ans. by NTA (B)

Allen Ans. (B)

Sol.



$H_1 = i^2R_1t$ $\quad H_2 = i_{rms}^2R_2t\left\{i_{rms} = \frac{i_0}{\sqrt{2}}\right\}$

$H_1 = 16(3)t$ $\quad H_2 = \frac{i_0^2}{2}R_2t$

$H_2 = 16t$

$H_1 : H_2 = 3 : 1$

15. A beam of light travelling along X-axis is described by the electric field $E_y = 900\sin\omega(t - x/c)$. The ratio of electric force to magnetic force on a charge q moving along Y-axis with a speed of $3\times10^7\ ms^{-1}$ will be :

[Given speed of light = $3\times10^8\ ms^{-1}$]

(A) 1 : 1 (B) 1 : 10

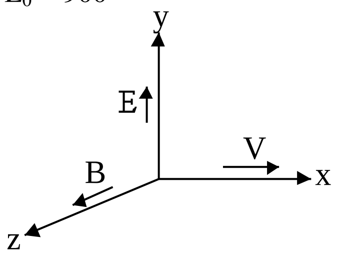
(C) 10 : 1 (D) 1 : 2

Official Ans. by NTA (C)

Allen Ans. (C)

Sol. $E_y = 900\sin\left(\omega t - \frac{\omega x}{c}\right)$

$E_0 = 900$



$F_E = qE_0$

$F_B = qvB_0$

$$\frac{F_E}{F_B} = \frac{E_0}{vB_0} = \frac{c}{v} = \frac{3\times10^8}{3\times10^7} = 10:1$$

16. A microscope was initially placed in air (refractive index 1). It is then immersed in oil (refractive index 2). For a light whose wavelength in air is λ, calculate the change of microscope's resolving power due to oil and choose the correct option

(A) Resolving power will be $\frac{1}{4}$ in the oil than it was in the air

(B) Resolving power will be twice in the oil than it was in the air.

(C) Resolving power will be four times in the oil than it was in the air.

(D) Resolving power will be $\frac{1}{2}$ in the oil than it was in the air.

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. $(R.P)_{air} = \frac{2\sin\theta}{1.22\lambda}$

$$(R.P)_{oil} = \frac{2\sin\theta}{1.22\lambda_{oil}} = \frac{2\sin\theta\times\mu}{1.22\lambda}$$

$(R.P)_{oil} = (R.P)_{air} \times 2$

17. An electron (mass m) with an initial velocity $\vec{v} = v_0\hat{i}(v_0 > 0)$ is moving in an electric field $\vec{E} = -E_0\hat{i}(E_0 > 0)$ where E_0 is constant. If at t = 0 de Broglie wavelength is $\lambda_0 = \frac{h}{mv_0}$, then its de Broglie wavelength after time t is given by

(A) λ_0

(B) $\lambda_0\left(1 + \frac{eE_0t}{mv_0}\right)$

(C) $\lambda_0 t$

(D) $\frac{\lambda_0}{\left(1 + \frac{eE_0t}{mv_0}\right)}$

Official Ans. by NTA (D)

Allen Ans. (D)

Sol. e ⟶ V_0

$E = -E_0\hat{i}$

$$\lambda_0 = \frac{h}{mv_0}$$

$$v = v_0 + \frac{eE_0t}{m}$$

$$\lambda = \frac{h}{mv} = \frac{h}{m\left(v_0 + \frac{eE_0}{m}t\right)}$$

$$\lambda' = \frac{h}{mv_0\left(1 + \frac{eE_0}{mv_0}t\right)}$$

$$\lambda' = \frac{\lambda_0}{\left(1 + \frac{eE_0}{mv_0}t\right)}$$

18. What is the half-life period of a radioactive material if its activity drops to 1/16th of its initial value of 30 years ?

(A) 9.5 years (B) 8.5 years

(C) 7.5 years (D) 10.5 years

Official Ans. by NTA (C)

Allen Ans. (C)

Sol. $A = A_0e^{-\lambda t}$

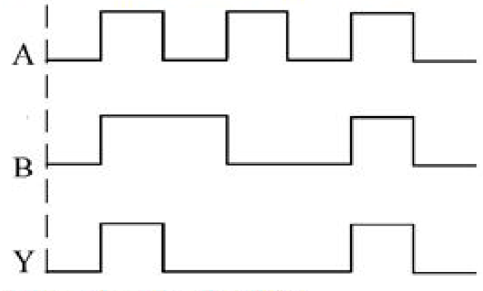
$$\Rightarrow -\lambda t = \ell n\left(\frac{A}{A_0}\right)$$

$$\Rightarrow -\frac{\ell n2}{t_{1/2}}\times 30 = \ell n\left(\frac{1}{16}\right)$$

$$\Rightarrow -\frac{\ell n2}{t_{1/2}}\times 30 = -4\ell n2$$

$$\Rightarrow t_{1/2} = \frac{30}{4} = 7.5 \text{ yrs}$$

19. A logic gate circuit has two inputs A and B and output Y. The voltage waveforms of A, B and Y are shown below



The logic gate circuit is

(A) AND gate (B) OR gate

(C) NOR gate (D) NAND gate

Official Ans. by NTA (A)

Allen Ans. (A)

Sol. By making Truth table

A	B	Output
0	0	0
1	1	1
0	1	0
1	0	0

Comparing with output of AND gate

A	B	AND
0	0	0
0	1	0
1	0	0
1	1	1

$\Rightarrow$logic gate present is AND gate

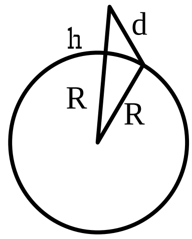
20. At a particular station, the TV transmission tower has a height of 100 m. To triple its coverage range, height of the tower should be increased to

(A) 200 m (B) 300 m

(C) 600 m (D) 900 m

Official Ans. by NTA (D)

Allen Ans. (D)



Sol.

Let d be range

$d^2 = (h+R)^2 - R^2$

$= h^2+R^2+2RH-R^2$

$d^2 = h^2+2Rh$

as R >>>> h then

$d \approx \sqrt{2Rh}$ …. (1)

Now, if coverage is to be increased 3 times

$3d = \sqrt{2Rh'}$ …. (2)

Divide 2 and 1 $\frac{3d}{d} = \sqrt{\frac{2Rh'}{2Rh}}$

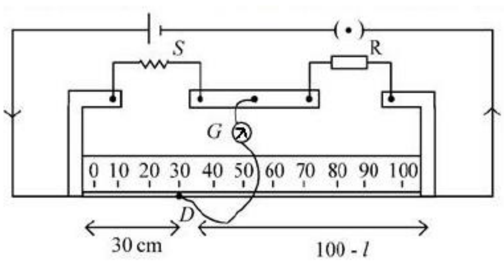
$9 = \frac{h'}{h}$

$9h = h'$

If h = 100 m then tower of height 900 m is required

SECTION-B

1. In meter bridge experiment for measuring unknown resistance 'S', the null point is obtained at a distance 30 cm from the left side as shown at point D. If R is 5.6 kΩ, then the value of unknown resistance 'S' will be ________ Ω.



Official Ans. by NTA (2400)

Allen Ans. (2400)

Sol. $\frac{S}{30} = \frac{5.6\times10^3}{70}$

$S = \frac{3}{7}\times5.6\times10^3 = 2400$

2. The one division of main scale of vernier callipers reads 1 mm and 10 divisions of Vernier scale is equal to the 9 divisions on main scale. When the two jaws of the instrument touch each other the zero of the Vernier lies to the right of zero of the main scale and its fourth division coincides with a main scale division. When a spherical bob is tightly placed between the two jaws, the zero of the Vernier scale lies in between 4.1 cm and 4.2 cm and 6^{th} Vernier division coincides with a main scale division. The diameter of the bob will be_____ 10^{-2} cm

Official Ans. by NTA (412)

Allen Ans. (412)

Sol. 10 VSD = 9 MSD

1 VST = .9 MSD

L.C. = .1 mm = .01 cm

+ve zero error = .4mm

= 0.04 cm

Negative zero error = 4.1 cm + 6 × .01

= 4.12 cm

= 412 × 10^{-2} cm

3. Two beams of light having intensities I and 4I interfere to produce a fringe pattern on a screen. The phase difference between the two beams are $\pi/2$ and $\pi/3$ at points A and B respectively. The difference between the resultant intensities at the two points is xI. The value of x will be _____ .

Official Ans. by NTA (2)

Allen Ans. (2)

Sol. $\phi_A = \dfrac{\pi}{2}$

$\phi_B = \dfrac{\pi}{3}$

$I_A = I + 4I + 2\sqrt{I}\ \sqrt{4I}\ \cos\left(\dfrac{\pi}{2}\right)$

= 5I + 4I (0) = 5I

$I_B = I + 4I + 2\sqrt{I}\ \sqrt{4I}\ \cos(60°)$

$= 5I + 4I \times \dfrac{1}{2} = 7I$

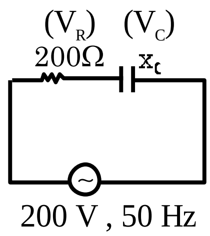
$I_B - I_A = 7I - 5I = 2I$, (x = 2)

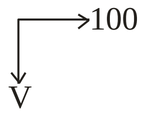
4. To light, a 50 W, 100 V lamp is connected, in series with a capacitor of capacitance $\dfrac{50}{\pi\sqrt{x}}\mu F$, with 200 V, 50Hz AC source. The value of x will be ____ .

Official Ans. by NTA (3)

Allen Ans. (3)

Sol. $P = \dfrac{V^2}{R} \Rightarrow R = \dfrac{V^2}{P}$





$R = \dfrac{100 \times 10^2}{50} = R = 200\Omega$

$V_R^2 + V_C^2 = V^2$

$(100)^2 + V_C^2 = (200)^2$

$i = \dfrac{100}{200} = \dfrac{1}{2}$; $V^2 = 40000$

$V = I \times X_C$; $V_C^2 = 30000$

$V_C = 100\sqrt{3}$

$X_C = 200\sqrt{3}$

$200\sqrt{3} = \dfrac{1}{\omega C}$

$C = \dfrac{1}{20 \times 50 \times 20\sqrt{3}} = \dfrac{50 \times 10^{-6}}{\sqrt{x}}$

$\sqrt{x} = 50 \times 10^{-6} \times 100 \times 200\sqrt{3}$

X = 3

5. A 1 m long copper wire carries a current of 1 A. If the cross section of the wire is 2.0 mm^2 and the resistivity of copper is 1.7×10^{-8} Ωm. the force experienced by moving electron in the wire is ______ $\times$ 10^{-23} N. (charge on electron $= 1.6 \times 10^{-19}$ C)

Official Ans. by NTA (136)

Allen Ans. (136)

Sol. $l = 1m$

$i = 1A$

$Area = 2 \times 10^{-6}$

$\rho = 1.7 \times 10^{-8}$

$$R = \frac{\rho \ell}{A} = \frac{1.7 \times 10^{-8} \times 1}{2 \times 10^{-5}} = \frac{1.7}{2} \times 10^{-2}$$

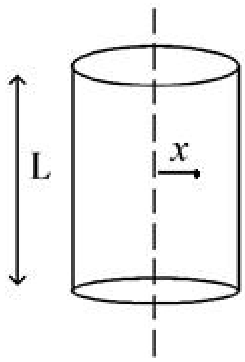
$$v = \frac{1.7}{2} \times 10^{-2}$$

$$F = 1.6 \times 10^{-19} \times \frac{1.7}{2} \times 10^{-2}$$

$= 1.36 \times 10^{-21}$

$= 136 \times 10^{-23}$

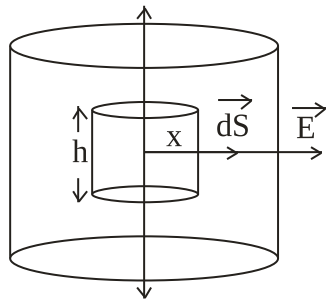
6. A long cylindrical volume contains a uniformly distributed charge of density ρ Cm^{-3}. The electric field inside the cylindrical volume at a distance $x = \frac{2\varepsilon_0}{\rho}$ m from its axis is ______ Vm^{-1}



Official Ans. by NTA (1)

Allen Ans. (1)

Sol.



$$\int E ds \cos 0 = \frac{q}{\varepsilon_0}$$

$$\Rightarrow E.2\pi xh = \frac{\rho \times \pi x^2 h}{\varepsilon_0}$$

$$\Rightarrow E = \frac{\rho x}{2\varepsilon_0}$$

$$\Rightarrow E = \frac{\rho}{2\varepsilon_0} \times \frac{2\varepsilon_0}{\rho} = 1$$

7. A mass 0.9 kg, attached to a horizontal spring, executes SHM with an amplitude A_1. When this mass passes through its mean position, then a smaller mass of 124 g is placed over it and both masses move together with amplitude A_2. If the ratio $\frac{A_1}{A_2}$ is $\frac{\alpha}{\alpha - 1}$, then the value of α will be ____ .

Official Ans. by NTA (16)

Allen Ans. (16)

Sol. $\frac{1}{2}kA^2 = \frac{p^2}{2m}$

$$\Rightarrow \left(\frac{A_1}{A_2}\right)^2 = \frac{m_2}{m_1} = \frac{1024}{900}$$

$$\Rightarrow \frac{A_1}{A_2} = \frac{32}{30} = \frac{16}{15} = \frac{16}{16-1}$$

$\therefore \alpha = 16$

8. A square aluminium (shear modulus is 25×10^9 Nm^{-2}) slab of side 60 cm and thickness 15 cm is subjected to a shearing force (on its narrow face) of 18.0×10^4 N. The lower edge is riveted to the floor. The displacement of the upper edge is ____ μ m.

Official Ans. by NTA (48)

Allen Ans. (48)

Sol. $\frac{F}{A} = \eta\frac{x}{\ell} \Rightarrow \frac{F\ell}{A\eta} = x$

$\Rightarrow x = \frac{18\times10^4 \times 60\times10^{-2}}{60\times10^{-2}\times15\times10^{-2}\times25\times10^9}$

$= 48 \times 10^{-6}$ m = 48 μ m

9. A pulley of radius 1.5 m is rotated about its axis by a force $F = (12t - 3t^2)$ N applied tangentially (while t is measured in seconds). If moment of inertia of the pulley about its axis of rotation is 4.5 kg m^2, the number of rotations made by the pulley before its direction of motion is reversed, will be $\frac{K}{\pi}$. The value of K is ____ .

Official Ans. by NTA (18)

Allen Ans. (18)

Sol. $\tau = I\alpha \Rightarrow (12t - 3t^2)1.5 = 4.5\,\alpha$

$\Rightarrow \alpha = 4t - t^2$

$\Rightarrow \frac{d\omega}{dt} = 4t - t^2 \Rightarrow \omega = \int_0^t (4t - t^2)dt$

$\Rightarrow \omega = 2t^2 - t^3/3$

For $\omega = 0 = 2t^2 - \frac{t^3}{3} \Rightarrow t^2\left(2 - \frac{t}{3}\right) = 0$

$\Rightarrow t = 0, 6.$

$\frac{d\theta}{dt} = 2t^2 - \frac{t^3}{3} \Rightarrow \theta = \int_0^6 (2t^2 - \frac{t^3}{3})dt$

$= \left[\frac{2t^3}{3} - \frac{t^4}{12}\right]_0^6$

$= 6^3\left(\frac{2}{3} - \frac{6}{12}\right) = 6^3\left(\frac{8-6}{12}\right)$

$= \frac{6^3}{6} = 36$

No. of revolutions $= \frac{36}{2\pi} = \frac{18}{\pi}$

$\therefore K = 18$

10. A ball of mass m is thrown vertically upward. Another ball of mass 2 m is thrown an angle θ with the vertical. Both the balls stay in air for the same period of time. The ratio of the heights attained by the two balls respectively is $\frac{1}{x}$. The value of x is _____ .

Official Ans. by NTA (1)

Allen Ans. (1)

Sol. Time of flight is same

$\Rightarrow$ vertical component of velocity is same

$\Rightarrow H_{max}$ is same