JEE Main 2021 Paper

Date: 25th February 2021 (Shift-2)

Subject: Physics

Section - A

1. Match List I with List II.

List I		**List II**
(a)	Rectifier	(i) Used either for stepping up or stepping down the A.C. Voltage
(b)	Stabilizer	(ii) Used to convert A.C. voltage into D.C. voltage
(c)	Transformer	(iii) Used to remove any ripple in the rectified output voltage
(d)	Filter	(iv) Used for constant output voltage even when the input voltage or load current change

Choose the correct answer form the options given below:

(1)(a)-(ii), (b)- (i), (c)-(iv), (d)-(iii)

(2)(a)-(ii), (b)- (iv), (c)-(i), (d)-(iii)

(3)(a)-(ii), (b)- (i), (c)-(iii), (d)-(iv)

(4 (a)-(iii), (b)- (iv), (c)-(i), (d)-(ii)

Ans. **(2)**

Sol. (a) Rectifier:- used to convert A.C voltage into D.C. Voltage.

(b) Stabilizer:- used for constant output voltage even when the input voltage or load current change

(c) Transformer:- used either for stepping up or stepping down the A.C. voltage.

(d) Filter:- used to remove any ripple in the rectified output voltage.

2. $Y = A \sin(\omega t + \phi_0)$ is the time – displacement equation of an SHM, At t = 0, the displacement of the particle is $Y = \frac{A}{2}$ and it is moving along negative x-direction. Then, the initial phase angle ϕ_0 will be.

(1) $\frac{\pi}{6}$

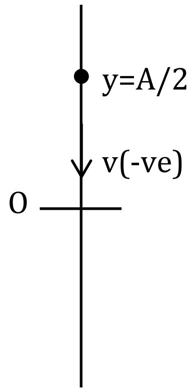
(2) $\frac{\pi}{3}$

(3) $\frac{2\pi}{3}$

(4) $\frac{5\pi}{6}$

Ans. **(4)**

Sol.



$y = A \sin(\omega t + \phi)$

$t = 0, x = \frac{A}{2}$

$\frac{1}{2} = \sin\phi$

$\phi = \frac{\pi}{6}, \frac{5\pi}{6}$

$v = \frac{dy}{dt} = A\,\omega\cos(\omega t + \phi)$

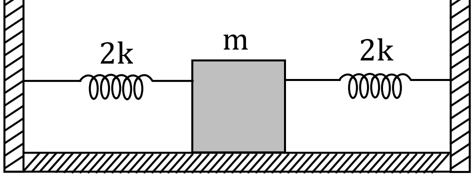
$t = 0, v = A\,\omega\cos\phi$

$\phi = \frac{\pi}{6}$, for v (positive)

$\phi = \frac{5\pi}{6}$, for v (negative)

$\therefore \phi = \frac{5\pi}{6}$

3. Two identical springs of spring constant '2K' are attached to a block of mass m and to fixed support (see figure). When the mass is displaced from equilibrium position on either side, it executes simple harmonic motion. Then, time period of oscillations of this system is:

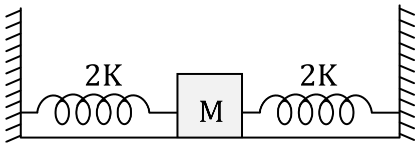


(1) $\pi\sqrt{\frac{m}{k}}$ (2) $\pi\sqrt{\frac{m}{2k}}$

(3) $2\pi\sqrt{\frac{m}{k}}$ (4) $2\pi\sqrt{\frac{m}{2k}}$

Ans. (1)

Sol.



Springs are in parallel combination.

Hence, $K_{eff} = 2k + 2k = 4k$

$$\because T = 2\pi\sqrt{\frac{m}{k_{eff}}}$$

$$= 2\pi\sqrt{\frac{m}{4k}}$$

$$T = \pi\sqrt{\frac{m}{k}}$$

4. The wavelength of the photon emitted by a hydrogen atom when an electron makes a transition from n = 2 to n = 1 state is:

(1)194.8 nm (2) 490.7 nm

(3) 913.3 nm (4) 121.8 nm

Ans. (4)

Sol. $\Delta E = 10.2$ eV is the energy difference between the state n = 2 & n = 1

$\Delta E = -3.4-(-13.6)=10.2$ eV

$\frac{hc}{\lambda} = 10.2$ ev

$\lambda = \frac{hc}{(10.2)e}$ (in meters) where 'e' = 1.6×10^{-19} J/V

$= \frac{12400}{10.2}$ Å (because hc = 12400 eV nm)

= 121.56 nm

$\simeq$121.8 nm

5. In a ferromagnetic material below the Curie temperature, a domain is defined as:

(1) a macroscopic region with consecutive magnetic diploes oriented in opposite direction.

(2) a macroscopic region with zero magnetization.

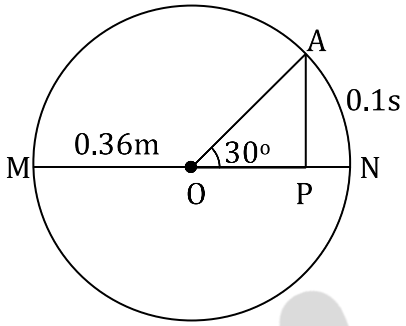
(3) a macroscopic region with saturation magnetization.

(4) a macroscopic region with randomly oriented magnetic dipoles.

Ans. (3)

Sol. In a ferromagnetic material below the Curie temperature, domain is defined as a macroscopic region with saturation magnetization.

6. The point A moves with a uniform speed along the circumference of a circle of radius 0.36m and cover 30^o in 0.1s. The perpendicular projection 'P' form 'A' on the diameter MN represents the simple harmonic motion of 'P'. The restoring force per unit mass when P touches M will be:

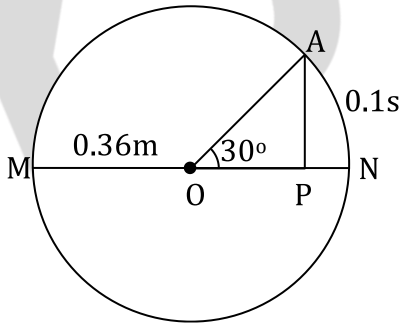


(1)100 N (2)50 N

(3)9.87 N (4)0.49 N

Ans. (3)

Sol.



The point a covers 30^o in 0.1 sec.

Means

$\frac{\pi}{6} \rightarrow 0.1$sec.

$1 \longrightarrow \frac{0.1}{\frac{\pi}{6}}$

$2\pi = \longrightarrow \frac{0.1 \times 6}{\pi} \times 2\pi$

T = 1.2 sec.

We know that $\omega = \frac{2\pi}{T}$

$\omega = \frac{2\pi}{1.2}$

Restoring force (F) = $m\omega^2 A$

Then, Restoring force per unit mass $\left(\frac{F}{m}\right) = \omega^2 A$

$\left(\frac{F}{m}\right) = \left(\frac{2\pi}{1.2}\right)^2 \times 0.36$

$\cong 9.87$ N

7. The stopping potential for electrons emitted from a photosensitive surface illuminated by light of wavelength 491 nm is 0.710 V. When the incident wavelength is changed to a new value, the stopping potential is 1.43 V. The new wavelength is:

(1)400 nm (2)382 nm

(3)309 nm (4)329 nm

Ans. **(2)**

Sol. From the photoelectric effect equation

$\frac{hc}{\lambda} = \phi + ev_s$

where V_s is the stopping potential and ϕ is work function of the metal.

So, $ev_{s_1} = \frac{hc}{\lambda_1} - \phi$ ......(i)

$ev_{s_2} = \frac{hc}{\lambda_2} - \phi$ .....(ii)

Subtract equation (i) from equation (ii)

$ev_{s_1} - ev_{s_2} = \frac{hc}{\lambda_1} - \frac{hc}{\lambda_2}$

$v_{s_1} - v_{s_2} = \frac{hc}{e}\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)$

$(0.710 - 1.43) = 1240\left(\frac{1}{491} - \frac{1}{\lambda_2}\right)$

(because hc = 1240 eV nm)

$\frac{-0.72}{1240} = \frac{1}{491} - \frac{1}{\lambda_2}$

$\frac{1}{\lambda_2} = \frac{1}{491} + \frac{0.72}{1240}$

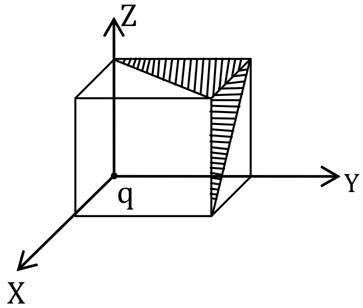
$\frac{1}{\lambda_2} = 0.00203 + 0.00058$

$\frac{1}{\lambda_2} = 0.00261$

$\lambda_2 = 383.14$

$\lambda_2 \simeq 382$ nm

8. A charge 'q' is placed at one corner of a cube as shown in figure. The flux of electrostatic field $\vec{E}$ though the shaded area is:



(1) $\frac{q}{48\varepsilon_0}$ (2) $\frac{q}{8\varepsilon_0}$

(3) $\frac{q}{24\varepsilon_0}$ (4) $\frac{q}{4\varepsilon_0}$

Ans. (3)

Sol. Total flux through the cube = $\frac{q}{\epsilon_0} \times \frac{1}{8} = \frac{q}{8\epsilon_0}$

Total flux through one "outer" face of the cube = $\frac{q}{8\epsilon_0} \times \frac{1}{3} = \frac{q}{24\epsilon_0}$

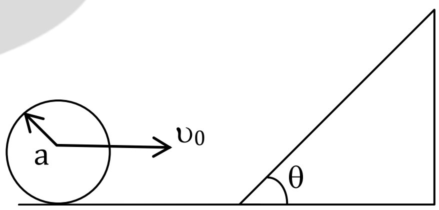
[Because there is flux only through 3 faces]

Hence, total flux through shaded area

$\phi_T = \left(\frac{q}{24\varepsilon_0} + \frac{q}{24\varepsilon_0}\right) \times \frac{1}{2}$ [half of each face is shaded]

$\phi_T = \frac{q}{24\varepsilon_0}$

9. A sphere of radius 'a' and mass 'm' rolls along horizontal plane with contant speed υ_0. It encounters an inclined plane at angle θ and climbs upward. Assuming that it rolls without slipping how far up the sphere will travel (along the incline)?

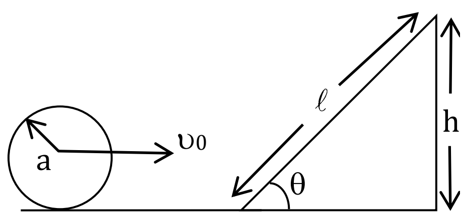


(1) $\frac{2}{5}\frac{\upsilon_0^2}{g\sin\theta}$ (2) $\frac{10\upsilon_0^2}{7g\sin\theta}$

(3) $\frac{\upsilon_0^2}{5g\sin\theta}$ (4) $\frac{7\upsilon_0^2}{10g\sin\theta}$

Ans. (4)

Sol.



From energy conservation

$mgh = \frac{1}{2}m\upsilon_0^2 + \frac{1}{2}I\omega^2$

$mgh = \frac{1}{2}m\upsilon_0^2 + \frac{1}{2} \times \frac{2}{5}ma^2 \times \frac{\upsilon_0{}^2}{a^2}$

$gh = \frac{1}{2}\upsilon_0{}^2 + \frac{1}{5}\upsilon_0{}^2$

$gh = \frac{7}{10}\upsilon_0{}^2$

$h = \frac{7}{10}\frac{\upsilon_0{}^2}{g}$

From triangle, $\sin\theta = \frac{h}{\ell}$

Then, $h = \ell\sin\theta$

$\ell\sin\theta = \frac{7}{10}\frac{\upsilon_0{}^2}{g}$

$\ell = \frac{7}{10}\frac{\upsilon_0{}^2}{g\sin\theta}$

10. Consider the diffraction pattern obtained from the sunlight incident on a pinhole of diameter 0.1 μm. If the diameter of the pinhole is slightly increased, it will affect the diffraction pattern such that:

(1) its size decreases, but intensity increases

(2) its size increases, but intensity decreases

(3) its size increases, and intensity increases

(4) its size decreases, and intensity decreases

Ans. (1)

Sol. For diffraction through a single slit, for first minimum.

$$\text{Sin}\theta = \frac{1.22\lambda}{D}$$

If D is increased, then sinθ will decrease i.e θ will decrease

∴ size of circular fringe will decrease but intensity increases

11. An electron of mass m_e and a proton of mass $m_p = 1836\ m_e$ are moving with the same speed. The ratio of their de Broglie wavelength $\frac{\lambda_{electron}}{\lambda_{Proton}}$ will be:

(1)918

(2)1836

(3)$\frac{1}{1836}$

(4)1

Ans. (2)

Sol. Given mass of electron = m_e

Mass of proton = m_p

∴ given $m_p = 1836\ m_e$

From de-Broglie wavelength

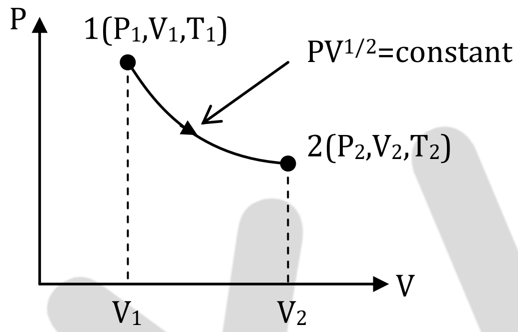
$\lambda = \frac{h}{p} = \frac{h}{mv}$

$\frac{\lambda_e}{\lambda_p} = \frac{m_p}{m_e}$ [v is same]

$= \frac{1836 m_e}{m_e}$

$\frac{\lambda_e}{\lambda_p} = 1836$

12. Thermodynamic process is shown below on a P-V diagram for one mole of an ideal gas. If $V_2 = 2V_1$ then the ratio of temperature T_2/T_1 is:



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

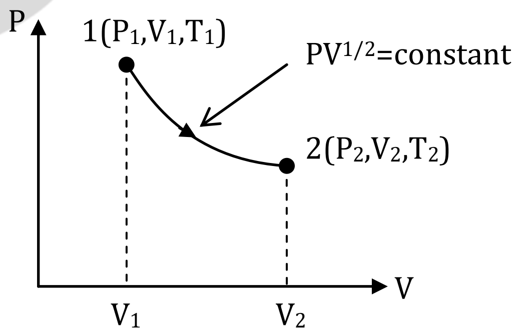
(2) $\frac{1}{2}$

(3) 2

(4) $\sqrt{2}$

Ans. **(4)**

Sol.



From P-V diagram,

Given $PV^{1/2}$ = constant .....(i)

We know that

PV = nRT

$P \propto \left(\frac{T}{V}\right)$ [for 1 mole]

Put in equation (i)

$\left(\frac{T}{V}\right)(V)^{1/2}$ = constant

$T \propto V^{1/2}$

$\frac{T_2}{T_1} = \sqrt{\frac{V_2}{V_1}}$

$\frac{T_2}{T_1} = \sqrt{\frac{2V_1}{V_1}}$

$\frac{T_2}{T_1} = \sqrt{2}$

13. A stone is dropped from the top of a building. When it crosses a point 5m below the top, another stone starts to fall from a point 25m below the top, both stones reach the bottom of building simultaneously. The height of the building is: [Take g = 10 m/s2]

(1)45 m

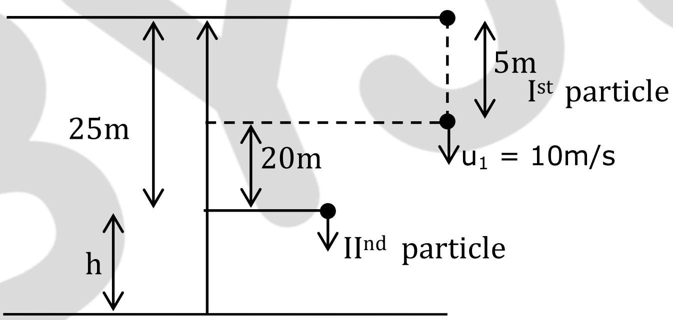
(2)35 m

(3)25 m

(4)50 m

Ans. (1)

Sol.



Velocity of particle (1) at 5m below top $u_1 = \sqrt{2gh} = \sqrt{2 \times 10 \times 5} = 10$ m/s

For particle (1), using 2nd equation of motion

$20 + h = 10t + \frac{1}{2}gt^2$ .....(i)

For particle (2), using 2nd equation of motion

$h = \frac{1}{2}gt^2$ .....(ii)

Put equation (ii) in equation (i)

$20 + \frac{1}{2}gt^2 = 10t + \frac{1}{2}gt^2$

t = 2sec.

Put in equation (ii)

$h = \frac{1}{2}gt^2$

$= \frac{1}{2} \times 10 \times 2^2$

h = 20m

The height of the building = 25 + 20 = 45m

14. If a message signal of frequency 'f_m' is amplitude modulated with a carrier signal of frequency 'f_c' and radiated through an antenna, the wavelength of the corresponding signal in air is:

[Given, C is the speed of electromagnetic waves in vacuum / air]

(1) $\frac{c}{f_c+f_m}$ (2) $\frac{c}{f_c-f_m}$

(3) $\frac{c}{f_m}$ (4) $\frac{c}{f_c}$

Ans. (4)

Sol. Equation of amplitude modulated wave y = $(A_c + A_m \sin \omega_m t) \sin \omega_c t$

Here angular frequency of modulated signal = ω_c

Thus frequency of modulated signal = f_c

Thus wavelength = $\frac{c}{f_c}$

15. Given below are two statements:

Statement I: In a diatomic molecule, the rotational energy at a given temperature obeys Maxwell's distribution.

Statement II: in a diatomic molecule, the rotational energy at a given temperature equals the translational kinetic energy for each molecule.

In the light of the above statements, choose the correct answer from the options given below:

(1)Both statement I and statement II are false.

(2)Both statement I and statement II are true.

(3)Statement I is false but statement II is true

(4)Statement I is true but statement II is false.

Ans. (4)

Sol. The translational kinetic energy & rotational kinetic energy both obey Maxwell's distribution independent of each other.

T.K.E. of diatomic molecules = $\frac{3}{2}kT$ [3 translational D.O.F.]

R.K.E. of diatomic molecules = $\frac{2}{2}kT$ = [2 rotational D.O.F.]

So statement I is true but statement II is false.

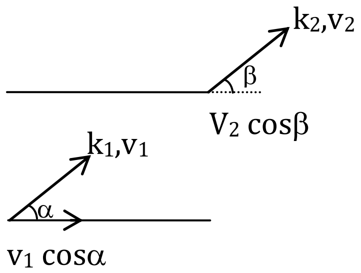
16. An electron with kinetic energy K_1 enters between parallel plates of a capacitor at an angle 'α' with the plates. It leaves the plates at angle 'β' with kinetic energy K_2. Then the ratio of kinetic energies $K_1 : K_2$ will be:

(1) $\frac{\sin^2\beta}{\cos^2\alpha}$ (2) $\frac{\cos^2\beta}{\cos^2\alpha}$

(3) $\frac{\cos\beta}{\sin\alpha}$ (4) $\frac{\cos\beta}{\cos\alpha}$

Ans. **(2)**

Sol.



$\because$ $v_1\cos\alpha = v_2\cos\beta$ [electric field inside a parallel plate capacitor is perpendicular to the plates, hence, there will be no change in parallel component of velocity]

$\frac{v_1}{v_2} = \frac{\cos\beta}{\cos\alpha}$

Then the ratio of kinetic energies

$\frac{k_1}{k_2} = \frac{\frac{1}{2}mv_1^{\,2}}{\frac{1}{2}mv_2^{\,2}} = \left(\frac{v_1}{v_2}\right)^2 = \left(\frac{\cos\beta}{\cos\alpha}\right)^2$

$\frac{k_1}{k_2} = \frac{\cos^2\beta}{\cos^2\alpha}$

17. An LCR circuit contains resistance of 110 Ω and a supply of 220 V at 300 rad/s angular frequency. If only capacitance is removed from the circuit, current lags behind the voltage by 45°. If on the other hand, only inductor is removed the current leads by 45° with the applied voltage. The rms current flowing in the circuit will be:

(1)2.5 A (2)2 A

(3)1 A (4)1.5 A

Ans. **(2)**

Sol. When L and C are connected with R in series the circuit will come in resonance

So, current in the circuit will be:

$I_{rms} = \frac{V_{rms}}{R} = \frac{220}{110} = 2\text{ A}$

18. For extrinsic semiconductors: when doping level is increased;

(1) Fermi–level of p and n-type semiconductors will not be affected.

(2) Fermi–level of p-type semiconductors will go downward and Fermi–level of n-type semiconductor will go upward.

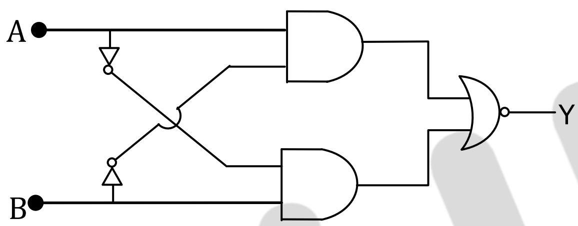
(3)Fermi–level of both p–type and n–type semiconductors will go upward for $T > T_F$ K and downward for $T < T_F$K, where T_F is Fermi temperature.

(4) Fermi–level of p-type semiconductor will go upward and Fermi–level of n–type semiconductors will go downward.

Ans. **(2)**

Sol. In n-type semiconductor pentavalent impurity is added. Each pentavalent impurity donates a free electron. So the Fermi-level of n-type semiconductor will go upward .
and In p-type semiconductor trivalent impurity is added. Each trivalent impurity creates a hole in the valence band. So the Fermi-level of p-type semiconductor will go downward.

19. The truth table for the following logic circuit is:



(1)

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	0

(2)

A	B	Y
0	0	0
0	1	1
1	0	0
1	1	1

(3)

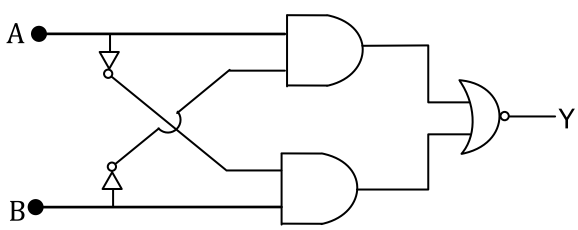
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

(4)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

Ans. **(4)**

Sol.



If A = B = 0 then output y = 1

If A = B = 1 then output y = 1

20. If e is the electronic charged, c is the speed of light in free space and h is planck's constant, the quantity $\frac{1}{4\pi\varepsilon_0}\frac{|e|^2}{hc}$ has dimensions of :

(1) $[LC^{-1}]$ (2) $[M^0 L^0 T^0]$

(3) $[M L T^0]$ (4) $[M L T^{-1}]$

Ans. **(2)**

Sol. Given

e = electronic charge

c = speed of light in free space

h = planck's constant

$\frac{1}{4\pi\varepsilon_0}\frac{e^2}{hc} = \frac{ke^2}{hc} \times \frac{\lambda^2}{\lambda^2}$ [multiply and divide by lambda = wavelength]

$= \frac{F\times\lambda}{E}$ [$\frac{ke^2}{\lambda^2}$ has dimensions of force and $\frac{hc}{\lambda} = E$]

$= \frac{E}{E}$ [F× λ has dimension of E]

= dimensionless

$= [M^0 L^0 T^0]$

SECTION – B

1. The percentage increase in the speed of transverse waves produced in a stretched string if the tension is increased by 4% will be __________%.

Ans. **2**

Sol. Speed of transverse wave is

$V = \sqrt{\frac{T}{\mu}}$

Taking log on both sides

$\ell n\, v = \frac{1}{2}\ell nT - \frac{1}{2}\ell n\mu$

$\frac{\Delta v}{v} = \frac{1}{2}\frac{\Delta T}{T} \Rightarrow \frac{\Delta v}{v} \times 100 = \frac{1}{2}\ \frac{\Delta T}{T} \times 100$

$= \frac{1}{2} \times 4$ [μ is constant for a string]

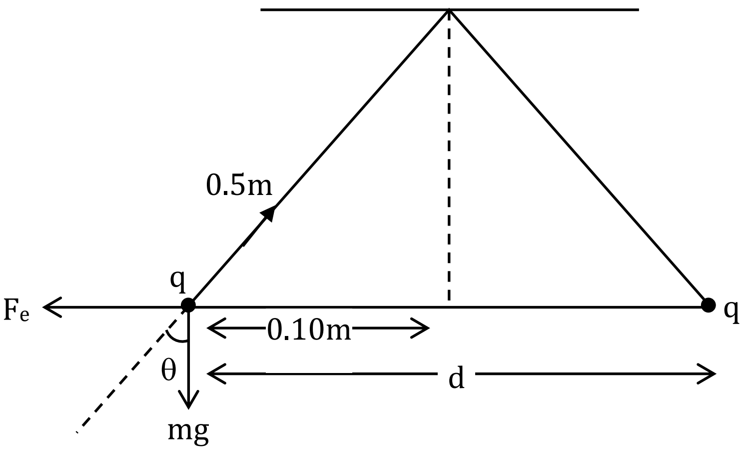
$\frac{\Delta v}{v} \times 100 = 2\%$

2. Two small spheres each of mass 10 mg are suspended from a point by threads 0.5 m long. They are equally charged and repel each other to a distance of 0.20 m. Then charge on each of the sphere is $\frac{a}{21} \times 10^{-8}$C. The value of 'a' will be_______.

[Take $g = 10\ m/s^2$]

Ans. **20**

Sol.



From FBD, $T\sin\theta = \frac{kq^2}{d^2}$ and $T\cos\theta = mg$

Dividing them,

$mg\tan\theta = \frac{kq^2}{d^2}$

$q = \sqrt{\frac{mg\tan\theta}{25k}}$

$= \sqrt{\frac{10\times10^{-6}\times10\times1}{\sqrt{24}(25)9\times10^{9}}}$

$= \sqrt{\frac{10^{-4}\times4}{\sqrt{24}\times25\times4\times9\times10^{9}}}$

$= \frac{2}{3}\sqrt{\frac{10^{-4}}{\sqrt{24}\times10^{11}}}$

Thus $\frac{a}{21}\times10^{-8} = \frac{2}{3}\times\sqrt{\frac{10^{-15}}{\sqrt{24}}} = \frac{2}{3}\sqrt{\frac{10^{-16}}{0.49}}$

$a = \frac{2\times21}{3\times0.7} = 20$

3. The peak electric field produced by the radiation coming from the 8 W bulb at a distance of 10 m is $\frac{x}{10}\sqrt{\frac{\mu_0 c}{\pi}}\frac{V}{m}$. The efficiency of the bulb is 10% and it is a point source.The value of x is ___.

Ans. 2

Sol. Intensity $I = \frac{1}{2}c\in_0 E_0{}^2$

Intensity = Power / Area = $8/(4\pi\times10^2)$

$\frac{8}{4\pi\times10^2}\times\frac{1}{2} = \frac{1}{4}\times c\times\frac{1}{\mu_0 c^2}\times E_0^2$ [Multiply by ½ and $\in_0 = 1/\mu_0 c^2$]

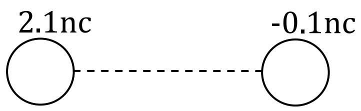
$E_0 = \frac{2}{10}\sqrt{\frac{\mu_0 c}{\pi}}$

$\Rightarrow x = 2$

4. Two identical conducting spheres with negligible volume have 2.1nC and -0.1nC charges, respectively. They are brought into contact and then separated by a distance of 0.5 m. The electrostatic force acting between the spheres is ______× 10^{-9} N. [Given : $4\pi\varepsilon_0 = \frac{1}{9\times10^9}$ SI unit]

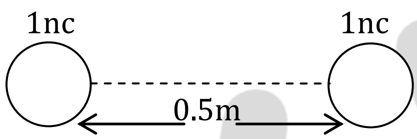
Ans. **36**

Sol.



When they are brought into contact& then separated by a distance = 0.5 m

Then charge distribution will be



The electrostatic force acting b/w the sphere is

$F_e = \frac{kq_1q_2}{r^2}$

$= \frac{9\times10^9\times1\times10^{-9}\times1\times10^{-9}}{(0.5)^2}$

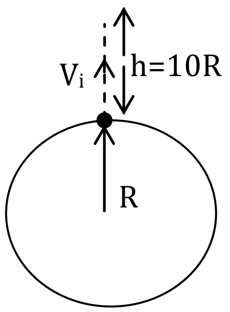
$= \frac{900}{25} \times 10^{-9}$

$F_e = 36 \times 10^{-9}$ N

5. The initial velocity υ_1 required to project a body vertically upward from the surface of the earth to just reach a height of 10R, where R is the radius of the earth, may be described in terms of escape velocity υ_e such that $\upsilon_i = \sqrt{\frac{x}{y}} \times \upsilon_e$. The value of x will be______.

Ans. **20**

Sol.



Here R = radius of the earth

From energy conservation

$$\frac{-Gm_em}{R}+\frac{1}{2}mv_i^2=\frac{-Gm_em}{11R}+0$$

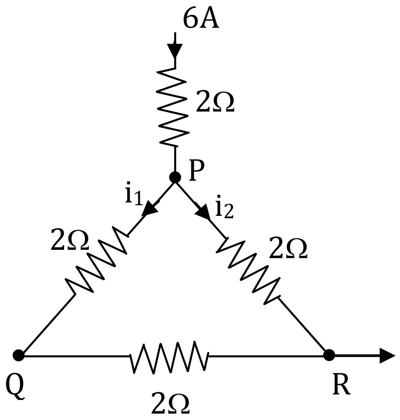
$$\frac{1}{2}mv_i^2=\frac{10}{11}\frac{Gm_em}{R}$$

$$V_i=\sqrt{\frac{20}{11}\frac{Gm_e}{R}}$$

$$V_i=\sqrt{\frac{20}{11}}v_e \qquad \left\{\because \text{escapc velocity } v_e=\sqrt{\frac{Gm_e}{R}}\right\}$$

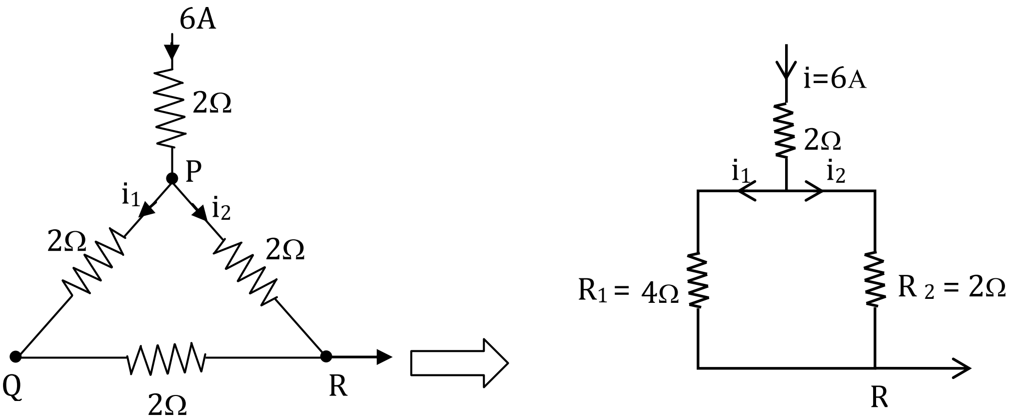
Then the value of x = 20

6. A current of 6A enters one corner P of an equilateral triangle PQR having 3 wires of resistance 21Ω each and leaves by the corner R. The currents i_1 in ampere is______.



Ans. **2**

Sol.



The current $i_1 = \left(\frac{R_2}{R_1+R_2}\right) i$

$= \left(\frac{2}{4+2}\right) \times 6$

$i_1 = 2A$

7. The wavelength of an X-ray beam is 10 Å. The mass of a fictitious particle having the same energy as that of the X – ray photons is $\frac{x}{3}$ h kg. The value of x is ______.

Ans. **10**

Sol. Given wavelength of an X-ray beam = 10Å

Q $E = \frac{hc}{\lambda} = mc^2$

$m = \frac{h}{c\lambda}$ will be the mass of a particle having the same energy

The mass of a fictitious particle having the same energy as that of the X-ray photons = $\frac{x}{3}$ hkg

$\frac{x}{3} h = \frac{h}{c\lambda}$

$x = \frac{3}{c\lambda}$

$= \frac{3}{3\times10^8\times10\times10^{-10}}$

x = 10

8. A reversible heat engine converts one- fourth of the heat input into work. When the temperature of the sink is reduced by 52 K, its efficiency is doubled. The temperature in Kelvin of the source will be______.

Ans. **208**

Sol. $\because\ n = \frac{W}{Q_{in}} = \frac{1}{4}$

$\frac{1}{4} = 1 - \frac{T_2}{T_1}$ [for reversible heat engine]

$\frac{T_2}{T_1} = \frac{3}{4}$

When the temperature of the sink is reduced by 52k then its efficiency is doubled.

$\frac{1}{2} = 1 - \frac{(T_2-52)}{T_1}$

$\frac{T_2-52}{T_1} = \frac{1}{2}$

$\frac{T_2}{T_1}\frac{-52}{T_1} = \frac{1}{2}$

$\frac{3}{4} - \frac{52}{T_1} = \frac{1}{2}$

$\frac{52}{T_1} = \frac{1}{4}$

T_1 = 208 K is the source temperature.

9. Two particles having masses 4g and 16g respectively are moving with equal kinetic energies. The ratio of the magnitudes of their linear momentum is n:2. The value of n will be_____.

Ans. **1**

Sol. ∵ Relation b/w kinetic energy & momentum is

$p = \sqrt{2mKE}$ (∵ KE = same)

$\frac{p_1}{p_2} = \sqrt{\frac{m_1}{m_2}}$

$\frac{n}{2} = \sqrt{\frac{4}{16}}$

n = 1

10. If $\vec{P} \times \vec{Q} = \vec{Q} \times \vec{P}$, the angle between $\vec{P}$ and $\vec{Q}$ is $\theta(0^o < \theta < 360^o)$. The value of 'θ' will be ____.

Ans. **180**

Sol. If $\vec{P} \times \vec{Q} = \vec{Q} \times \vec{P}$

$\vec{P} \times \vec{Q} = -\vec{P} \times \vec{Q}$

$2(\vec{P} \times \vec{Q}) = 0$

Or $(\vec{P} \times \vec{Q}) = 0$

Only if $\vec{P} = 0$ or $\vec{Q} = 0$

Or the angle b/w $\vec{P}$ & $\vec{Q}$ is 180^o $(0^o < \theta < 360^o)$

So $\theta = 180^o$