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PHYSICS

NEET and JEE Main 2020 : 45 Days Crash Course

Problem Solving Class
(Electrostatics, Gravitation and Radiation)

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Two charges q_1 and q_2 are placed in vacuum at a distance d and the force acting between them is F. If a medium of dielectric constant 4 is introduced around them, the force now will be

(a) $4F$

(b) $2F$

(c) $\frac{F}{2}$

(d) $\frac{F}{4}$

$$\frac{F_v}{F_m} = K = \varepsilon_r$$

$$F_m = \frac{F_v}{K} = \frac{F}{4}$$

P-Q1416-Solution

Ans [D]

In the presence of medium force becomes $\frac{1}{K}$ *times* .

$$F' = \frac{F}{4}$$

When dielectric insert it reduce the force by dielectric constant time

$$F_e = \frac{1}{4\pi K\varepsilon_0}\frac{q_1q_2}{r^2}$$

P-Q1418

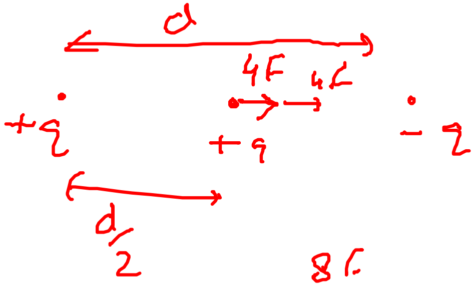
Two similar spheres having $+q$ and $-q$ charge are kept at a certain distance. F force acts between the two. If in the middle of two spheres, another similar sphere having $+q$ charge is kept, then it experience a force in magnitude and direction as

(a) Zero having no direction

(b) 8F towards + q charge

(c) 8F towards – q charge

(d) 4F towards + q charge



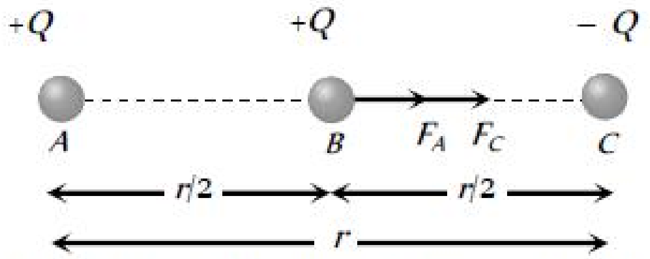
$$F = \frac{Kq^2}{d^2}$$

P-Q1418-Solution

Ans [C]

Initially, force between A and C $F = k\dfrac{Q^2}{r^2}$

Force formula btw two charge



When a similar sphere B having charge $+Q$ is kept at the mid point of line joining A and C, then Net force on B is

$$F_{net} = F_A + F_C = k\frac{Q^2}{(r/2)^2} + \frac{kQ^2}{(r/2)^2} = 8\frac{kQ^2}{r^2} = 8F.$$

(Direction is shown in figure)

Direction of force from + to –ve

P-Q1419

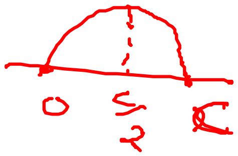
A charge Q is divided into two parts of q and $Q-q$. If the coulomb repulsion between them when they are separated is to be maximum, the ratio of $\frac{Q}{q}$ should be

(a) 2 (b) $1/2$

(c) 4 (d) $1/4$

$x(c-x) = xc - x^2$

max. $x = \frac{c}{2}$



$F = \frac{Kq(Q-q)}{r^2}$

$q = Q-q$

$q = \frac{Q}{2}$

$\frac{Q}{q} = 2$

P-Q1419-Solution

Ans [A]

Let separation between two parts be $r \Rightarrow F = k.q\dfrac{(Q-q)}{r^2}$

Force btw 2 charge

For maximum force

$$\frac{dF}{dq} = 0$$

$$\frac{kQ - 2kq}{r^2} = 0$$

Solving the equation

$$\Rightarrow \frac{Q}{q} = \frac{2}{1}$$

P-Q1420

The force between two charges $0.06\,m$ apart is $5\,N$. If each charge is moved towards the other by $0.01\,m$, then the force between them will become

(a) $7.20\,N$
[✓ (b) $11.25\,N$]
(c) $22.50\,N$
(d) $45.00\,N$

$$F = \frac{K q_1 q_2}{r^2}$$

$$\frac{F_1}{F_2} = \left(\frac{r_2}{r_1}\right)^2 \Rightarrow \frac{5}{F_2} = \left(\frac{0.0\cancel{4}^{\,2}}{0.0\cancel{6}_{\,3}}\right)^2$$

$$F_2 = 5 \times \frac{9}{4} = \frac{45}{4}$$

P-Q1420-Solution

Ans [B]

$$F \propto \frac{1}{r^2}$$

Force is inversely proportional to r^2

$$\Rightarrow \frac{F_1}{F_2} = \left(\frac{r_2}{r_1}\right)^2$$

$$\frac{5}{F_2} = \left(\frac{0.04}{0.06}\right)^2$$

Both moving 0.01m so new distance btw then is 0.04

$$= F_2 = 11.25\ N$$

P-Q1421

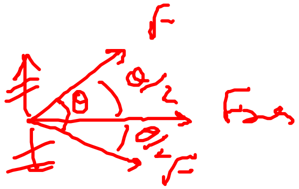
Electric charges of $1\mu C, -1\mu C$ and $2\mu C$ are placed in air at the corners *A*, *B* and *C* respectively of an equilateral triangle *ABC* having length of each side 10 *cm*. The resultant force on the charge at *C* is

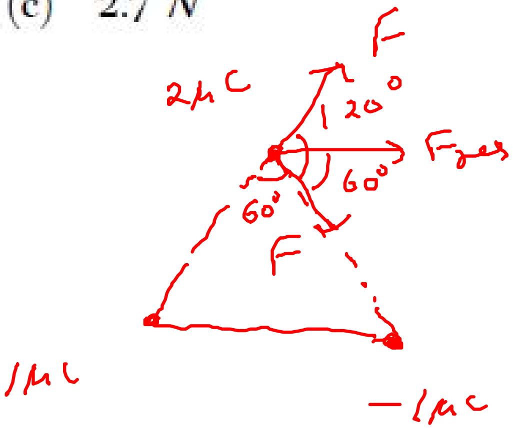
(a) 0.9 *N*

[✓ (b) 1.8 *N*]

(c) 2.7 *N*

(d) 3.6 *N*





$$F = \frac{K(1\mu C)(2\mu C)}{(10\,cm)^2}$$

$$= \frac{9\times10^{9}\times2\times10^{-12}}{10^{-2}}$$

$$= 1.8\,N$$

$$F_{res} = 2F\cos 60^\circ = \cancel{2}\times1.8\times\frac{1}{\cancel{2}}$$

$$= 1.8\,N$$

P-Q1421-Solution

Ans [B]

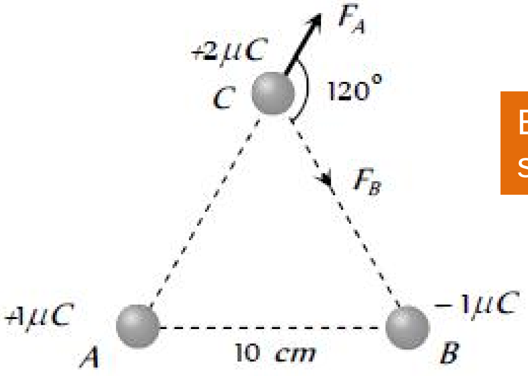
F = force on C due to charge placed at A

$$= 9 \times 10^{9} \times \frac{10^{-6} \times 2 \times 10^{-6}}{(10 \times 10^{-2})^{2}} = 1.8\ N$$

Force formula btw 2 charge

F= force on C due to charge placed at B

$$= 9 \times 10^{9} \times \frac{10^{-6} \times 2 \times 10^{-6}}{(0.1)^{2}} = 1.8 N$$



Electrostatic force is vector Quantity so apply vector sum

Net force on C

$$F_{net} = \sqrt{(F_A)^2 + (F_B)^2 + 2F_AF_B \cos 120^o} = 1.8\ N$$

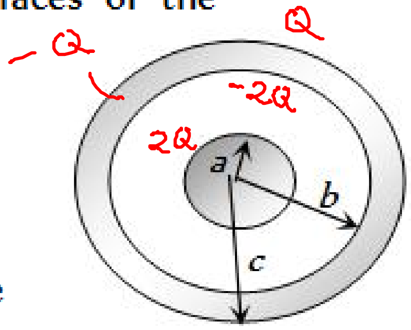
A solid conducting sphere of radius a has a net positive charge $2Q$. A conducting spherical shell of inner radius b and outer radius c is concentric with the solid sphere and has a net charge $-Q$. The surface charge density on the inner and outer surfaces of the spherical shell will be

[✓ (a)] $-\frac{2Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$

(b) $-\frac{Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$

(c) $0, \frac{Q}{4\pi c^2}$

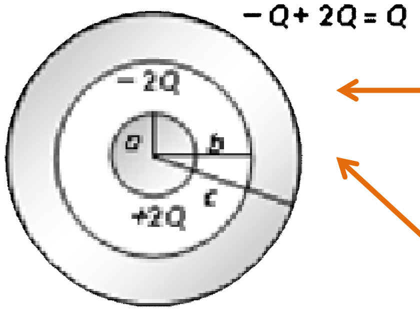
(d) None of the above



$-\frac{2Q}{4\pi b^2}$; $\frac{Q}{4\pi c^2}$

P-Q1422-Solution

Ans [A]



Charge distribution on surfaces

Net charge on each surface

$$\text{Surface charge density } (\sigma) = \frac{\text{Charge}}{\text{Surface area}}$$

$$\text{So } \sigma_{inner} = \frac{-2Q}{4\pi b^2} \text{ and } \sigma_{Outer} = \frac{Q}{4\pi c^2}$$

P-Q1426

The ratio of electrostatic and gravitational forces acting between electron and proton separated by a distance $5 \times 10^{-11} m$, will be (Charge on electron = $1.6 \times 10^{-}$ C, mass of electron = $9.1 \times \overset{-31}{10^{-}}$ kg, mass of proton = $1.6 \times 10^{-27} kg$, $G = 6.7 \times 10^{-11} Nm^2 / kg^2$)

✓ A) 2.36×10^{39} B) 4.72×10^{39} C) 2.16×10^{19} D) 1.23×10^{30}

$$F_e = \frac{Kq_1q_2}{r^2} \quad ; \quad F_g = \frac{Gm_1m_2}{r^2}$$

$$\frac{F_e}{F_g} = \frac{Kq_1q_2}{Gm_1m_2} = \frac{\cancel{9} \times 10^{9} \times 1.6 \times 10^{-19} \times \cancel{1.6} \times 10^{-19}}{6.7 \times 10^{-11} \times \cancel{9.1} \times 10^{-31} \times \cancel{1.6} \times 10^{-27}}$$

$$= \frac{\cancel{1.6}}{\underset{4}{\cancel{6.7}}} \times 10^{9+11+31+27-38}$$

$$0.25 \times 10^{40}$$

P-Q1426-Solution

Ans [A]

Gravitational force $F_G = \frac{Gm_e m_p}{r^2}$

Gravitational force

$$F_G = \frac{6.7\times10^{-11}\times9.1\times10^{-31}\times1.6\times10^{-27}}{(5\times10^{-11})^2} = 3.9 \times 10 \cdot N$$

Electrostatic force $F_e = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}$

Electrostatic force btw charges

$$F_e = \frac{9\times10^{9}\times1.6\times10^{-19}\times1.6\times10^{-19}}{(5\times10^{-11})^2} = 9.22 \times 10 \cdot N$$

So, $\frac{F_e}{F_G} = \frac{9.22\times10^{-8}}{3.9\times10^{-47}} = 2.36\times10^{39}$

P-Q1427

A charge ***q*** is placed at the Centre of the line joining two equal charges ***Q***. The system of the three charges will be in equilibrium, if ***q*** is equal to

(a) $-\frac{Q}{2}$

[✓ (b)] $-\frac{Q}{4}$

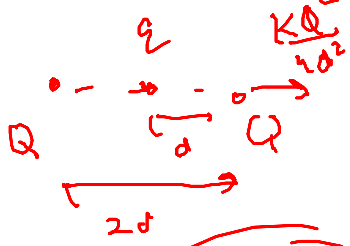
(c) $+\frac{Q}{4}$

(d) $+\frac{Q}{2}$

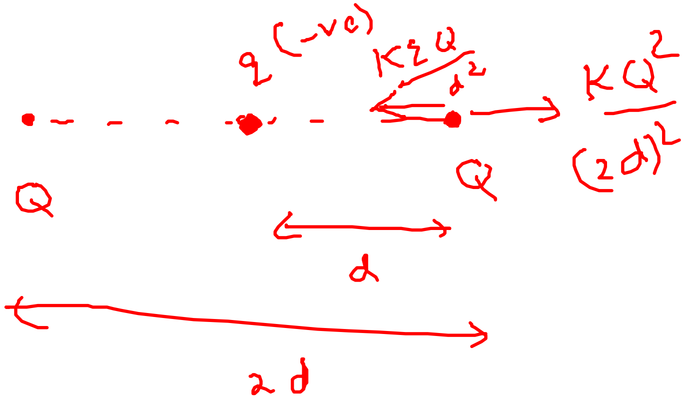
$$\frac{Kq\cancel{Q}}{\cancel{d^2}} = \frac{KQ^{\cancel{2}}}{4\cancel{d^2}}$$

$$q = \frac{Q}{4}$$

$$\frac{KQ^2}{4d^2} + \frac{KqQ}{d^2} = 0$$



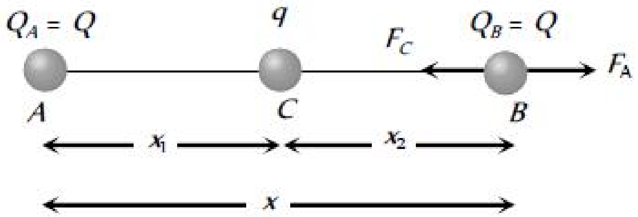
$$\boxed{q = -\frac{Q}{4}}$$



P-Q1427-Solution

Ans [B]

Suppose in the following figure, equilibrium of charge **B** is considered



Hence for it's equilibrium $|F_A| = |F_C|$

At equilibrium net force is zero

$$\Rightarrow \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{4x^2} = \frac{1}{4\pi\varepsilon_0}\frac{qQ}{x^2} \Rightarrow q = \frac{-Q}{4}$$

P-Q1428

The electric potential V at any point O (x, y, z all in meters) in space is given by $V = 4x^2$ *volt*. The electric field at the point $\underline{\underline{(1m, 0, 2m)}}$ in *volt* / *metre* is

[✓ (a)] 8 along negative X – axis

(b) 8 along positive X – axis

(c) 16 along negative X – axis

(d) 16 along positive Z – axis

$$E_x = -\frac{dV}{dx} = -8x$$

$$E = -8 \; V/m \; \hat{i}$$

P-Q1428-Solution

Ans [A]

The electric potential $V(x, y, z) = 4x^2\ volt$

Now $\vec{E} = -\left(\hat{i}\dfrac{\partial V}{\partial x} + \hat{j}\dfrac{\partial V}{\partial y} + \hat{k}\dfrac{\partial V}{\partial z}\right)$

Relation btw Electric potential and electric field

Now $\dfrac{\partial V}{\partial x} = 8x, \dfrac{\partial V}{\partial y} = 0$ and $\dfrac{\partial V}{\partial z} = 0$

Hence $\vec{E} = -8x\hat{i}$, so at point $(1m, 0, 2m)$

$\vec{E} = -8\hat{i}\ volt/metre$ Or 8 along negative X-axis.

P-Q1429

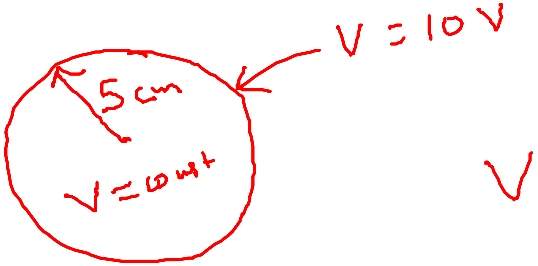
A hollow metal sphere of radius 5 cm is charged so that the potential on its surface is 10 V. The potential at the centre of the sphere is

(a) 0 V

[✓ (b)] 10 V

(c) Same as at point 5 cm away from the surface

(d) Same as at point 25 cm away from the surface



$$V(r \leq R) = \frac{KQ}{R}$$

P-Q1429-Solution

Ans [B]

Potential inside is 10V

Since potential inside the hollow sphere is same as that on the surface.

P-Q1430

If a unit positive charge is taken from one point to another over an equipotential surface, then

(a) Work is done on the charge

(b) Work is done by the charge

(c) Work done is constant

[✓ (d)] No work is done

$W_{ext} = q(V_f - V_i)$

P-Q1430-Solution

Ans [D]

On the equipotential surface, **electric field is normal to the charged surface** (where potential exists) so that **no work will be done**.

Equipotential Surface **à** same potential across surface

P-Q1431

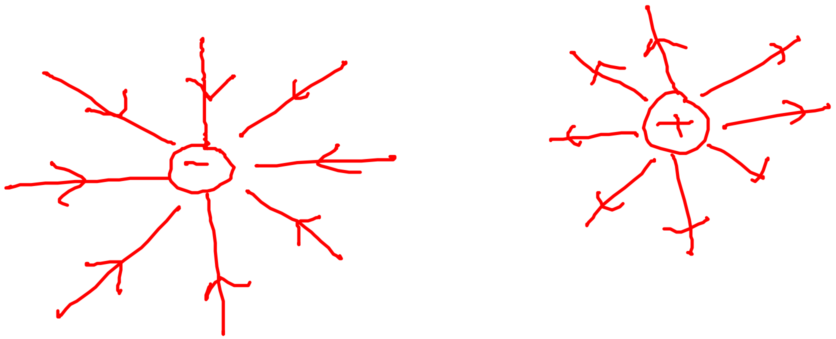
Electric lines of force about negative point charge are

(a) Circular, anticlockwise

(b) Circular, clockwise

[✓ (c) Radial, inward]

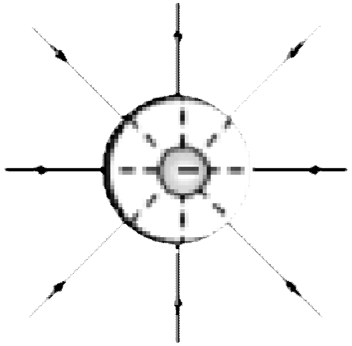
(d) Radial, outward



P-Q1431-Solution

Ans [C]

Electric lines force due to negative charge are radially inward.



Field lines come toward negative charge

P-Q1432

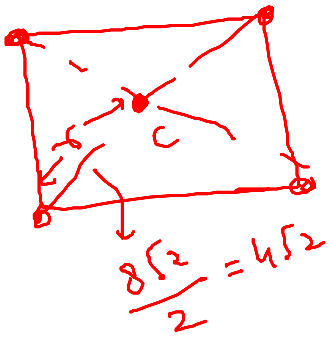
Charges of $+\frac{10}{3}\times 10^{-9}\,C$ are placed at each of the four corners of a square of side $8\,cm$. The potential at the intersection of the diagonals is

(a) $150\sqrt{2}\,volt$

[✓ (b) $1500\sqrt{2}\,volt$]

(c) $900\sqrt{2}\,volt$

(d) $900\,volt$



$\frac{8\sqrt{2}}{2} = 4\sqrt{2}$

$V_c = \frac{KQ_{Total}}{r}$

$= \frac{\overset{3}{\cancel{9}}\times 10^{\cancel{9}}\times\cancel{4}\times\frac{10}{\cancel{3}}\times 10^{\cancel{-9}}}{\cancel{4}\sqrt{2}\times 10^{-2}}$

$= \frac{30}{\sqrt{2}}\times 100$

$= 15\sqrt{2}\times 100$

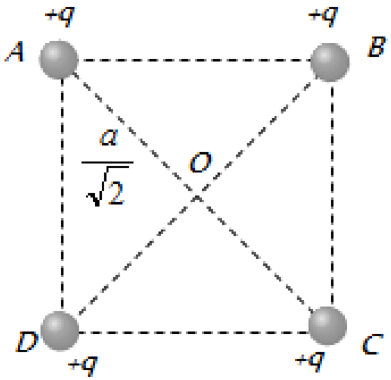
P-Q1432-Solution

Ans [B]

Potential at the centre O, $V = 4 \times \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{a/\sqrt{2}}$

Potential due to all four charges

Where $Q = \frac{10}{3} \times 10^{-9} C$ and $a = 8\,cm = 8 \times 10^{-2} m$



So $V = 4 \times 9 \times 10^{9} \times \frac{\frac{10}{3} \times 10^{-9}}{\frac{8 \times 10^{-2}}{\sqrt{2}}} = 1500\sqrt{2}\, volt$

P-Q1433

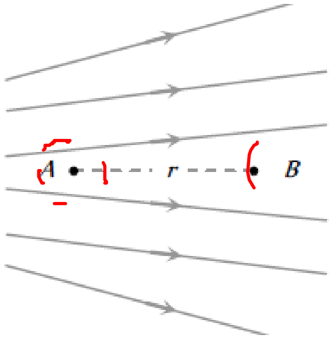
Figure shows the electric lines of force emerging from a charged body. If the electric field at A and B are E_A and E_B respectively and if the displacement between A and B is r then

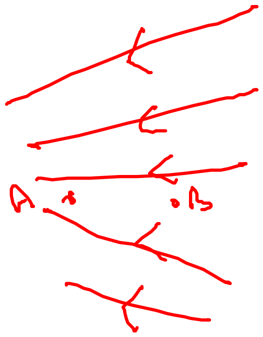
(a) $E_A > E_B$

(b) $E_A < E_B$

(c) $E_A = \frac{E_B}{r}$

(d) $E_A = \frac{E_B}{r^2}$





$E_A > E_B$

$V_B > V_A$

Line density ↑

E ↑

$\boxed{E_A > E_B}$

$\boxed{V_A > V_B}$

P-Q1433-Solution

Ans [A]

In non-uniform electric field. Intensity is more, where the **lines are more denser**

More the lines à charge more
More denser à electric field

P-Q1434

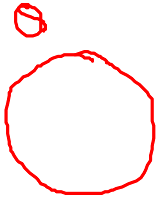
The insulation property of air breaks down at $E = 3\times10^6$ *volt/metre*. The maximum charge that can be given to a sphere of diameter $5\,m$ is approximately (in coulombs)

(a) 2×10^{-2}

[✓ (b) 2×10^{-3}]

(c) 2×10^{-4}

(d) 2×10^{-5}



$$E_{max} = \frac{KQ}{R^2} \quad \text{(at surface)}$$

$$\cancel{3}\times10^6 = \frac{\overset{3}{\cancel{9}}\times10^9 \times Q \times 4}{25}$$

$$Q_{max} = \frac{25}{12}\times10^{-3}$$

$$\approx 2\times10^{-3}$$

P-Q1434-Solution

Ans [B]

$$E = \frac{1}{4\pi\epsilon_0} \times \frac{q}{r^2} = 9 \times 10^9 \times \frac{q}{r^2}$$

Electric field due to charge at distance r

$$q = \frac{E \times r^2}{9 \times 10^9} = \frac{3 \times 10^6 \times (2.5)^2}{9 \times 10^9} = 2.0833 \times 10^{-3}$$

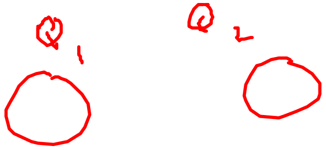
q should be less than 2.0833×10^{-3}. In the given set of options 2×10^{-3} is the maximum charge which is smaller than 2.0833×10^{-3}.

P-Q1436

Two spheres A and B of radius $4cm$ and $6cm$ are given charges of $80\mu c$ and $40\mu c$ respectively. If they are connected by a fine wire, the amount of charge flowing from one to the other is

(a) $20\mu C$ from A to B (b) $16\mu C$ from A to B

(c) $32\mu C$ from B to A (d) $32\mu C$ from A to B

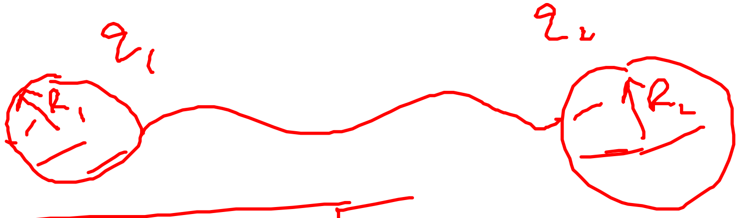


$q_1 + q_2 = Q_1 + Q_2$

$V_1 = V_2$

$\frac{Kq_1}{R_1} = \frac{Kq_2}{R_2}$

$C = 4\pi\epsilon_0 R$



$$q_1 = \left(\frac{R_1}{R_1+R_2}\right) Q_{Total}$$

$$q_2 = \left(\frac{R_2}{R_1+R_2}\right) Q_{Total}$$

$q_A = \frac{4\cancel{cm}}{10\cancel{cm}} \times 120\mu C$

$= 48\mu C$

$80 - 48 = 32\mu C$

P-Q1436-Solution

Ans [D]

Total charge $Q = 80 + 40 = 120\,\mu C$.

By using the formula $Q_1' = Q\left[\dfrac{r_1}{r_1 + r_2}\right]$.

Remember this formula

New charge on sphere A is

$$Q_A' = Q\left[\frac{r_A}{r_A + r_B}\right] = 120\left[\frac{4}{4+6}\right] = 48\,\mu C\,.$$

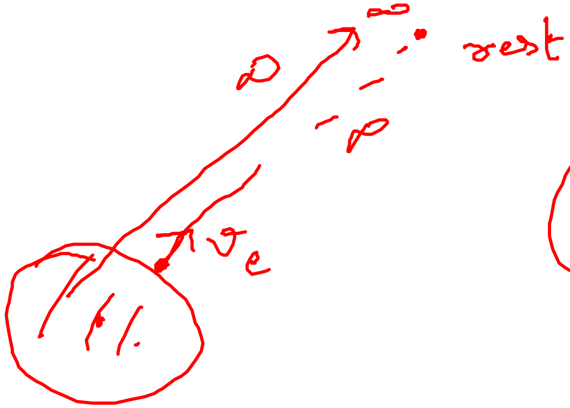
Initially it was $80\mu C$ *i.e.,* $32\,\mu C$ charge flows from A to B.

Charge distribute depends on radius

P-Q940

If a body is released from a great distance from the centre of the earth find the velocity when it strikes the surface of the earth . Take R=6400km

(A)7.2km/s
(B)11.8km/s
(C) 7.8km/s
(D) 11.2km/s



$v_e = 11.2$ Km/s

P-Q940-Solution

Ans [D]

It will collide the earth with escape velocity or 11.2km/s

Above result can also be found by taking initial Total energy zero.

Energy conservation

$$0 = \frac{1}{2}mv^2 - \frac{GmM}{R}$$

Energy on the surface of earth, when body hits

$$v^2 = \frac{2GM}{R}$$

$$v = \sqrt{\frac{2GM}{R}}$$

Putting the value of all constants

$$= 11.2km/s$$

P-Q943

Two particles of equal mass go round a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle is

(A) $v = \frac{1}{2R}\sqrt{\frac{1}{Gm}}$

(B) $v = \sqrt{\frac{Gm}{2R}}$

[✓ (C)] $v = \frac{1}{2}\sqrt{\frac{Gm}{R}}$

(D) $v = \sqrt{\frac{4Gm}{R}}$

$$F_{centre} = \frac{mv^2}{R}$$

$$\frac{Gm^{\cancel{2}}}{4R^{\cancel{2}}} = \frac{\cancel{m}v^2}{\cancel{R}} \Rightarrow v = \sqrt{\frac{Gm}{4R}}$$

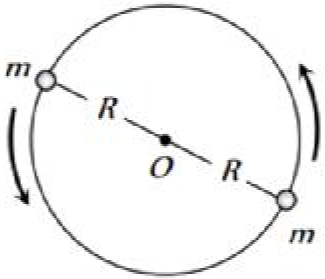
P-Q943-Solution

Ans [C]

Centripetal force is provided by the gravitational force of attraction between two particles

$$i.e.\ \frac{mv^2}{R} = \frac{Gm \times m}{(2R)^2}$$

$$\Rightarrow v = \frac{1}{2}\sqrt{\frac{Gm}{R}}$$



P-Q944

The earth (mass $= 6\times10^{24}\ kg$)) revolves round the sun with angular velocity $2\times10^{-7}\ rad/s$ in a circular orbit of radius $1.5\times10^{8}\ km$. The force exerted by the sun on the earth in *newtons*, is

(A) 18×10^{25}

(B) Zero

(C) 27×10^{39}

[✓ (D)] 36×10^{21}

$v = \omega r$

$F = m\omega^2 r$

$= 6\times10^{24} \times 4\times10^{-14} \times 1.5\times10^{11}$

$= 36 \times 10^{21}$

P-Q944-Solution

Ans [D]

$m = 6 \times 10^{24}\, kg, \ \ \omega = 2 \times 10^{-7}\, rad/s, \ \ R = 1.5 \times 10^{11}\, m$

The force exerted by the sun on the earth $F = m\omega^2 R$

By substituting the value we can get, $F = 36 \times 10^{21}\, N$

Earth revolving around sun so there is centripetal force

P-Q947

If the change in the value of 'g' at a height h above the surface of the earth is the same as at a depth x below it, then (both x and h being much smaller than the radius of the earth)

(A) $x = h$

[✓ (B) $x = 2h$]

(C) $x = \frac{h}{2}$

(D) $x = h^2$

$$g_h = g\left(1 - \frac{2h}{R}\right)$$

$h << R$

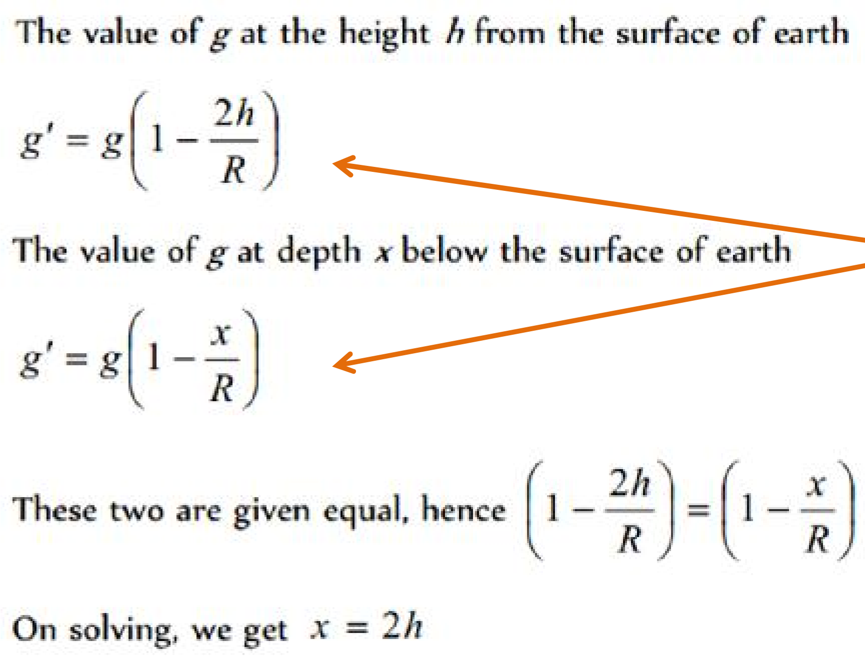
$$g_x = g\left(1 - \frac{x}{R}\right)$$

$x_{max} = R$

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

P-Q947-Solution

Ans [B]



The value of g at the height h from the surface of earth

$$g' = g\left(1 - \frac{2h}{R}\right)$$

The value of g at depth x below the surface of earth

$$g' = g\left(1 - \frac{x}{R}\right)$$

These two are given equal, hence $\left(1 - \frac{2h}{R}\right) = \left(1 - \frac{x}{R}\right)$

On solving, we get $x = 2h$

Variation of g with height and depth respectively

P-Q949

A body weighs 700 *gm wt* on the surface of the earth. How much will it weigh on the surface of a planet whose mass is $\frac{1}{7}$ and radius is half that of the earth

$\frac{4}{7} \times 700$

(A) 200 *gm wt*

(B) 400 *gm wt* ✓

(C) 50 *gm wt*

(D) 300 *gm wt*

$W = mg$

$$g_e = \frac{GM}{R^2}$$

$$g_p = \frac{G\,M/7}{(R/2)^2} = \frac{4g}{7}$$

P-Q949-Solution

Ans [B]

We know that $g = \frac{GM}{R^2}$

Gravitation on Earth

On the planet $g_p = \frac{GM/7}{R^2/4} = \frac{4g}{7} = \frac{4}{7}g$

Gravitation on planet

Hence weight on the planet $= 700 \times \frac{4}{7} = 400 \;\; gm\,wt$

P-Q952

The depth d at which the value of acceleration due to gravity becomes $\frac{1}{n}$ times the value at the surface, is [R = radius of the earth]

(A) $\frac{R}{n}$

[✓ (B)] $R\left(\frac{n-1}{n}\right)$

(C) $\frac{R}{n^2}$

(D) $R\left(\frac{n}{n+1}\right)$

$$g_d = g\left(1-\frac{d}{R}\right)$$

$$\frac{\cancel{g}}{n} = \cancel{g}\left(1-\frac{d}{R}\right)$$

$$\Rightarrow \frac{d}{R} = 1-\frac{1}{n}$$

$$\frac{d}{R} = \frac{n-1}{n}$$

$$d = R\left(\frac{n-1}{n}\right)$$

P-Q952-Solution

Ans [B]

$$g' = g\left(1 - \frac{d}{R}\right)$$

Gravitation varies with depth like this

$$\Rightarrow \frac{g}{n} = g\left(1 - \frac{d}{R}\right)$$

Gravitation decreases as we go depth

$$\Rightarrow d = \left(\frac{n-1}{n}\right)R$$

P-Q954

At what altitude in metre will the acceleration due to gravity be 25% of that at the earth's surface (Radius of earth = R metre)

(A) $\frac{1}{4}R$

[✓ (B)] R

(C) $\frac{3}{8}R$

(D) $\frac{R}{2}$

$$g = \frac{GM}{R^2}$$

$$25\% \quad g' = g/4$$

$$g_h = \frac{GM}{(R+h)^2}$$

$$\frac{g}{4} = \frac{GM}{R^2\left(1+\frac{h}{R}\right)^2} = \frac{g}{\left(1+\frac{h}{R}\right)^2}$$

$$\left(1+\frac{h}{R}\right)^2 = 4$$

$$1+\frac{h}{R} = 2$$

$$\boxed{\frac{h}{R} = 1}$$

P-Q954-Solution

Ans [B]

$$g' = g\left(\frac{R}{R+h}\right)^2$$

$$\Rightarrow \frac{g}{4} = g\left(\frac{R}{R+h}\right)^2$$

Given that gravity is only 25% of that on earth

$$\Rightarrow \frac{1}{2} = \frac{R}{R+h}$$

$$\Rightarrow R + h = 2R \;\therefore\; h = R$$

P-Q958

Radius of earth is around 6000 *km*. The weight of body at height of 6000 *km* from earth surface becomes

(A) Half

[✓ (B) One-fourth]

(C) One third

(D) No change

$$g = \frac{GM}{R^2}$$

$$g_h = \frac{GM}{(R+R)^2} = \frac{GM}{4R^2} = g/4$$

P-Q958-Solution

Ans [B]

$$g' = g\left(\frac{R}{R+h}\right)^2$$

$$\Rightarrow \text{when } h = R \text{ then } g' = \frac{g}{4}$$

So the weight of the body at this height will become one fourth.

P-Q2635

We consider the **radiation** emitted by the **human body**. Which of the following statements is true

(A) The radiation is emitted only during the day

(B) The radiation is emitted during the summers and absorbed during the winters

(C) The radiation emitted lies in the ultraviolet region and hence is not visible

[✓ (D)] The radiation emitted is in the infra-red region

P-Q2635-Solution

Ans [D]

The radiation emitted by the human body is in the infra-red region.

Every body **at all time**, **at all temperatures** emits radiation (except at **T = 0 K**)

T = 0 K is known as **absolute zero** temperature

P-Q2636

Good **absorbers** of heat are :

(A) Poor emitters
(B) Non-emitters
[✓ (C) Good emitters]
(D) Highly polished

P-Q2636-Solution

Ans [C]

Good absorbers are always **good emitters** of heat

Sand is a **good absorber** of heat but also **good emitter** of heat that is why **Days are hotter** and **nights are colder** in **deserts** as compare to the other places

P-Q2656

Liquid is filled in a vessel which is kept in a room with temperature **20°C** . When the temperature of the liquid is **80°C**, then it **loses** heat at the rate of **60 cal/sec**. . What will be the rate of loss of heat when the temperature of the liquid is **40°C.**

(A) 180 cal/sec (B) 40 cal/sec

(C) 30 cal/sec [✓ (D) 20 cal/sec]

$$P_1 = \frac{dQ}{dt} = -K(\theta - \theta_0)$$

$$\frac{P_1}{P_2} = \frac{\theta_1 - \theta_0}{\theta_2 - \theta_0}$$

$$\frac{\cancel{60}}{P_2} = \frac{80 - 20}{40 - 20} = \frac{\cancel{60}}{20}$$

$$\boxed{P_2 = 20}$$

P-Q2656-Solution

Ans [D]

Rate of loss of heat $\frac{\Delta Q}{t}$ ∝ temperature difference **D*q***

$$\frac{\left(\frac{\Delta Q}{t}\right)_1}{\left(\frac{\Delta Q}{t}\right)_2} = \frac{\Delta\theta_2}{\Delta\theta_1}$$

$$\Rightarrow \frac{60}{\left(\frac{\Delta Q}{t}\right)_2} = \frac{80-60}{40-20}$$

$$\Rightarrow \left(\frac{\Delta Q}{t}\right)_2 = \frac{20\ cal}{sec}$$

P-Q2658

A body takes **5 minute** to cool from **80°*C* to 50°*C***. How much time it will take to cool from **60°*C* to 30°*C***, if room temperature is **20°*C*.**

(A) 40 minute [✓ (B) 9 minute]

(C) 30 minute (D) 20 minute

$$-\frac{d\theta}{dt} = K(\theta - \theta_0)$$

$$\frac{\theta_i - \theta_f}{\Delta t} = -\left(\frac{\theta_f - \theta_i}{\Delta t}\right) = K\left(\frac{\theta_i + \theta_f}{2} - \theta_0\right)$$

$\underline{\underline{80 - 50}}$

$$\frac{80 - 50}{5} = K(65 - 20) \Rightarrow \overset{2}{\cancel{6}} = K \times \overset{15}{\cancel{45}} \quad K = \frac{2}{15}\,\text{min}^{-1}$$

$\underline{\underline{60 - 30}}$

$$\frac{60 - 30}{\Delta t} = \frac{2}{15}(45 - 20) \Rightarrow \frac{\overset{\overset{3}{\cancel{6}}}{\cancel{30}}}{\Delta t} = \frac{\cancel{2}}{\underset{3}{\cancel{15}}} \times \overset{\cancel{5}}{\cancel{25}}$$

$$\boxed{\Delta t = 9\ \text{min}}$$

P-Q2658-Solution

Ans [B]

According to Newton’s law of cooling.

In first case, $\frac{80-50}{5}=K\left[\frac{80+50}{2}-20\right]$ …..(i)

In second case, $\frac{60-30}{t}=K\left[\frac{60+30}{2}-20\right]$ (ii)

Dividing equation (i) by (ii) we get

$\frac{t}{2}=\frac{45}{25}\Rightarrow t=9$ min.