Test Your fiziks concepts!

Topic: Electromagnetic Theory

(For CSIR NET-JRF, GATE, JEST and TIFR Aspirants)

Q. Two point charges $+3Q$ and $-Q$ are placed at $(0,0,d)$ and $(0,0,2d)$ respectively, above an infinite grounded conducting sheet kept in the xy- plane. At a point $(0,0,z)$, where $z >> d$, the electrostatic potential of this charge configuration would approximately be

(a) $\frac{1}{4\pi\varepsilon_0}\frac{d^2}{z^3}Q$ (b) $\frac{1}{4\pi\varepsilon_0}\frac{2d}{z^2}Q$ (c) $\frac{1}{4\pi\varepsilon_0}\frac{3d}{z^2}Q$ (d) $-\frac{1}{4\pi\varepsilon_0}\frac{d^2}{z^3}Q$

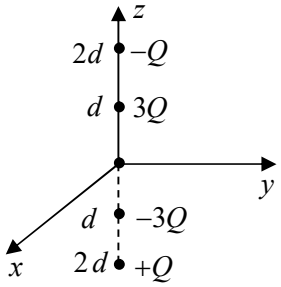
Ans.: (b)

Solution.: Monopole moment $Q_{mono} = -Q + 3Q - 3Q + Q = 0$

Dipole moment

$\vec{p} = +3Q\times(d\hat{z}) + (-Q)\times(2d\hat{z}) + (-3Q)\times(-d\hat{z}) + Q\times(-2d\hat{z})$

$\Rightarrow \vec{p} = 2Qd\hat{z}$



Thus $V_{dip} = \frac{1}{4\pi \in_0}\frac{\vec{p}\cdot\hat{r}}{r^2} \approx \frac{1}{4\pi \in_0}\frac{2Qd}{z^2}$

Note:

For detailed solutions, visit the *Free Download* section at www.physicsbyfiziks.com

Test Your fiziks concepts!

Topic: Solid State Physics

(For IIT-JAM, JEST, TIFR and CUET Aspirants)

Q. The lattice constant (in Å) of copper, which has FCC structure, is:

Given: density of copper is 8.91 gcm^{-3} and its atomic mass is 63.55 $gmol^{-1}$; Avogadro's number $= 6.023\times10^{23}\ mol^{-1}$

(a) 1.6 (b) 2.6 (c) 3.6 (d) 4.6

Ans.: (c)

Solution.: $\rho = \dfrac{n_{eff}\times M}{N_A\times a^3} \Rightarrow a^3 = \dfrac{n_{eff}\times M}{N_A\times\rho}$

Given, $n_{eff} = 4$, $\rho = 8.91\,\mathrm{g/cm^3}$, $M = 63.55\,\mathrm{g/mol}$ and $N_A = 6.023\times10^{23}\ \mathrm{mol^{-1}}$

$$\therefore\ a^3 = \frac{4\times63.55}{6.023\times10^{23}\times8.91} = 4.737\times10^{-23} \Rightarrow a = 3.61\times10^{-8}\ \mathrm{cm} = 3.61\times10^{-10}\ \mathrm{m} \Rightarrow a = 3.61\,A^\circ$$

Note:

For detailed solutions, visit the *Free Download* section at www.physicsbyfiziks.com

H.No. 40-D, G.F., Jia Sarai, Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498, Website: www.physicsbyfiziks.com, Email: fiziks.physics@gmail.com

Test Your fiziks concepts!

Topic: Mechanics

(For PGT: KVS, NVS, DSSSB, State Education Boards, etc.)

Q. A reference frame attached to the Earth

(a) is an inertial frame by definition.

(b) is an inertial frame because Newton's laws are applicable in this frame.

(c) cannot be an inertial frame because the Earth is revolving around the Sun.

(d) cannot be an inertial frame of reference because Newton's laws are not applicable.

Ans. (c):

Note:

For detailed solutions, visit the *Free Download* section at www.physicsbyfiziks.com

Test Your fiziks concepts!

Topic: Electromagnetic Theory

(For CSIR NET-JRF, GATE, JEST and TIFR Aspirants)

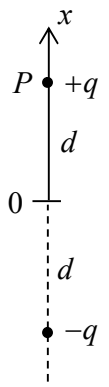
Q. A point charge q of mass m is released from rest at a distance d from an infinite grounded conducting plane (ignore gravity). How long does it take for the charge to hit the plane?

(a) $\dfrac{\sqrt{2\pi^3\varepsilon_0 md^3}}{q}$ (b) $\dfrac{\sqrt{2\pi^3\varepsilon_0 md}}{q}$

(c) $\dfrac{\sqrt{\pi^3\varepsilon_0 md^3}}{q}$ (d) $\dfrac{\sqrt{\pi^3\varepsilon_0 md}}{q}$

Ans.: (a)

Solution.: $F = ma = m\dfrac{d^2x}{dt^2} = -\dfrac{1}{4\pi\varepsilon_0}\dfrac{q^2}{4d^2} \Rightarrow \dfrac{d^2x}{dt^2} = -\dfrac{A}{x^2}$ where $A = \dfrac{q^2}{16\pi m\varepsilon_0}$.



$$\Rightarrow \frac{dv}{dt} = -\frac{A}{x^2} \Rightarrow v\frac{dv}{dt} = -\frac{A}{x^2}\frac{dx}{dt} \Rightarrow \frac{1}{2}\frac{d}{dt}\left(v^2\right) = \frac{d}{dt}\left(\frac{A}{x}\right)$$

$$\Rightarrow \frac{v^2}{2} = \frac{A}{x} + C \text{, at } x = d,\ v = 0 \Rightarrow C = -\frac{A}{d} \Rightarrow v = \sqrt{2A}\sqrt{\left(\frac{1}{x} - \frac{1}{d}\right)}.$$

$$\Rightarrow -\frac{dx}{dt} = \sqrt{2A}\sqrt{\left(\frac{1}{x} - \frac{1}{d}\right)} \Rightarrow \int_d^0 \sqrt{\frac{xd}{d-x}}dx = -\sqrt{2A}\int_0^t dt$$

Put $x = d\sin^2\theta \Rightarrow dx = x = 2d\sin\theta\cos\theta d\theta$

$$\Rightarrow \int_{\pi/2}^0 \sqrt{\frac{\left(d\sin^2\theta\right)d}{d\cos^2\theta}}2d\sin\theta\cos\theta d\theta = -\sqrt{2A}t$$

$$\Rightarrow -\sqrt{2A}t = \int_{\pi/2}^0 \sqrt{d}\frac{\sin\theta}{\cos\theta}2d\sin\theta\cos\theta d\theta = 2d^{3/2}\int_{\pi/2}^0 \sin^2\theta d\theta$$

$$\Rightarrow -\sqrt{2A}t = 2d^{3/2}\int_{\pi/2}^0 \frac{(1-\cos 2\theta)}{2}d\theta = d^{3/2}\left[\theta - \frac{\sin 2\theta}{2}\right]_{\pi/2}^0 = -d^{3/2}\frac{\pi}{2}$$

$$\Rightarrow -\sqrt{2A}t = -d^{3/2}\frac{\pi}{2} \Rightarrow -\sqrt{2\frac{q^2}{16\pi m\varepsilon_0}} \times t = -d^{3/2}\frac{\pi}{2}$$

$$\Rightarrow t = d^{3/2}\frac{\pi}{2} \times \sqrt{\frac{8\pi m\varepsilon_0}{q^2}} = \frac{\sqrt{2\pi^3\varepsilon_0 md^3}}{q}$$

Note:

For detailed solutions, visit the *Free Download* section at www.physicsbyfiziks.com

H.No. 40-D, G.F., Jia Sarai, Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498, Website: www.physicsbyfiziks.com, Email: fiziks.physics@gmail.com

Test Your fiziks concepts!

Topic: Solid State Physics

(For IIT-JAM, JEST, TIFR and CUET Aspirants)

Q. In a crystalline solid, the energy band structure (E-k relation) for an electron of mass m is given by $E = \frac{\hbar^2 k(2k-3)}{2m}$. The effective mass of the electron in the crystal is

(a) m (b) $\frac{2}{3}m$ (c) $\frac{m}{2}$ (d) $2m$

Ans.: (c)

Solution.: The expression of effective mass of electron in solid is $m^* = \frac{\hbar^2}{d^2E/dk^2}$

$$\frac{dE}{dk} = \frac{\hbar^2}{2m}(4k-3) \Rightarrow \frac{d^2E}{dk^2} = \frac{\hbar^2}{2m}(4) = \frac{2\hbar^2}{m} \Rightarrow m^* = \frac{m}{2}$$

Note:

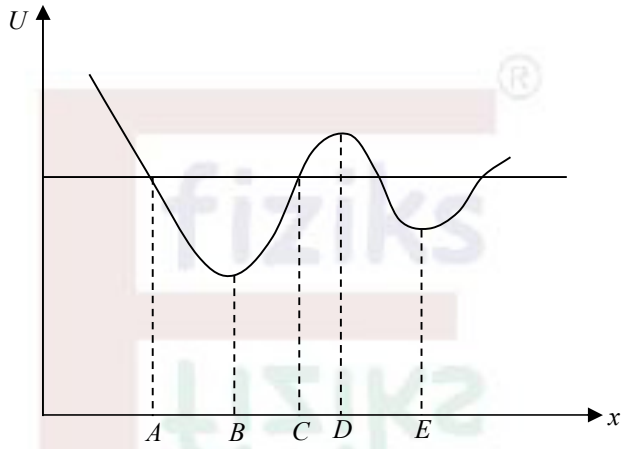
For detailed solutions, visit the *Free Download* section at www.physicsbyfiziks.com

Test Your fiziks concepts!

Topic: Mechanics

(For PGT: KVS, NVS, DSSSB, State Education Boards, etc.)

Q. Motion of a particle is shown in the figure. At which point does the particle have unstable equilibrium? (where U is the potential energy)



(a) A (b) B (c) D (d) E

Ans. (c):

Note:

For detailed solutions, visit the *Free Download* section at www.physicsbyfiziks.com

H.No. 40-D, G.F., Jia Sarai, Near IIT, Hauz Khas, New Delhi-16
Phone: 011-26865455/+91-9871145498, Website: www.physicsbyfiziks.com, Email: fiziks.physics@gmail.com