Test Your fiziks concepts!

Topic: Electromagnetic Theory

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

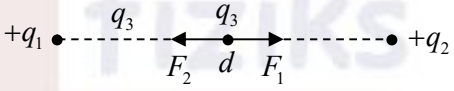
Q. Two-point charges $+q_1$ and $+q_2$ are fixed with a finite distance d between them. It is desired to put a third charge q_3 in between these two charges on the line joining them so that the charge q_3 is in equilibrium. This is

(a) Possible only if q_3 is positive (b) Possible only if q_3 is negative

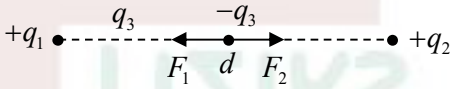
(c) Possible irrespective of the sign of q_3 (d) Not possible at all

Ans.: (c)

Solution.: If q_3 is positive,



If q_3 is negative,



In both case there is possibility that charge q_3 may be in equilibrium.

Note:

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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) $a = 3.61\,A°$ (b) $a = 2.61\,A°$ (c) $a = 1.61\,A°$ (d) $a = 0.61\,A°$

Ans.: (a)

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

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

Note:

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Test Your fiziks concepts!

Topic: Mechanices

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

Q. For a particle moving in a general central force field, which of the following statement not true?

(a) The angular momentum is a constant of motion

(b) Kepler's second law is valid

(c) The motion is confined to a plane

(d) Kepler's third law is valid

Ans.: (d)

Solution.:

(a) $\vec{\tau} = \frac{d\vec{L}}{dt} = \vec{r} \times f(r)\hat{r} = 0 \quad \Rightarrow \vec{L} = \text{constant}$

(b) $\frac{dA}{dt} = \frac{l}{2m} = \text{constant}$

(c) $\vec{L} \perp \vec{r}$

(d) Kepler's third law $\left(T^2 \propto a^3\right)$ is valid only for the inverse-square law.

Note:

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Test Your fiziks concepts!

Topic: Electromagnetic Theory

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

Q. Three equal charges $+q$ are placed at the corners of an equilateral triangle. A test charge constrained to move on the plane of the triangle is placed at the center of the triangle. Which of the following statements about the test charge is true?

(a) Stability of the equilibrium depends on the sign of the test charge.

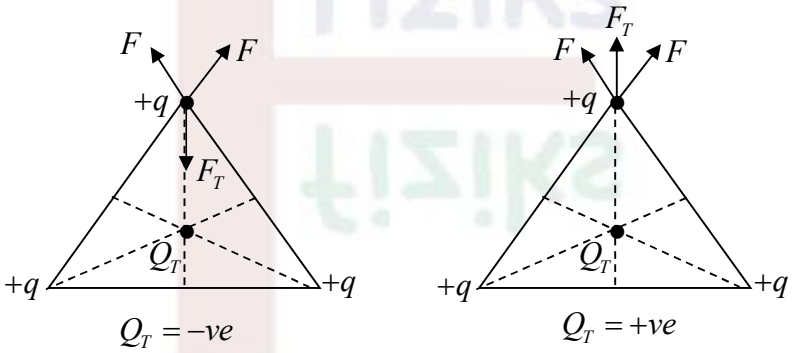
(b) It is in a stable equilibrium.

(c) It is not in an equilibrium.

(d) It is in an unstable equilibrium.

Ans.: (a)

Solution.:



Let F be the force on $+q$ charge due to other charges and F_T be the force on $+q$ charge due to test charge Q_T.

The system will be in equilibrium if net force on any charge $+q$ is zero.

$\Rightarrow$ stability of the equilibrium depends on the sign of the test charge.

Note:

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Test Your fiziks concepts!

Topic: Solid State Physics

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

Q. The total number of Na and Cl ions per unit cell of the NaCl crystal is:

(a) 2 (b) 4

(c) 8 (d) 16

Ans.: (c)

Solution:

In a NaCl crystal:

- The structure is face-centered cubic (FCC) with Na^+ and Cl^- ions arranged alternately.

In one-unit cell:

- The Na^+ ions contribute 4 ions (from 8 corner atoms contributing 1/8 each and 6 face atoms contributing 1/2 each).

- The Cl^- ions also contribute 4 ions in the same arrangement.

Thus, the total number of ions ($Na^+ + Cl^-$) per unit cell is: $4 + 4 = 8$

Thus, correct answer is option (c)

Note:

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Test Your fiziks concepts!

Topic: Mechanices

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

Q. A projectile of mass m is moving in the vertical $x-y$ plane with the origin on the ground and y-axis pointing vertically up. Taking the gravitational potential energy to be zero on the ground, the total energy of the particle written in planar polar coordinates (r,θ) is (here g is the acceleration due to gravity)

(a) $\frac{m}{2}\dot{r}^2 + mgr\sin\theta$

(b) $\frac{m}{2}\left(\dot{r}^2 + r^2\dot{\theta}^2\right) + mgr\cos\theta$

(c) $\frac{m}{2}\left(\dot{r}^2 + r^2\dot{\theta}^2\right) + mgr\sin\theta$

(d) $\frac{m}{2}\left(\dot{r}^2 + r^2\dot{\theta}^2\right) - mgr\cos\theta$

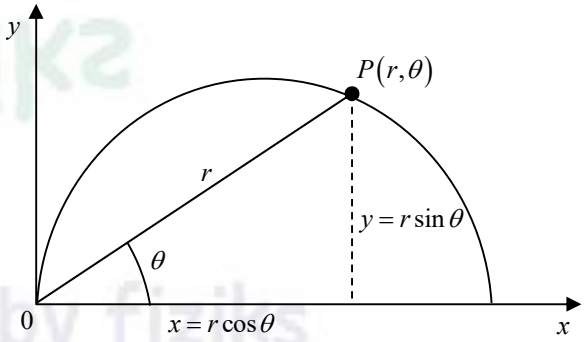
Ans.: (c)

Solution.:

The total energy of the particle is

$$E = T + V$$

where $T = \frac{1}{2}m\left(\dot{x}^2 + \dot{y}^2\right)$ and $V = mgy$.



Since $x = r\cos\theta$, $y = r\sin\theta$

$\Rightarrow \dot{x} = \dot{r}\cos\theta - r\dot{\theta}\sin\theta$ and $\dot{y} = \dot{r}\sin\theta + r\dot{\theta}\cos\theta$

$\Rightarrow \dot{x}^2 + \dot{y}^2 = \dot{r}^2 + r^2\dot{\theta}^2$

Thus $E = \frac{1}{2}m\left(\dot{r}^2 + r^2\dot{\theta}^2\right) + mgr\sin\theta$

Note:

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