

Test Your fiziks concepts!**Topic: Electromagnetic Theory****(For CSIR NET-JRF, GATE, JEST and TIFR Aspirants)**

Q. The electrostatic potential $V(x, y)$ in free space in a region where the charge density ρ is zero is given by $V(x, y) = 4e^{2x} + f(x) - 3y^2$. Given that the x -component of the electric field E_x , and V are zero at the origin, $f(x)$ is

(a) $3x^2 - 4e^{2x} + 8x$

(b) $3x^2 - 4e^{2x} + 16x$

(c) $4e^{2x} - 8$

(d) $3x^2 - 4e^{2x}$

Ans.: (d)

Solution.: $V = 4e^{2x} + f(x) - 3y^2$. Since $\rho = 0 \Rightarrow \nabla^2 V = 0 \Rightarrow 16e^{2x} + f''(x) - 6 = 0$.

Since $E_x = 0$ at origin $\Rightarrow \vec{E} = -\vec{\nabla}V \Rightarrow E_x = -[8e^{2x} + f'(x)]$

$$E_x(0, 0) = -[8 + f'(0)] = 0 \Rightarrow f'(0) = -8.$$

$$\text{Since } V(0, 0) = 0 \Rightarrow 4 + f(0) = 0 \Rightarrow f(0) = -4$$

Solve equation $16e^{2x} + f''(x) - 6 = 0 \Rightarrow f''(x) = 6 - 16e^{2x} \Rightarrow f'(x) = 6x - 8e^{2x} + c_1$, since $f'(0) = -8 + c_1 = -8 \Rightarrow c_1 = 0$.

$$\text{Again Integrate } f'(x) = 6x - 8e^{2x} \Rightarrow f(x) = 3x^2 - 4e^{2x} + c_2$$

$$\text{since } f(0) = -4 + c_2 = -4 \Rightarrow c_2 = 0. \text{ Thus } f(x) = 3x^2 - 4e^{2x}$$

Note:

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Test Your fiziks concepts!**Topic: Solid State Physics****(For IIT-JAM, JEST, TIFR and CUET Aspirants)**

Q. The packing fraction for a two-dimensional hexagonal lattice having sides $2r$ with atoms of radii r placed at each vertex and at the center is

(a) 0.61

(b) 0.71

(c) 0.81

(d) 0.91

Ans.: (d)**Solution.:**

Packing fraction for a two-dimensional hexagonal lattice (with a center atom)

Given: Regular hexagon of side $a = 2r$ and atoms of radii r placed at each vertex and at the center.

Number of atoms per unit cell

6 corner atoms, each shared by 3 hexagons $6 \times \frac{1}{3} = 2$ and 1 atom fully inside at the center.

$$N = 2 + 1 = 3 \text{ atoms.}$$

Area occupied by atoms

Area of one atom (circle): $= \pi r^2$; Total atomic Area: $= 3\pi r^2$

Area of hexagonal unit cell

Area of a regular hexagon of side a is $A_{\text{hex}} = \frac{3\sqrt{3}}{2} a^2 = \frac{3\sqrt{3}}{2} (2r)^2 = 6\sqrt{3} r^2$

$$\text{Packing fraction } \eta = \frac{A_{\text{atom}}}{A_{\text{hex}}} = \frac{3\pi r^2}{6\sqrt{3} r^2} = \frac{\pi}{2\sqrt{3}} \approx \frac{3.141}{3.464} \approx 0.91$$

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Note:

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Test Your fiziks concepts!**Topic: Mechanics****(For PGT: KVS, NVS, DSSSB, State Education Boards, etc.)**

Q. A satellite is revolving round the earth with a speed of 7.6 km/s. What is your estimation of the height of the satellite from the earth surface. Consider the mass of the earth = $6 \cdot 10^{24}$ kg and radius of the earth = 6400 km

(a) 500 km

(b) 550 km

(c) 600 km

(d) 650 km

Ans.: (b)

Solution.: $v_0 = \sqrt{\frac{GM}{r}} \Rightarrow r = \frac{GM}{v_0^2} = \frac{6.67 \times 10^{-11} \times 6 \times 10^{24}}{(7600)^2} \quad \therefore v_0 = 7600 \text{ m/s}$

$$r = \frac{40.02 \times 10^{13}}{57.76 \times 10^6} = 0.692867 \times 10^6 = 6928.67 \times 10^3 \text{ m} = 6928.67 \text{ km}$$

$$r = R + h = 6928.67 \text{ km} \Rightarrow h = 6928.67 - 6400 \Rightarrow h = 528.67 \text{ km}$$

Note:

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Test Your fiziks concepts!**Topic: Electromagnetic Theory****(For CSIR NET-JRF, GATE, JEST and TIFR Aspirants)**

Q. In a coaxial cable, the radius of the inner conductor is 2 mm and that of the outer one is 5 mm . The inner conductor is at a potential of 10 V , while the outer conductor is grounded. The value of the potential at a distance of 3.5 mm from the axis is

- (a) 2.8 V
- (b) 3.8 V
- (c) 4.8 V
- (d) 5.8 V

Ans.: (b)

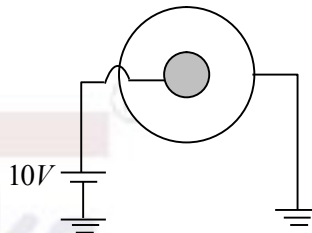
Solution: $\because \nabla^2 V = 0$

In Cylindrical coordinate system, $\frac{1}{r} \frac{\partial}{\partial r} \left(r \frac{\partial V}{\partial r} \right) = 0 \Rightarrow r \frac{\partial V}{\partial r} = A \Rightarrow V = A \ln r + B$

Thus $10 = A \ln 2 + B$ and $0 = A \ln 5 + B$

$$\Rightarrow 10 = A \ln 2 - A \ln 5 \Rightarrow A = -\frac{10}{\ln(5/2)} = -10.86 \text{ and } \Rightarrow B = \frac{10 \ln 5}{\ln(5/2)} = 17.39$$

$$\Rightarrow V(r = 3.5) = A \ln 3.5 + B = 3.82\text{ V}$$



Note:

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Test Your fiziks concepts!**Topic: Solid State Physics****(For IIT-JAM, JEST, TIFR and CUET Aspirants)**

Q. In an orthorhombic crystal, the lattice constants are $3.0\text{\AA}$, $3.2\text{\AA}$, and $4.0\text{\AA}$. The distance d_{101} between the successive (101) planes is

- (a) $2.20\text{\AA}$ (b) $2.40\text{\AA}$ (c) $2.60\text{\AA}$ (d) $2.80\text{\AA}$

Ans.: (b)

Solution.: For orthorhombic crystal $\frac{1}{d_{hkl}^2} = \frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}$

$$\Rightarrow \frac{1}{d_{101}^2} = \frac{1^2}{3.0^2} + \frac{0^2}{3.2^2} + \frac{1^2}{4.0^2} = \frac{1}{9} + 0 + \frac{1}{16} = 0.1111 + 0.0625 = 0.1736$$

$$\Rightarrow d_{101} = \frac{1}{\sqrt{0.1736}} \approx 2.40\text{\AA}$$

Note:

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Test Your fiziks concepts!**Topic: Mechanics****(For PGT: KVS, NVS, DSSSB, State Education Boards, etc.)**

Q. Arrange the following in the correct sequence of chronological order:

- (A). Bernoulli's theorem (B). Conservation of energy
(C). Newton's law of motion (D). Kepler's laws

Choose the CORRECT answer from the given option below

- (a). (D), (B), (C), (A) (b). (D), (C), (B), (A)
(c). (B), (A), (D), (C) (d). (C), (B), (D), (A)

Ans.: (b)

Solution.:

Bernoulli's theorem (1738)

Newton's laws of motion (1687)

Kepler's laws (1609, 1619)

Note:

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