

SECOND MIDTERM

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Discussion Instructor (circle): Gramada Hansen Li Zbukov

Discussion Section # _____

10/50

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!

Use the conversion constants and data given on the front page.

$AV = 12.1$

- (a) Given an electric potential of the form $V = Ax^2y^2z^4$, calculate the y-component of the electric field at the point: $x = +2.00$, $y = -3.00$, $z = +1.50$. A is a constant.

$$E_y \sim -\frac{\partial V}{\partial y} = -\frac{\partial Ax^2y^2z^4}{\partial y} = -2Ax^2yz^4 = -2 \cdot A \cdot 2^2 \cdot (-3)^2 \cdot 1.5^4 = -547A$$

- (b) Find the electric field at a point 7.5 cm from the center of a conducting sphere. The sphere has a charge of 3.5×10^{-9} C and a diameter of 20.0 cm.

$$E = 0$$

- (c) A comet is presumed to be in an orbit that has a speed of zero when it is very far from the sun. What is its speed when it is at its closest approach to the sun if its distance then is 1.00×10^7 miles from the center of the sun?

$$0 = \frac{1}{2}mv^2 - \frac{GMm}{r} \Rightarrow v = \sqrt{\frac{2GM}{r}} = \sqrt{\frac{2 \cdot 6.67 \times 10^{-11} \cdot 1.99 \times 10^{30}}{1.609 \times 10^7 \cdot 1.609 \times 10^3}} = 42.9 \times 10^5 \text{ m/s}$$

- (d) Given a non-conducting sphere of radius 5.00 cm whose total charge (uniformly distributed) is $+9.00 \times 10^{-9}$ C. Find the work needed from the external world to move one electron from $R = 7.00$ cm to $R = 11.25$ cm. R is measured from the center of the sphere.

$$W = e \cdot \left(\frac{kq}{R_1} - \frac{kq}{R_2} \right) = 1.6 \times 10^{-19} \left(\frac{1}{0.07} - \frac{1}{0.1125} \right) \times 9 \times 10^9 \times 7 \times 10^{-9} = 6.99 \times 10^{-17} \text{ (J)}$$

(eV)

- (e) Take the radius of the earth's orbit about the sun as 1.00 AU (astronomical unit). Calculate the radius in A.U. of the orbit of an asteroid (assumed circular) with a period of 4.50 years.

$$T = \frac{2\pi R}{v} \Rightarrow v = \sqrt{\frac{GM}{R}} \Rightarrow T = \frac{2\pi R}{\sqrt{\frac{GM}{R}}} = \frac{2\pi R^{3/2}}{\sqrt{GM}}$$

$$\Rightarrow \frac{T_1}{T_2} = \frac{R_1^{3/2}}{R_2^{3/2}} \Rightarrow R_1 = R_2 \left(\frac{T_1}{T_2} \right)^{2/3} = 1 \left(\frac{4.5}{1} \right)^{2/3} = 2.73 \text{ AU}$$