

FIRST MIDTERM

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Name: KEY

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Discussion Section # _____

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REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
 Use the conversion constants and data given on the front page.

-1 UNITS
 -1 SF

- (a) Calculate the force between two protons ($q = +1.6 \times 10^{-19} \text{ C}$) that are $1.5 \times 10^{-15} \text{ m}$ apart (approximately the separation that exists in an atomic nucleus).

$$F = \frac{kq^2}{r^2} = \boxed{102 \text{ N}} \quad \text{or} \quad \boxed{\begin{matrix} 101 \text{ N} \\ 103 \text{ N} \end{matrix}}$$

- (b) For the expression $(x - a)^{-7/2}$, where $a \ll x$, calculate completely the term in a^2 using the binomial expansion.

$$x^{-7/2} (1 - a/x)^{-7/2} = \frac{1}{2} x^{-7/2} (-7/2)(-9/2) \frac{a^2}{x^2} + \frac{63}{8} \frac{a^2}{x^{11/2}}$$

or $\boxed{7.88 a^2 / x^{11/2}}$

- (c) An electron is accelerated from rest in an electric field of 0.325 N/C . After it has traveled 1.20 m , what is its speed?

$$E = \frac{F}{q} = \frac{ma}{q} = E = \frac{m}{q} \left(\frac{v^2}{2x} \right) \quad (Eq2x)^{1/2} = v = \boxed{3.70 \times 10^5 \text{ m/s}}$$

or $\boxed{\begin{matrix} 3.71 \times 10^5 \text{ m/s} \\ 3.69 \times 10^5 \text{ m/s} \end{matrix}}$

- (d) Calculate the numerical magnitude of the electric field at a distance of $1.20 \times 10^{-10} \text{ m}$ from an electron.

$$E = \frac{kq}{r^2} = \boxed{1 \times 10^{11} \text{ N/C}} \quad \text{or} \quad \boxed{\begin{matrix} .99 \times 10^{11} \text{ N/C} \\ 1.01 \times 10^{11} \text{ N/C} \end{matrix}}$$

- (e) A cube of non-conductor is uniformly charged with a total charge of $+6.20 \times 10^{-6} \text{ C}$. Calculate the electric flux through one face of the cube.

$$\Phi = \frac{q}{\epsilon_0} = \boxed{\begin{matrix} 1.17 \times 10^5 \text{ N/cm}^2 \\ 1.18 \times 10^5 \text{ N/cm}^2 \\ 1.16 \times 10^5 \text{ N/cm}^2 \end{matrix}}$$

$$\frac{9 \times 10^9 \cdot 1.6 \times 10^{-19}}{(1.2)^2 \times 10^{-20}} \quad \text{2 SF}$$