

FIRST MIDTERM

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Discussion Section # _____

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!

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

- (a) Calculate the magnitude of the electric field, including units, 4.75 m from a point charge of value $Q = +2.95 \times 10^{-3}$ C.

$$E = k \frac{Q}{r^2} = 9 \cdot 10^9 \left(\frac{2.95 \cdot 10^{-3}}{4.75^2} \right) = \boxed{1.18 \cdot 10^6 \text{ V/C}}$$

- (b) Calculate the complete term that involves a^4 in the binomial expansion of the expression below.

$$\frac{1}{(x^2 - a^2)^{0.25}} = \frac{1}{x^2} \left(1 + \frac{a}{x} \frac{a^2}{x^2} + \frac{0.25 a^4}{x^4} \right) \Rightarrow \boxed{\frac{0.25 a^4}{x^4}}$$

- (c) Calculate the gravitational force on a 100 kg astronaut in a satellite that is 1.50 earth radii above the earth's surface.

$$F = G \frac{mM}{(R+1.5R)^2} = \frac{m}{6.25} G \frac{M}{R^2} = \frac{100}{6.25} \cdot 9.8 = \boxed{157 \text{ N}}$$

- (d) If an asteroid orbits the sun in 400 days at a distance of 200,000,000 km (2.00×10^8 km), from the center of the sun, calculate the mass of the sun from this information.

$$T^2 = \left(\frac{4\pi^2}{GM} \right) R^3 \Rightarrow M = \frac{4\pi^2}{G} \frac{R^3}{T^2} = \boxed{3.96 \cdot 10^{30} \text{ kg}}$$

- (e) The nucleus of a lithium atom has an electric charge equal to $+3e$, since it has three protons. Calculate the magnitude of the electric force between a lithium nucleus and an electron if they are 0.25×10^{-10} m apart.

$$F = k \frac{q_1 q_2}{r^2} = \boxed{1.33 \cdot 10^{-6} \text{ N}}$$