SECOND MIDTERM

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

(a) [5 pts.] Given an electric potential of the form $V = Ax^2y^2z^2$, calculate the magnitude of the electric field at the point $x = 2, y = 4, z = 6$.

$$E = -\nabla V = -3Ax^2y^2z^2 \hat{i} - 2Ax^2y^2z^2 \hat{j} - 5Ax^2y^2z^2 \hat{k}$$

$$= 1492992 \quad 497664 \quad 83940 \quad 1 E = 1.78 \times 10^6 \text{ N/C}$$

(b) [5 pts.] Given the function $\frac{1}{(a-x)^{3/4}}$, calculate the coefficient of the term in $x^4$ in the binomial expansion.

$$C = \left( \frac{-1}{4} \right) \left( \frac{-3}{4} \right) \left( \frac{-3}{4} \right) \left( \frac{-3}{4} \right) \left( \frac{-3}{4} \right) a^{-3/4} = 0.564 a^{-1/4} = \frac{115}{64} a^{-1/4}$$

(c) [5 pts.] The electric field just above the surface of a sphere of radius 5.00 cm is 1250 N/C. Calculate the total charge on the sphere.

$$E = \frac{kQ}{r^2} \Rightarrow Q = \frac{E r^2}{k} = \frac{1250 \times (5 \times 10^{-2})^2}{8.9 \times 10^9} = 3.47 \times 10^{-10} \text{ C}$$

(d) [5 pts.] In moving an electron from point A to point B $4.00 \times 10^{-19} \text{ J}$ of work is done from the outside world. Calculate the potential difference $V_B - V_A$, with sign.

$$W = q \Delta V \quad V_B - V_A = \frac{W}{q} = \frac{4.00 \times 10^{-19}}{1.6 \times 10^{-19}} = -2.50 \text{ V}$$

(e) [5 pts.] If all capacitors have the same value, $C$, calculate the effective capacitance between a and b.

$$C + C = 2C \Rightarrow \frac{1}{2} \frac{1}{C} = \frac{2}{3} C$$

$$\Rightarrow \frac{2}{3} C + \frac{1}{C} = \frac{5}{3} C$$

$$\Rightarrow \frac{2}{3} C + \frac{5}{3} C = \frac{8}{5} C$$

$$\therefore C_{tot} = \frac{1}{C} = \frac{5C}{8} = 0.625 C$$