1) a) $F = k\frac{qq}{r^2} \Rightarrow$ If $r \to 3r$, $F \to F/9$

b) $E = k\frac{q}{r^2} \Rightarrow$ if $r \to 3r$, $E \to E/9$

2) a) Field lines never cross. E is tangent to field lines and is single valued. If lines cross, there are two tangents.

b) density of lines $\propto |E|$

c) away from charge

3) a) $E = 0$ inside conductor

b) excess charge is on surface

c) Gauss' law says: no charge inside $\Rightarrow$ no net flux

4) $V = k\frac{q}{r} \Rightarrow$ A (r) is highest, then
B (2r), and then
C (3r) is lowest.

5) a) increase

b) stays the same

c) voltage decreases

Problems

1) a) $F = k\frac{q_1 q_2}{r^2} = 9\times10^9 \frac{(4\times10^{-6})(2\times10^{-6})}{(0.3m)^2}$

$\boxed{F = 0.8N}$

and q_2 is attracted to q_1, so to

$\boxed{\text{the left}}$

b) $\boxed{\text{attractive}}$

2) a) $E = k\frac{q}{r^2} = 9\times10^9 \frac{3\times10^{-6}}{(0.2)^2} = \boxed{6.7\times10^5 \frac{N}{C} = E}$

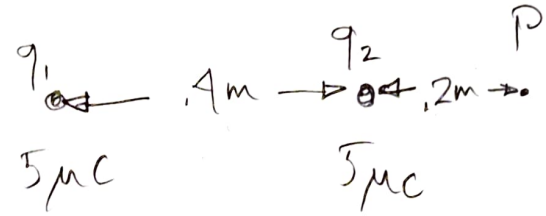
b) $F = qE = 1\times10^{-6}(6.7\times10^5) = \boxed{0.67N = F}$

c) $\boxed{\text{Opposite}}$ since the charge is negative.

3) a) From symmetry, midpoint between 2 identical positive charges

$\boxed{E = 0}$

b)



$$E_1 = k\frac{q_1}{r_1^2} = 9\times10^9 \frac{5\times10^{-6}}{(0.6)^2} = 1.25\times10^5 \ N/C$$

(to the right)

$$E_2 = k\frac{q_2}{r_2^2} = 9\times10^9 \frac{5\times10^{-6}}{(0.2)^2} = 1.12\times10^6 \ N/C$$

(to the right)

$$E = E_1 + E_2$$

$$= 1.25\times10^5 + 1.12\times10^6 = \boxed{1.25\times10^6 \frac{N}{C} = E}$$

4) a) Gauss' law: $\Phi = \frac{q_{enc}}{\epsilon_0}$

$$\Phi = \frac{6 \times 10^{-6}}{8.85 \times 10^{-12}} = \boxed{6.78 \times 10^5 \frac{N \cdot m^2}{C} = \Phi}$$

b) The enclosed charge does not change, so the flux does not change

5) a) $V = k\frac{q}{r} = 9 \times 10^9 \frac{2 \times 10^{-6}}{0.5}$

$$\boxed{V = 3.6 \times 10^4 \text{ V}}$$

b) $U = qV = -3 \times 10^{-6}(3.6 \times 10^4)$

$$\boxed{U = -1.08 \times 10^{-1} \text{ J}}$$

c) Opposites attract; toward the positive charge

6) a) $C = \frac{\epsilon_0 A}{d} = \frac{8.85 \times 10^{-12}(0.02)}{2 \times 10^{-3}}$

$$\boxed{C = 8.85 \times 10^{-11}\ F}$$

b) $C = \frac{q}{\Delta V} \Rightarrow q = C\Delta V$

$$q = 8.85 \times 10^{-11}(12) = \boxed{1.06 \times 10^{-9}\ C = q}$$

c) $C' = kC = 4(8.85 \times 10^{-11})$

$$\boxed{C' = 3.54 \times 10^{-10}\ F}$$

d) $q' = C'\Delta V = 3.54 \times 10^{-10}(12)$

$$\boxed{q' = 4.25 \times 10^{-9}\ C}$$