

Answers to the review #1 problems:

21-R1: $N_e \approx 10^{13}$

21-R2: $a_y \approx -4 \times 10^{12} \text{ m/s}^2$

21-R3: *see next page*

21-R4: *B*

21-R5: $Q \approx -71.4 \text{ nC}$

22-R1: $E \approx 135 \text{ N/C}$ from positive to negative wire

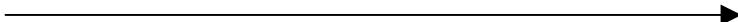
22-R2: $Q \approx -833 \text{ pC}$

22-R3: $Q_A = 0$; $Q_B = -250 \text{ nC}$; $Q_C = +250 \text{ nC}$; $Q_D = -210 \text{ nC}$

22-R4: $E_p \approx 0.6786 \text{ N/C}$

22-R5: *C*

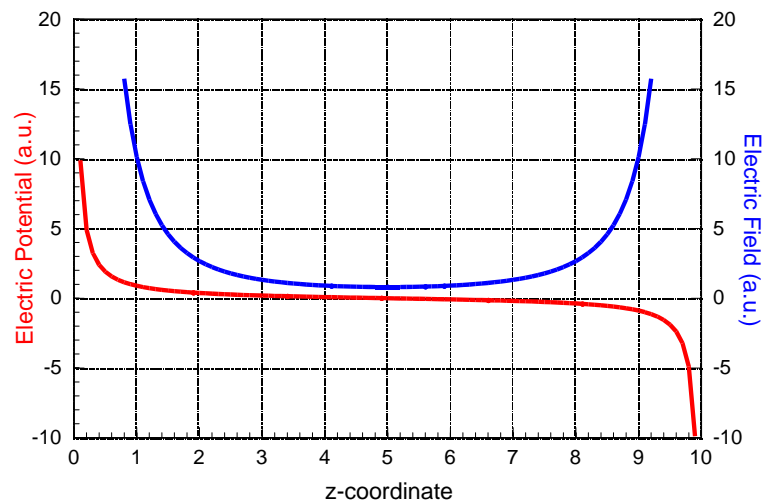
23-R1: $v_\infty \approx 1.55 \times 10^7 \text{ m/s}$

23-R2: 

23-R3: $V \approx 2348 \text{ V}$

23-R4: *B*

23-R5: $V \approx 882 \text{ V}$



21-R3:

Since I messed it in the class, let me give for this problem a complete solution here.

Two charges are attracted. That means that their signs are opposite.

Let's assume q_1 will be positive and q_2 negative. We know that

$$q_1 + q_2 = -24 \mu\text{C} = -q_0; \quad q_2 = -q_0 - q_1, \quad \text{where we call } q_0 = +24 \mu\text{C}$$

Information about the signs of the charges have been used when we said that force between charges is attractive:

$$\vec{F} = k \frac{q_1 q_2}{r^2} \cdot \hat{r} \quad \text{Due to different signs of } q_1 \text{ and } q_2, \text{ directions of the}$$

force and unit vector \hat{r} are opposite.

Now we will be interested only in magnitudes of charges and do not need to use sign information for second time. We need to use:

$$|\vec{F}| = k \cdot \frac{|q_1| \cdot |q_2|}{r^2} \quad (1)$$

$$|q_1| = q_1 \quad \text{as we assumed that } q_1 \text{ is positive}$$

$$|q_2| = |-24 \mu\text{C} - q_1| = 24 \mu\text{C} + q_1 \quad \text{to write this value as positive}$$

Now we can calculate magnitudes of charges using equation (1):

$$F = k \cdot \frac{q_1 \cdot (q_0 + q_1)}{r^2} \rightarrow q_1 \cdot (q_0 + q_1) = \frac{F \cdot r^2}{k}$$

$$q_1^2 + q_0 q_1 - \frac{F \cdot r^2}{k} = 0; \quad q_1 = -\frac{q_0}{2} \pm \sqrt{\left(\frac{q_0}{2}\right)^2 + \frac{F \cdot r^2}{k}}$$

$$\text{solution here } q_1 = -12 \mu\text{C} \pm 24 \mu\text{C}$$

$$q_1' = +12 \mu\text{C} \equiv q_1 \quad q_1'' = -36 \mu\text{C} \equiv q_2$$