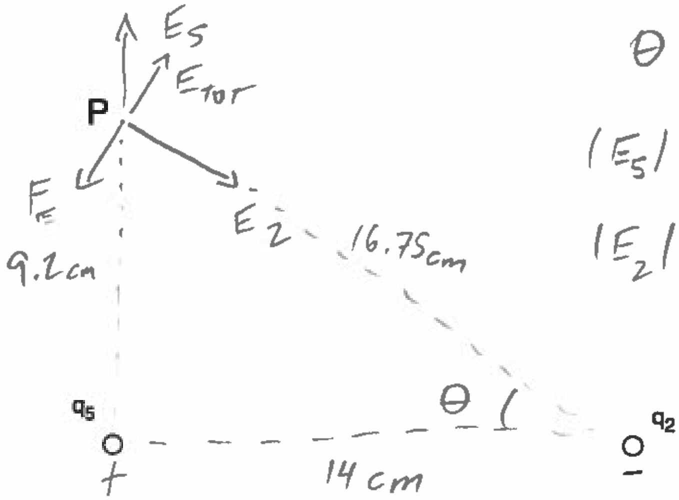
Physics 10164 - Exam 1A

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work even if you get the right answer. Clearly indicate your answer with a circle or a box and remember to include correct units and significant figures.

1. (35 pts) Charge q_5 = +5.00 nC and is located at the origin. Charge q_2 = -2.00 nC and is located at x = 14.0 cm.

a) Find the magnitude and direction of the electric field at point P, located at y = 9.20 cm.

b) A small 135 gram mass with a charge q = -244 nC is placed at point P. What is the magnitude and direction of the acceleration this mass experiences?



$$\theta = \tan^{-1}\left(\frac{9.2}{14}\right) = 33.3^\circ$$

$$|E_5| = \frac{(9\times10^{9})(5\times10^{-9})}{.092^2} = 5317$$

$$|E_2| = \frac{(9\times10^{9})(2\times10^{-9})}{.1675^2} = 642$$

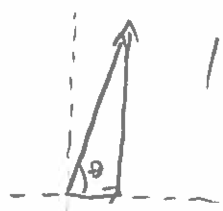
$$E_{5,x} = 0 \qquad E_{5,y} = 5317$$

$$E_{2,x} = 642\cos 33^\circ = 536$$

$$E_{2,y} = -642\sin 33^\circ = -352$$

$$E_{TOT,x} = 536$$

$$E_{TOT,y} = 4965$$



$$|\vec{E}| = \sqrt{536^2 + 4965^2} = \boxed{4990\ V/m}$$

$$\theta = \tan^{-1}\left(\frac{4965}{536}\right) = \boxed{83.8^\circ \text{ above } +x}$$

b) $|F_E| = |qE| = .00122\ N$

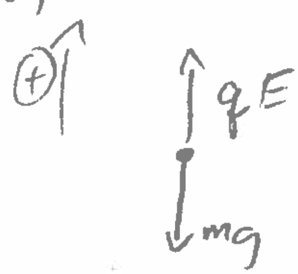
$$a = \frac{F_E}{m} = \frac{.00122}{.135} = \boxed{.00902\ m/s^2}$$

$$\boxed{\theta = 83.8^\circ \text{ below } -x}$$

2. (35 pts) A 35.0-gram mass carries a net charge of $-562\ \mu C$ and is initially at rest at ground level. A uniform electric field is now applied to the region, and as a result, the mass accelerates upward at a constant rate of $2.60\ m/s^2$. Assume the only forces experienced by the mass are gravity and the electric force.

a) What is the magnitude and direction of the electric field?
b) After the mass has risen 12.4 meters, how much work has been done by the electric force?
c) If the voltage at ground level is 0 Volts, what is the voltage at a height of 12.4 meters above the ground?

a)



$\vec{E}$ points down since F_E on ⊖ charge points up

$$\Sigma F_y = |qE| - |mg| = ma$$

$$E = \frac{ma + mg}{q} = \frac{(.035)(12.4)}{562 \times 10^{-6}}$$

$$= \boxed{772\ V/m, \downarrow}$$

b) $W_E = +|qE| \cdot |\Delta s| = (562 \times 10^{-6})(772)(12.4)$

$= \boxed{5.38\ J}$ (positive since qE + Δs in same dir).

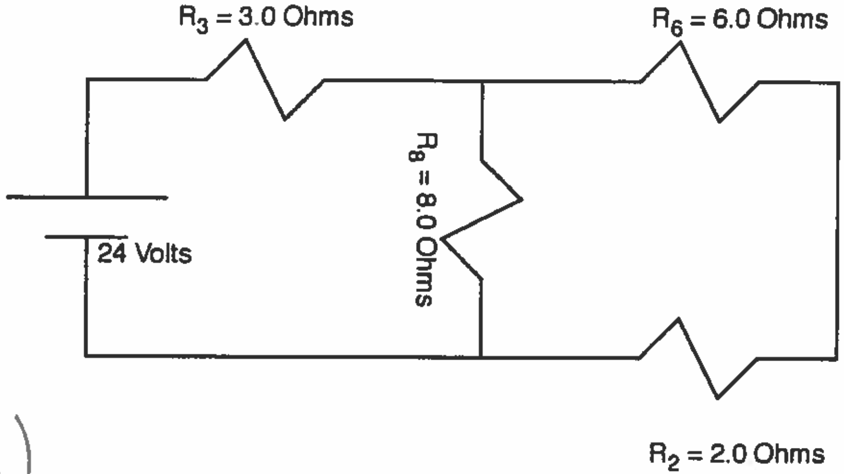
c) $\Delta V = \pm E \cdot \Delta s = \pm (772)(12.4) = 9570$ Volts

Since E points $\downarrow$, V at 12.4 m is higher

so $\boxed{V_{top} = 9570\ \text{Volts}}$

#3. (30 pts) For the circuit shown below, answer the following:

a) Determine the power dissipated by the resistor R_6.
b) If the resistor R_3 were increased to 12 Ohms, what would happen to your answer to (a)? Increase, decrease or remain the same? Justify your answer.



$R_{26} = R_2 + R_6$

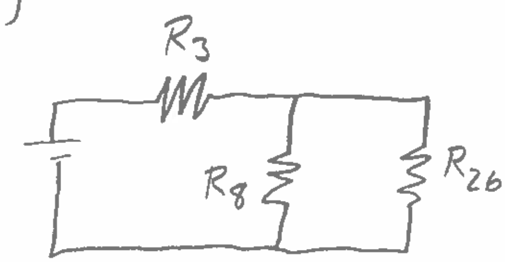
$= 8.0\ \Omega$

$\frac{1}{R_{268}} = \frac{1}{R_{26}} + \frac{1}{R_8}$

$\Rightarrow R_{268} = 4\ \Omega$

$R_{tot} = R_3 + R_{268} = 7\ \Omega$

a)



$\Rightarrow I_{tot} = \frac{24}{7} = 3.43\ A$

$I_{tot} = I_3 = I_{268}$ (series)

$\Delta V_{268} = I_{268} R_{268} = 13.7$ Volts

$\Delta V_{268} = \Delta V_{26} = \Delta V_8 = 13.7$ (parallel)

$I_{26} = \frac{\Delta V_{26}}{R_{26}} = \frac{13.7}{8} = 1.71\ A$

$I_{26} = I_2 = I_6 = 1.71\ A$ (series)

$P_6 = I_6^2 R_6 = \boxed{18\ W}$

b) If $R_3 \uparrow$, $I_{tot} \downarrow$, so less current flows through R_{268}, R_{26}, R_6, so $\boxed{P_6 \downarrow}$