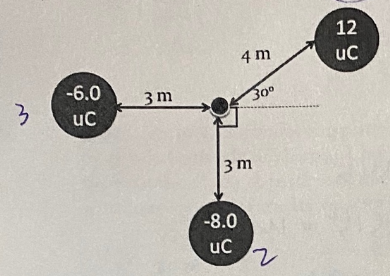
1. (3 marks) What is the electric potential at the point P shown below?



$V_1 = \frac{kq}{r} = \frac{(8.99\times10^9)(12\times10^{-6})}{4} = +26970.$

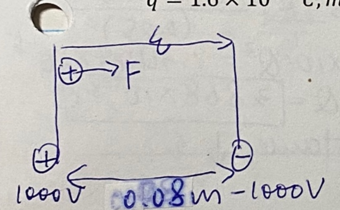
$V_2 = -23973$

$V_3 = -17980.$

$V_{total} = V_1 + V_2 + V_3 = \boxed{-14983\ V}$

(scalar addition)

2. (3 marks) A proton is accelerated from rest from one charged plate to another separated 0.0800 m, where the electric potential is $-1000V$ and $1000V$. At what speed does it leave the second plate? Include a diagram, label the charge and potential of each plate!
$q = 1.6 \times 10^{-19} C, m = 1.67 \times 10^{-27} kg$



$\Delta E_E = \frac{1}{2} m v_f^2$

$\Delta V \cdot q_1 = \frac{1}{2} m v_f^2$

$(2000V)(1.6\times10^{-19}) = \frac{1}{2}(1.67\times10^{-27}) v_f^2$

$v_f = \boxed{6.2\times10^5\ m/s}$

3. (2 marks) What is the electric field strength at a point in space where a proton experiences an acceleration of $9.8 \times 10^4 m/s^2$?

$F = ma$

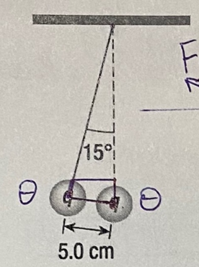
$a = \frac{F}{m} = \frac{E q_1}{m}$

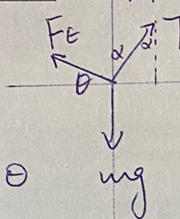
$9.8\times10^4 = \frac{E(1.6\times10^{-19})}{1.67\times10^{-27}}$

$9.8\times10^4 = E(9.581\times10^7)$

$E = \boxed{1.02\times10^{-3}}\ N/C$

4. (5 marks) A metal-coated table tennis ball with a mass of 2.1 g is suspended by an insulating thread. A similar table tennis ball touches the first, giving each ball an equal negative charge. When the two balls are separated horizontally by 5.0 cm, the string hangs at 15° with respect to the vertical.
   a) Calculate the charge on each table tennis ball in coulombs.
   b) Determine approximately how many excess electrons are on each table tennis ball.





$m = 2.1\times10^{-3}$ kg

a) $\theta = 7.5°$ $\alpha = 15°$

$F_E = \frac{k q_1 q_2}{r^2}$

$\begin{cases} F_E \cos 7.5° = T \sin 15° \\ F_E \sin 7.5° + T\cos 15° = mg \end{cases}$

$F_E(0.99) = T(0.259)$

$F_E = 0.2614T$

$(0.2614T)(0.1305) + T(0.9659) = (2.1\times10^{-3})(9.8)$

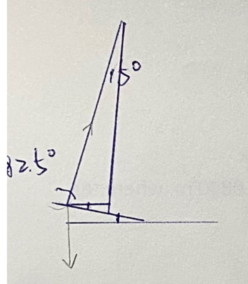
$T = 0.02058$ N.

$F_E = 5.38\times10^{-3}$ N

$\therefore F_E = \frac{(8.99\times10^9)Q^2}{(0.05)^2}$

$8.99\times10^9 Q^2 = 1.3449\times10^{-5}$

$Q = 3.868\times10^{-8}$ C.



b) $\frac{3.868\times10^{-8}}{1.6\times10^{-19}} = 2.417\times10^{11}\ e$

6. (2 marks) If a test charge with 1C being replaced by the other test charge with 2C, and the amount of point charge get reduced to half, how does the electric force and electric potential change?

$F = \frac{k q_1 q_2}{r^2}$ $\Delta V = -\varepsilon \Delta d$ $V = \frac{k q_2}{r}$

Electric force: same

Electric potential: ½ half.

8. (2 marks) **How** did Millikan adjust and balance the net force on the oil droplet so that he figured out the elementary charge?

- Adjust the voltage by adding more or remove main power (batteries).
- or adjust the distance b/w 2 plates.