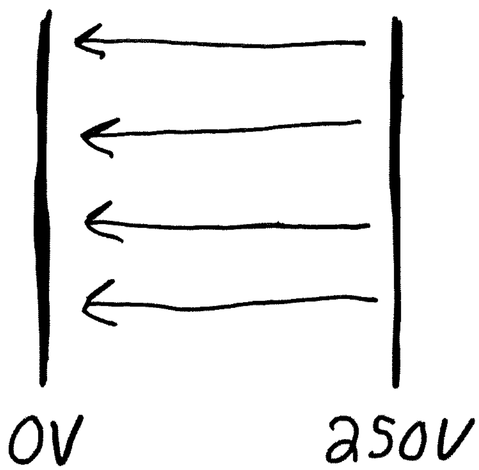
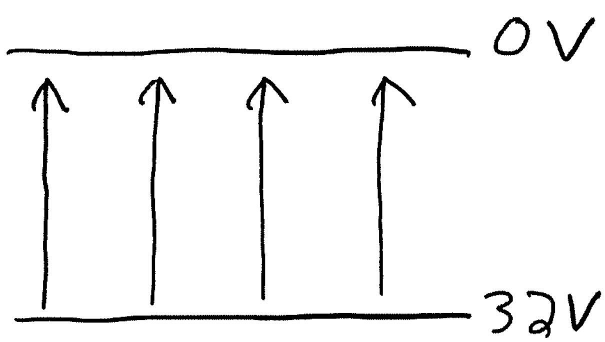
1. Sketch the electric field with direction indicated between each of the following sets of plates

a.

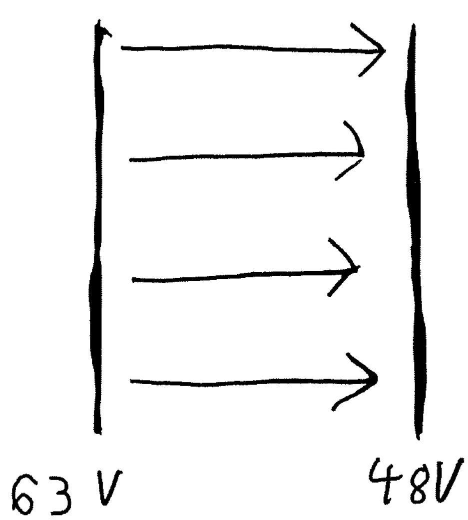


Direction of field is the direction a positive charge world move, from high to low potential

b.



c.



2. The potential difference between two plates is 325 V, what is the electric field strength between the plates if they are:

a. 0.25 metres apart

$$E = \frac{\Delta V}{r} = \frac{325V}{0.25m} = 1300 \, N/C$$

b. 0.025 metres apart

$$E = \frac{325V}{0.025m} = 13\,000 \, N/C$$

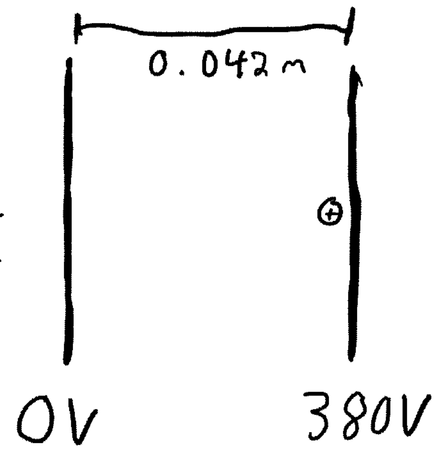
c. 0.0025 metres apart

$$E = \frac{325V}{0.0025V} = 130\,000 \, N/C$$

3. What does it mean that the electric field strength between two plates is "uniform"?

Everywhere in the field the strength and direction of the field is the same.

4. A $+4.5\ \mu C$ charge is placed near the positive plate of a capacitor which has the plates 4.2 cm apart.



a. What is the electric field strength between the plates?

$$E = \frac{\Delta V}{r} = \frac{380\ V}{0.042 m} = 9048 N/C$$

$$\approx 9.0 \times 10^{3} \frac{N}{C}$$

b. What is the electric force acting on the charge while it is moving between the plates?

$$F_F = Eq = 9048 \frac{N}{C} \times 4.5\times10^{-6} C = 0.04071 N$$

$$\approx 0.041 N$$

c. What is the acceleration of the charge while it is moving between the plates?

$$a = \frac{F_{net}}{m} = \frac{0.04071 N}{0.025 kg} = 1.6286 \frac{m}{s^2} \approx 1.6 \frac{m}{s^2}$$

d. Use the kinematics equation $v_f^2 = v_o^2 + 2ad$ to determine the final velocity of the charge.

$$V_f = \sqrt{2(1.6286 \tfrac{m}{s^2})(0.042 m)} = 0.3699 m/s$$

$$\approx 0.37 m/s$$

e. Use the formulas $W = q\Delta v$ and $E_K = \frac{1}{2}mv^2$ to determine the final velocity of the charge (you should get the same answer as you got for d).

$$\Delta E_p = (4.5\times10^{-6})(-380) = -0.00171 J$$

E_K gained $= E_p$ lost

$$V = \sqrt{\frac{2 E_K}{m}} = \sqrt{\frac{2(0.00171)}{0.025}} = 0.3699 m/s$$

$$\approx 0.37 m/s$$

5. What is the potential difference between two plates 6.3cm apart if the electric field between them has a strength of 2 500 N/C?

↖ 0.063m

$$E = \frac{\Delta V}{r} \rightarrow Er = \Delta V$$

$$(2500\ \tfrac{N}{C})(0.063m) = 157.5\ V \approx \boxed{160V}$$

6. What is the potential difference between two plates 2.6cm apart if a 6.6 μC charge experiences an electric force of 0.019 N?

0.026m

$$E = \frac{F_E}{q} = \frac{0.019N}{6.6\times10^{-6}C} = 2878.79\ \tfrac{N}{C}$$

$$Er = \Delta V$$

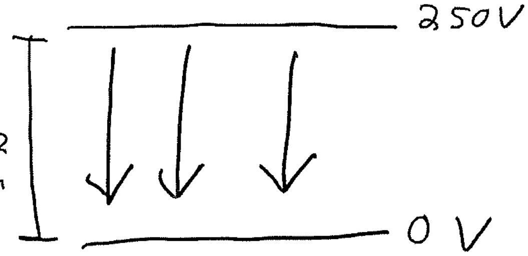
$$(2878.79)(0.026) = 74.85V \approx \boxed{75V}$$

7. What is the distance between two plates if the electric field between them has a strength of 65000 N/C and the potential difference between the plates is 7600 volts?

$$E = \frac{\Delta V}{r} \rightarrow Er = \Delta V \rightarrow r = \frac{\Delta V}{E}$$

$$r = \frac{7600}{65000} = \boxed{0.12m}$$

8. A pair of plates, with a potential difference of 250 volts and a separation of 6.2 cm are put horizontally on Earth, so that electric force and gravity affect objects between the plates. Determine the ~~acceleration~~ F_{net} of each of the following objects and the direction they are accelerating (up or down)

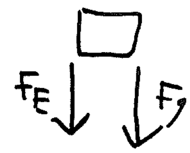


$$E = \frac{250V}{0.062m} = 4032.26\ N/C$$

a. A 0.052 kg object with a charge of 230 μC.

F_g pulls down $= mg = 0.052 \times 9.8 = 0.5096N$

F_E also pulls down since ⊕ moves to low potentia $= Eq = 0.9274N$

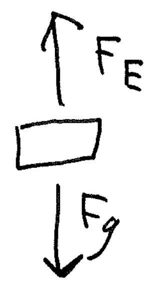


Total: $0.5096N + 0.9274N =$ **1.4 N down**

b. A 0.082 kg object with a charge of -62~~0~~ μC

$F_g = mg = 0.8036\ N$ down

$F_E = Eq = 0.25\ N$ up

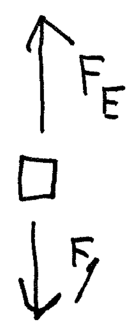


$F_{net} =$ winners − losers $= 0.8036 - 0.25 =$ **0.55N down**

c. A ~~0.0062~~ 0.062 kg object with a charge of $-930\ \mu C$

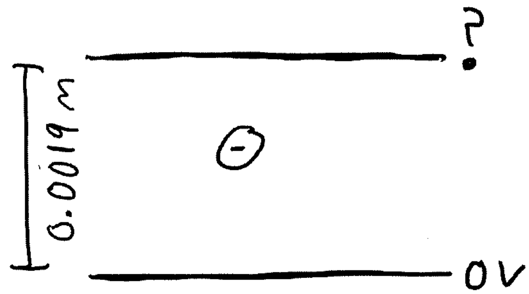
$F_g = mg = 0.6076\ N$ down

$F_E = Eq = 3.75\ N$ up



$F_{net} =$ winners − losers $= 3.75N - 0.6076N =$ **3.1N up**

9. A $-2.3 \times 10^{-9} C$ charge with a mass of 0.0026 kg is perfectly suspended between two plates, with the electric force pushing it up perfectly balanced by the force of gravity pushing it down. What is the potential difference between the plates if the distance between them is 1.9 mm?



$$F_g = F_E$$

$$mg = Eq$$

$$mg = \frac{\Delta V}{r} q$$

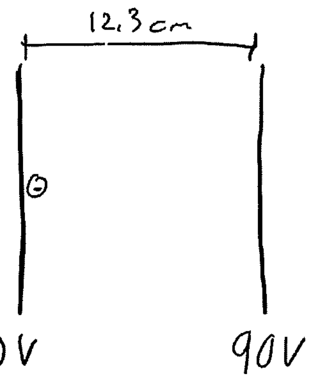
$$\frac{mgr}{q} = \Delta V$$

$$\frac{(0.0026\,kg)(9.8\,\frac{N}{kg})(0.0019\,m)}{2.3 \times 10^{-9}\,C}$$

$$= 21\,049\ V$$

$$\approx 21\,000\ V$$

10. Two plates with a potential difference of 90.0 V are separated by a distance of 12.3 cm and placed horizontally on Earth so that objects between the plates are affected both by gravity and by the electric force, a 0.0027kg, $-9.3\mu C$ charged object is placed on the negative plate.



a. What is the acceleration of the object due to the electric force?

$$E = \frac{\Delta V}{r} = \frac{90}{0.123} = 731.71 \frac{N}{C}$$

$$F_E = E_q = \left(731.71 \frac{N}{C}\right)(9.3\times10^{-6}) = 0.006805\ N$$

$$a = \frac{F}{m} = \frac{0.006805}{0.0027} = 2.5203 \frac{m}{s^2} \quad \left(\simeq 2.52\ m/s^2\right)$$

b. How long will it take the charge to move from the negative plate to the positive plate?

Use $d = v_0 t + \frac{1}{2} a t^2$

$a = 2.52\ m/s^2$

$d = 0.123\ m$

$v_0 = 0$

$$t = \sqrt{\frac{2d}{a}} = 0.3124\ sec$$

$$\left(\simeq 0.31\ sec\right)$$

c. How far will the charge have dropped in that time due to gravity?

Use $d = v_0 t + \frac{1}{2} a t^2$

$a = 9.8\ m/s^2$

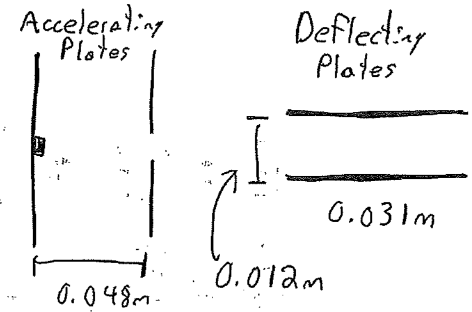
$v_0 = 0$

$t = 0.3124\ sec$

$$\left(d = 0.48\ m\right)$$

Uniform Electric Fields Practice Name:______________________________

11. A cathode ray tube is a device used in pre-flatscreen TV's, the key idea is to control a beam of electrons which hit different parts of the screen and cause them to change colour. There are two sets of plates used, the first accelerates a beam of electrons, the second deflects the beam of electrons. By controlling the potential differences of the plates, the beam can be very precisely directed.



a. If the distance between the accelerating plates is 4.8 cm, and their potential difference is 120 volts, what will be the velocity of an electron leaving the positive plate if it starts from rest on the negative plate. (Mass of an electron is about 9.11×10^{-31}kg and charge of an electron is about -1.6×10^{-19} C)

$$\Delta E_p = q\Delta V = (-1.6\times10^{-19}C)(120V)$$

$$= -1.92\times10^{-17}J \rightarrow E_K = 1.92\times10^{-17}J$$

$$V = \sqrt{\frac{2E_K}{m}} = 6.4924\times10^{6} m/s$$

b. At the speed found in a, how long will it take an electron to travel the 0.031 m length of the deflecting plates?

$$t = \frac{d}{V} = \frac{0.031m}{6.4924\times10^{6} m/s}$$

$$= 4.7748\times10^{-9} sec$$

Uniform Electric Fields Practice Name:______________________________

c. If the top deflecting plate has a potential of 25 volts and the bottom plate has a potential of 0 volts, what will the upward acceleration of the electron be while it is between the deflecting plates?

$$E = \frac{\Delta V}{d} = \frac{25V}{0.012m} = 2083.33\,\frac{N}{C}$$

$$F_E = Eq = 2083.33\,\frac{N}{C} \times 1.6\times10^{-19}C = 3.333\times10^{-16}N$$

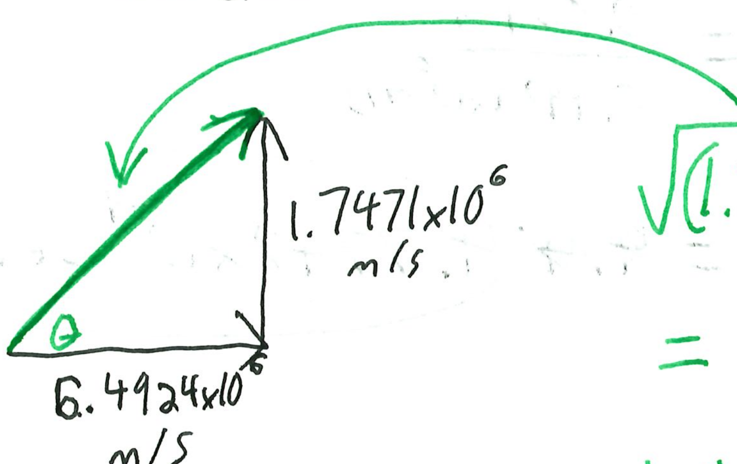
$$a = \frac{F}{m} = \frac{3.333\times10^{-16}}{9.11\times10^{-31}} = 3.6590\times10^{14}\,m/s^2$$

d. Using the acceleration found in c and the time found in b what will be the final vertical velocity of the electrons leaving the deflecting plates?

$$\Delta v = at = \left(3.6590\times10^{14}\frac{m}{s^2}\right)\left(4.7748\times10^{-9}sec\right)$$

$$= 1.7471\times10^{6}\,m/s$$

e. What is the total velocity of the electrons (magnitude and direction) as they leave the deflecting plates?

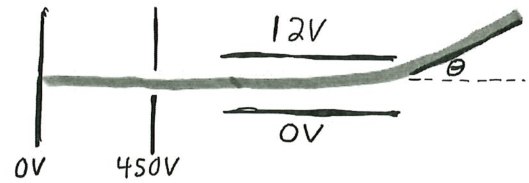


$$\sqrt{(1.7471\times10^6)^2 + (6.4924\times10^6)^2}$$

$$= 6.7234\times10^{6}\,m/s$$

$$\theta = \tan^{-1}\left(\frac{1.7471}{6.4924}\right) = 15^\circ$$ above right

12. In a cathode ray tube, a stream of electrons is accelerated by being pulled across a potential difference of 450 V between two vertical parallel pates.



Then the stream is directed towards 11 cm long horizontal plates which are separated by a distance of 1.2 cm and have a potential difference of 12V between them. Determine the angle of deflection of the electron stream. The mass of an electron is approximately 9.11×10^{-31} kg, and its charge is approximately -1.6×10^{-19}C.

Vel after leaving accelerating plates $\Delta E_p = q\Delta v$

$= -1.6\times10^{-19}C \times 450V$

$= -7.2\times10^{-17}$

$E_K = 7.2\times10^{-17} J$

$v = \sqrt{\frac{2\times7.2\times10^{-17}}{9.11\times10^{-31}}} = 1.257\times10^{7} m/s$

Acceleration in deflecting plates

$E = \frac{\Delta v}{r} = \frac{12}{0.012} = 1000 N/C$

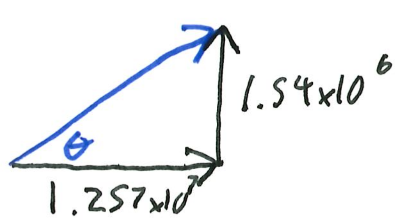
$F_E = Eq = (1000 N/C)(1.6\times10^{-19}C) = 1.6\times10^{-16} N$

$a = \frac{F_{net}}{m} = \frac{1.6\times10^{-16} N}{9.11\times10^{-31} kg} = 1.756\times10^{14} m/s^2$

Time in deflecting plates $= \frac{0.11}{1.257\times10^{7}} = 8.751\times10^{-9}$ sec

Final upward velocity $= at = 1.756\times10^{14} \times 8.751\times10^{-9}$

$= 1.54\times10^{6} m/s$



$\theta = \tan^{-1}\left(\frac{1.54\times10^{6}}{1.257\times10^{7}}\right) = 7.0°$