PHYS 202 S2017 Ch18 Problems

1. Common static electricity involves charges ranging from nanocoulombs to microcoulombs. (a) How many electrons are needed to form a charge of –2.00 nC (b) How many electrons must be removed from a neutral object to leave a net charge of 0.500 μC ?

(a) 1.25×10^{10}

(b) 3.13×10^{12}

3. To start a car engine, the car battery moves 3.75×1021 electrons through the starter motor. How many coulombs of charge were moved?

−600C

9. How many coulombs of positive charge are there in 4.00 kg of plutonium, given its atomic mass is 244 and that each plutonium atom has 94 protons? [1.48×10^{8} C]

16. A test charge of +2 μC is placed halfway between a charge of +6 μC and another of +4 μC separated by 10 cm. (a) What is the magnitude of the force on the test charge? (b) What is the direction of this force (away from or toward the +6 μC charge)?

$F_6 = \frac{9\times10^{9} \times 2\times10^{-6} \times 6\times10^{-6}}{0.05^2} = 43.2\,N \rightarrow$

$F_4 = \frac{9\times10^{9} \times 2\times10^{-6} \times 4\times10^{-6}}{0.05^2} = 28.8\,N \leftarrow$

Net: 14.4 N →

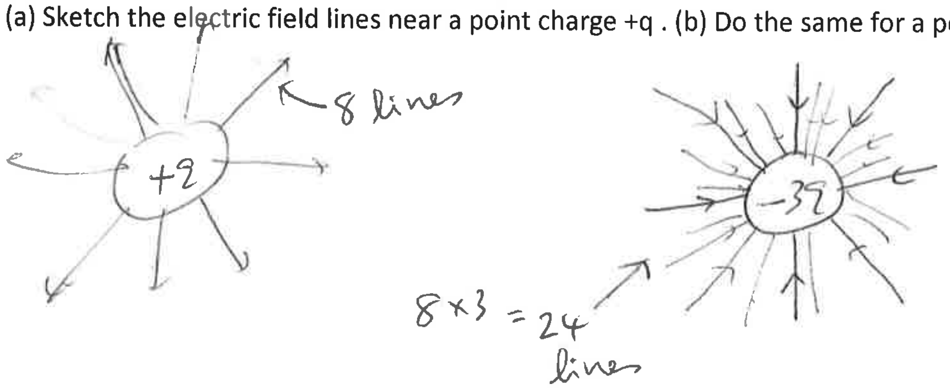
6μC 2μC 4μC (F_4 ← → F_6)

25. Point charges of 5.00 μC and –3.00 μC are placed 0.250 m apart. (a) Where can a third charge be placed so that the net force on it is zero? (b) What if both charges are positive? [0.109 m from 3μC charge]

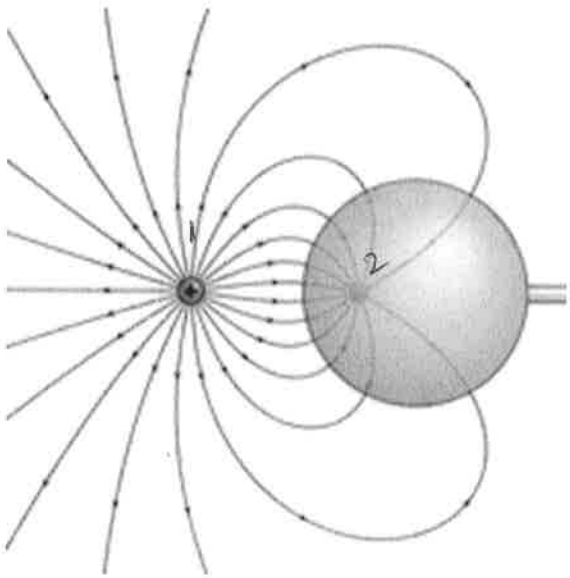
⊕ 5 ⊖ 3 0.859 m

27. What is the magnitude and direction of an electric field that exerts a 2.00×10-5 N upward force on a –1.75 μC charge? 11.4 N/C ↓

33. (a) Sketch the electric field lines near a point charge +q . (b) Do the same for a point charge –3.00q .



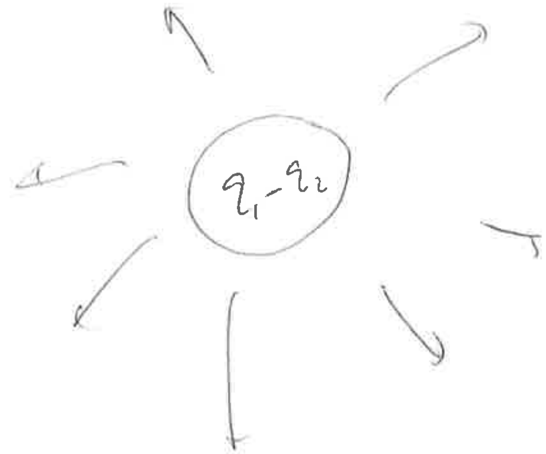
35. Figure 18.47 shows the electric field lines near two charges q1 and q2 . What is the ratio of their magnitudes? (b) Sketch the electric field lines a long distance from the charges shown in the figure.
Figure 18.47 The electric field near two charges.



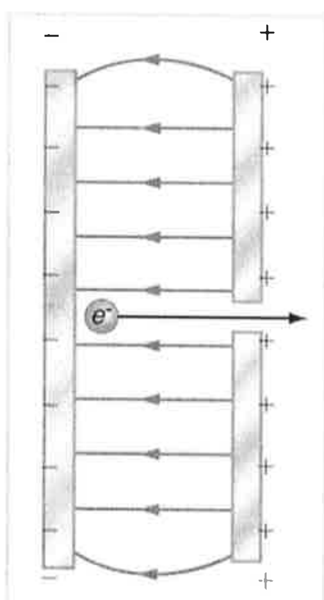
$$\left|\frac{q_1}{q_2}\right| = \left|\frac{23}{12}\right|$$

$q_1 \rightarrow (+)$

$q_2 \rightarrow (-)$



53. A simple and common technique for accelerating electrons is shown in Figure 18.55, where there is a uniform electric field between two plates. Electrons are released, usually from a hot filament, near the negative plate, and there is a small hole in the positive plate that allows the electrons to continue moving. (a) Calculate the acceleration of the electron if the field strength is 2.50×10^{4} N/C . (b) Explain why the electron will not be pulled back to the positive plate once it moves through the hole.



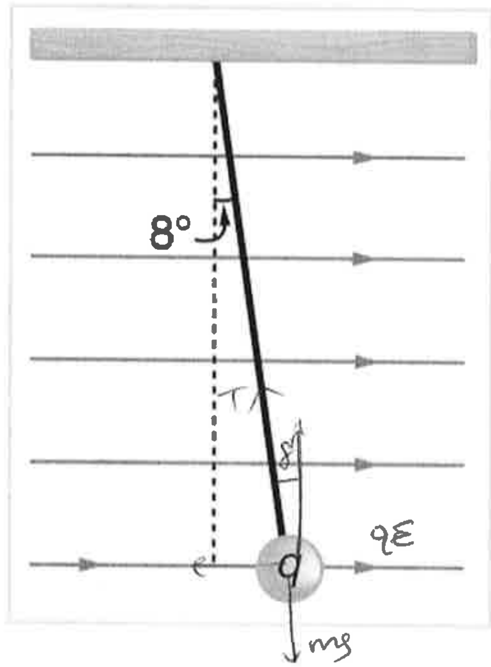
$$a = F/m = \frac{qE}{m} = \frac{1.6\times10^{-19} \times 2.5\times10^{4}}{9.11\times10^{-31}}$$

$$= 0.4391\times10^{16}$$

$$a = 4.39\times10^{15}\ m/s^2$$

(b) no field outside

60. Integrated Concepts: A 5.00 g charged insulating ball hangs on a 30.0 cm long string in a uniform horizontal electric field as shown in Figure 18.56. Given the charge on the ball is 1.00 μC , find the strength of the field.



$$T\cos 8^\circ = mg$$

$$T\sin\theta = qE$$

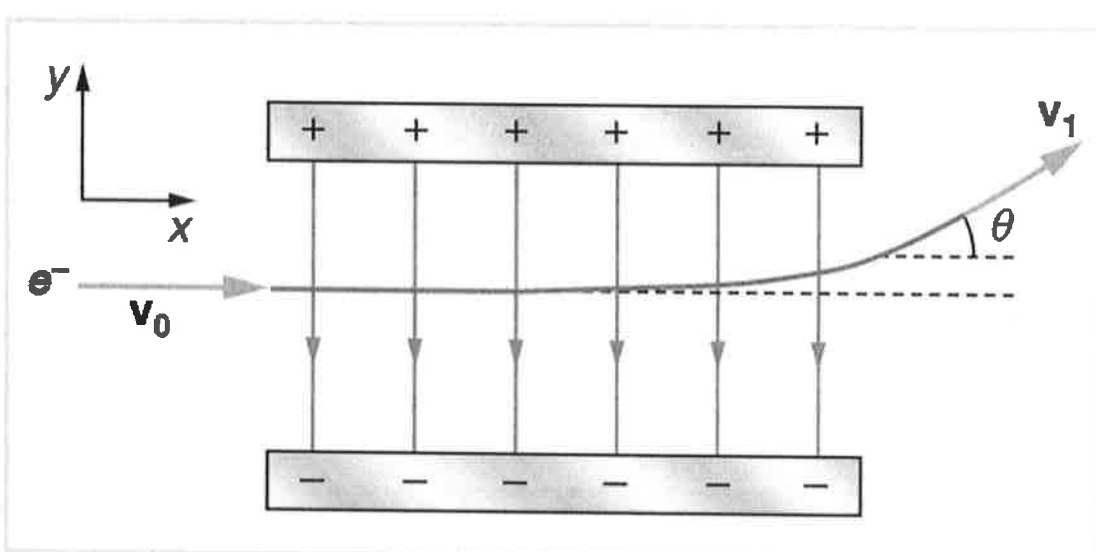
$$\tan\theta = \frac{qE}{mg}$$

$$E = \frac{mg\tan\theta}{q} = \frac{5\times10^{-3}\times 9.8\times\tan 8}{10^{-6}}$$

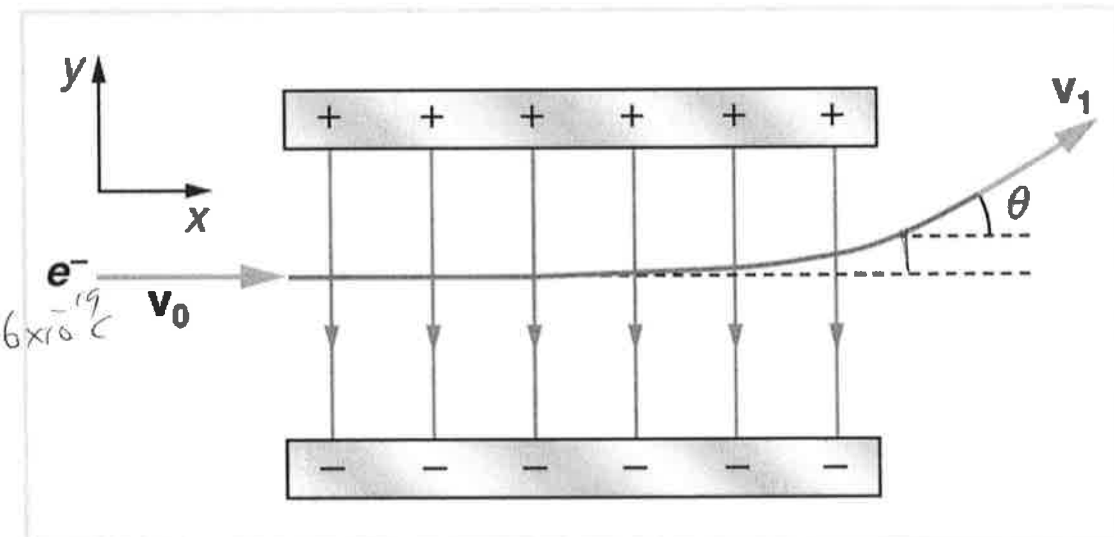
$$= 5\times 1000\times 9.8\times\tan 8$$

$$\vec{E} = 6886.5\ N/C$$

61. Integrated Concepts: Figure 18.57 shows an electron passing between two charged metal plates that create an 100 N/C vertical electric field perpendicular to the electron's original horizontal velocity. (These can be used to change the electron's direction, such as in an oscilloscope.) The initial speed of the electron is 3.00×106 m/s , and the horizontal distance it travels in the uniform field is 4.00 cm. (a) What is its vertical deflection? (b) What is the vertical component of its final velocity? (c) At what angle does it exit? Neglect any edge effects.



61. Integrated Concepts: Figure 18.57 shows an electron passing between two charged metal plates that create an 100 N/C vertical electric field perpendicular to the electron's original horizontal velocity. (These can be used to change the electron's direction, such as in an oscilloscope.) The initial speed of the electron is 3.00×10^{6} m/s , and the horizontal distance it travels in the uniform field is 4.00 cm. (a) What is its vertical deflection? (b) What is the vertical component of its final velocity? (c) At what angle does it exit? Neglect any edge effects.



-1.6×10^{-19} C

$$t = \frac{4\times10^{-2}}{3\times10^{6}} = 1.33\times10^{-8}\ s$$

$$a_y = \frac{F}{m} = \frac{1.6\times10^{-19}\times 100}{9.11\times10^{-31}} = 17.56\times10^{12} = 1.756\times10^{13}\ m/s^2$$

$$\Delta y = \frac{1}{2}a_y t^2 = \frac{1}{2}\times 1.756\times10^{13}\times(1.33\times10^{-8})^2$$

$$= 1.55\times10^{-3}\ m$$

$$V_y = V_{0y} + a_y t = 1.756\times10^{13}\times 1.33\times10^{-8}$$

$$= 2.33\times10^{5}\ m/s$$

$$\tan\theta = \frac{2.33\times10^{5}}{3\times10^{6}} =$$

$$\theta = 4.4^\circ$$