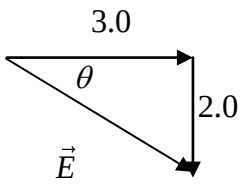
Physics 30 – Lesson 15
Electric Fields

/57

Practice problems

1)



$$\left|\vec{E}\right| = \sqrt{3.0^2 + 2.0^2} = 3.61 \text{ N/C}$$

$$\theta = \tan^{-1}\left(\frac{2.0}{3.0}\right) = 33.7^\circ \text{ S of E}$$

$$\boxed{\vec{E} = 3.61 \text{ N/C} @ 33.7^\circ \text{ S of E}}$$

2)

$q = -2.0 \times 10^{-6} C$

$r = 6.0cm = .060m$

$\left|\vec{E}\right| = ?$

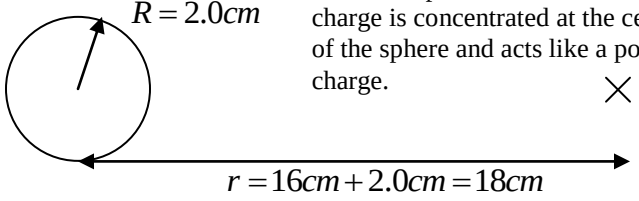
$$\left|\vec{E}\right| = \frac{kq}{r^2}$$

$$\left|\vec{E}\right| = \frac{8.99 \times 10^9 \frac{N \cdot m^2}{C^2}(-2.0 \times 10^{-6} C)}{(0.060m)^2}$$

$$\boxed{\left|\vec{E}\right| = 5.0 \times 10^6 \frac{N}{C}}$$

The direction of the electric field will be toward the charge.

3)



The assumption made is that the charge is concentrated at the centre of the sphere and acts like a point charge.

$$q = 2.4 \times 10^{20} \cancel{e^-} \times \frac{-1.60 \times 10^{-19} C}{\cancel{e^-}}$$

$$q = -38.4C$$

$$\left|\vec{E}\right| = \left|\frac{kq}{r^2}\right|$$

$$\left|\vec{E}\right| = \left|\frac{8.99 \times 10^9 \frac{N \cdot m^2}{C^2}(-38.4C)}{(0.18m)^2}\right|$$

$$\boxed{\left|\vec{E}\right| = 1.1 \times 10^{13} \frac{N}{C}}$$

4)

$q = -40 \times 10^{-6} C$

$F = 0.80N$

$\left|\vec{E}\right| = ?$

$$\left|\vec{E}\right| = \left|\frac{\vec{F}}{q}\right|$$

$$\left|\vec{E}\right| = \left|\frac{0.80N}{-40 \times 10^{-6} C}\right|$$

$$\boxed{\left|\vec{E}\right| = 2.0 \times 10^4 \frac{N}{C}}$$

5) From the data sheet:

$m = 1.67 \times 10^{-27}\, kg$

$q = +1.60 \times 10^{-19}\, C$

$\vec{E} = +25\ {}^{N}\!/_{C}$

$a = ?$

$\vec{E} = \dfrac{\vec{F}}{q}$ and $\vec{F} = m\vec{a}$

$\vec{E} = \dfrac{m\vec{a}}{q}$

$\vec{a} = \dfrac{q\vec{E}}{m}$

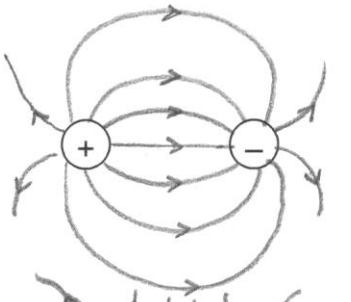
$\vec{a} = \dfrac{(1.60 \times 10^{-19}\, C)(+25\ {}^{N}\!/_{C})}{1.67 \times 10^{-27}\, kg}$

$\boxed{\vec{a} = +2.4 \times 10^{9}\ {}^{m}\!/_{s^2}}$

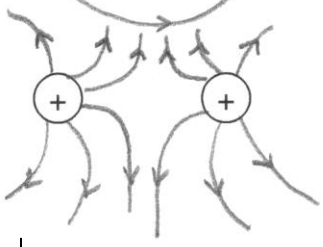
Assignment

1) /4

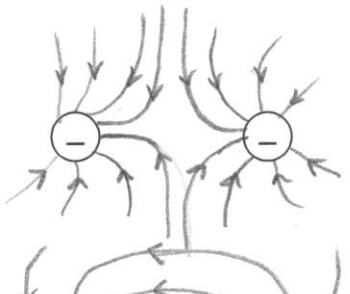
a.



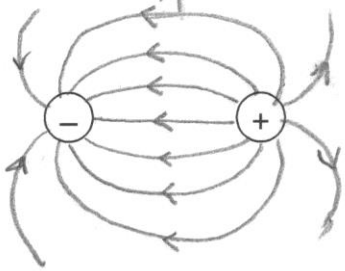
b.



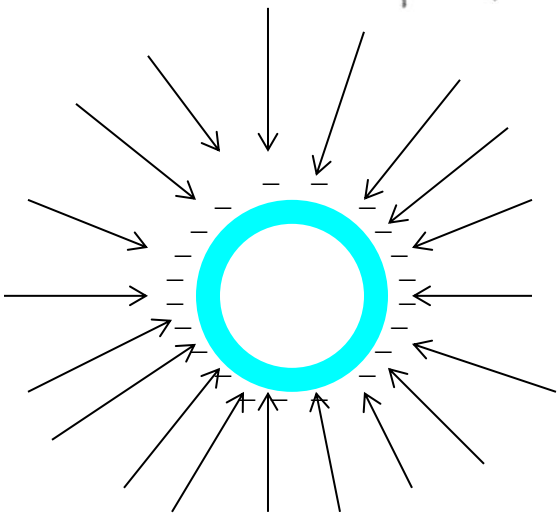
c.

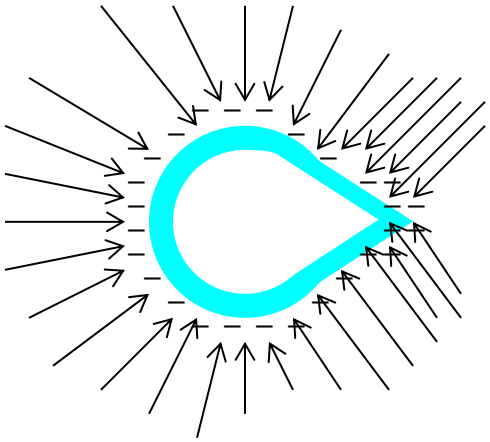


d.



2) /4

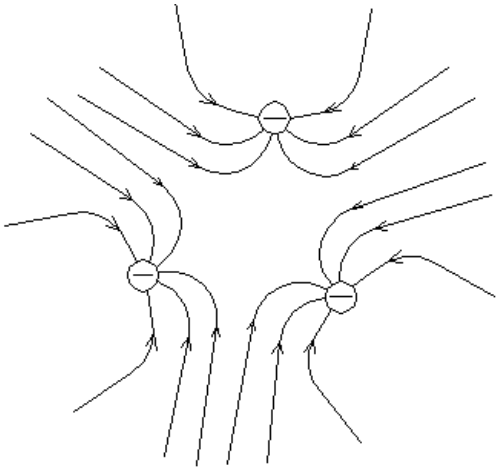




3) A small test charge would not interfere with the electric field being mapped.

/1

4)



in the center $\vec{E} = 0$

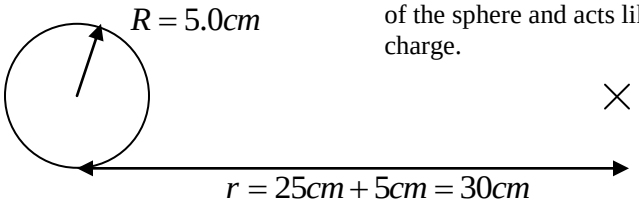
/4

5)

$A = 4\pi r^2$

$A = 4\pi(5.0cm)^2$

$A = 314cm^2$



The assumption made is that the charge is concentrated at the centre of the sphere and acts like a point charge.

/8

$$q = \frac{e^-}{cm^2} \times area \times \frac{\text{charge}}{e^-}$$

$$q = \frac{1.09085 \times 10^{18}\ \cancel{e^-}}{\cancel{cm^2}} \times 314\ \cancel{cm^2} \times \frac{-1.60 \times 10^{-19} C}{\cancel{e^-}}$$

$$q = -54.8C$$

$$\vec{E} = \frac{-kq}{r^2}$$

$$\vec{E} = \frac{-8.99 \times 10^9\ \frac{N \cdot m^2}{C^2}\,(54.8C)}{(0.30m)^2}$$

$$\boxed{\vec{E} = -5.5 \times 10^{12}\ \tfrac{N}{C}}$$

6)

/6

a)

$q = +1.0 \times 10^{-6} C$

$F = 6.0 \times 10^{-6} N$

$E = ?$

$$\vec{E} = \frac{\vec{F}}{q}$$

$$\vec{E} = \frac{6.0 \times 10^{-6} N}{1.0 \times 10^{-6} C}$$

$$\boxed{\vec{E} = +6.0\ \tfrac{N}{C}}$$

b)

$\vec{E} = 6.0\ \frac{N}{C}$

$q = -7.2 \times 10^{-4} C$

$\vec{F} = ?$

$$\vec{F} = \vec{E}q$$

$$\vec{F} = 6.0\ \tfrac{N}{C}(-7.2 \times 10^{-4} C)$$

$$\boxed{\vec{F} = -4.3 \times 10^{-3} N}$$

7)

$q = 8.0\times10^{-3}C$

$r = 1.5m$

/ 2 $\left|\vec{E}\right| = ?$

$$\left|\vec{E}\right| = \frac{kq}{r^2}$$

$$\left|\vec{E}\right| = \frac{8.99\times10^{9}\ \frac{N\cdot m^2}{C^2}(8.0\times10^{-3}C)}{(1.5m)^2}$$

$$\boxed{\left|\vec{E}\right| = +3.2\times10^{7}\ \frac{N}{C}}$$

8)

/ 4

$$\vec{E}_{\times} = \vec{E}_{-20} + \vec{E}_{+8.0}$$

$$\vec{E}_{\times} = -\frac{kq_{-20}}{r_{-20}^2} + \frac{kq_{+8.0}}{r_{+8.0}^2}$$

$$\vec{E}_{\times} = \frac{-8.99\times10^{9}\ \frac{N\cdot m^2}{C^2}(2.0\times10^{-5}C)}{(0.90m)^2} + \frac{8.99\times10^{9}\ \frac{N\cdot m^2}{C^2}(8.0\times10^{-6}C)}{(0.30m)^2}$$

$$\boxed{\vec{E}_{\times} = +5.8\times10^{5}\ \frac{N}{C}}$$

9)

$a = +4.3\times10^{14}\ {}^{m}\!/_{s^2}$

$m = 9.11\times10^{-31}kg$

$F = ?$

/ 5 $q = -1.60\times10^{-19}C$

$\vec{E} = ?$

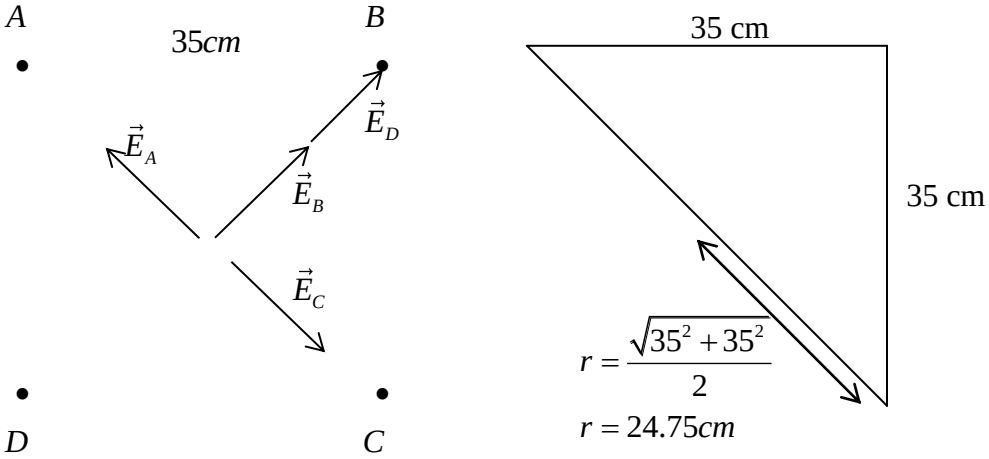
$$\vec{F} = m\vec{a}$$

$$\vec{E} = \frac{\vec{F}}{q} = \frac{m\vec{a}}{q}$$

$$\vec{E} = \frac{9.11\times10^{-31}kg(4.39\times10^{14}\ {}^{m}\!/_{s^2})}{-1.60\times10^{-19}C}$$

$$\boxed{\vec{E} = -2.50\times10^{3}\ \frac{N}{C}}$$

10) $-24.0\mu C$ $-24.0\mu C$



/10

note that $\vec{E}_A$ cancels $\vec{E}_C$

$$E_B = \frac{kq}{r^2} = \frac{8.99\times10^9 \frac{N\cdot m^2}{C^2}(24.0\times10^{-6}C)}{(0.2475m)^2}$$

$$E_B = 3.52\times10^6 \frac{N}{C}$$

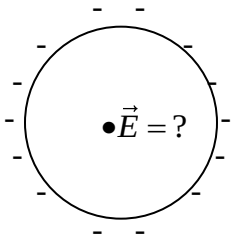
$$E_D = \frac{kq_D}{r^2} = \frac{8.99\times10^9 \frac{N\cdot m^2}{C^2}(38.0\times10^{-6}C)}{(0.2475m)^2}$$

$$E_D = 5.58\times10^6 \frac{N}{C}$$

$$\vec{E} = \vec{E}_B + \vec{E}_D = 3.52\times10^6 \frac{N}{C} + 5.58\times10^6 \frac{N}{C}$$

$\boxed{\vec{E} = 9.10\times10^6 \frac{N}{C} \text{ away from the } +38.0\mu\text{C charge}}$

11)



$\vec{E} = 0$

because the electric field inside a conductor is zero

/3

12) /5

$$F_{net} = 0$$
$$F_E = F_g$$
$$q\left|\vec{E}\right| = mg$$
$$\left|\vec{E}\right| = \frac{mg}{q}$$
$$\left|\vec{E}\right| = \frac{6.65\times10^{-27}\,kg(9.81\,{}^{m}\!/_{s^2})}{3.20\times10^{-19}\,C}$$
$$\boxed{\left|\vec{E}\right| = 2.03\times10^{-7}\,\frac{N}{C}}$$

13) Since the electric field points into the Earth, the Earth has a negative electric field /5

$$\left|\vec{E}\right| = \frac{kq}{r^2}$$
$$q = \frac{\left|\vec{E}\right| r^2}{k}$$
$$q = \frac{150\,\frac{N}{C}(6.37\times10^{6}\,m)^2}{8.99\times10^{9}\,\frac{N\cdot m^2}{C^2}}$$
$$\boxed{q = -6.77\times10^{5}\,C}$$