Solutions

Each answer shows the steps, then the **result**.

2.1

- repel

2.2

- $F = k\dfrac{q_1 q_2}{r^2}$, so $F \propto \dfrac{1}{r^2}$: doubling r makes F one quarter as large

2.3

- Coulomb's law with the magnitudes of the charges:

$$F = k\frac{|q_1 q_2|}{r^2} = (8.99 \times 10^9\ \text{N m}^2\,\text{C}^{-2})\frac{(3.0 \times 10^{-6}\ \text{C})(3.0 \times 10^{-6}\ \text{C})}{(0.20\ \text{m})^2}$$

- $F = \mathbf{2.0}$ N, attractive (opposite charges)

3.1 B

- $1/r^2$.

3.2 C

- $n = \dfrac{|q|}{e} = \dfrac{4.8 \times 10^{-19}\ \text{C}}{1.6 \times 10^{-19}\ \text{C}} = 3$

3.3

(a)

- convert to coulombs: $5.0\ \mu\text{C} = 5.0 \times 10^{-6}$ C, $2.0\ \mu\text{C} = 2.0 \times 10^{-6}$ C

$$F = k\frac{q_1 q_2}{r^2} = (8.99 \times 10^9\ \text{N m}^2\,\text{C}^{-2})\frac{(5.0 \times 10^{-6}\ \text{C})(2.0 \times 10^{-6}\ \text{C})}{(0.30\ \text{m})^2}$$

- $F = \mathbf{1.0}$ N

(b)

- repulsive (both charges positive)

3.4

(a)

- Coulomb's law, $F = k\dfrac{|q_1 q_2|}{r^2}$:

$$F_0 = k\frac{|q_1 q_2|}{r^2} = (8.99 \times 10^9\ \text{N m}^2\,\text{C}^{-2})\,\frac{(3.0 \times 10^{-6}\ \text{C})(3.0 \times 10^{-6}\ \text{C})}{(0.10\ \text{m})^2}$$

- $F_0 = \mathbf{8.1}$ N, repulsive

(b)

- the oil's permittivity is $\kappa\varepsilon_0$, so the force is divided by κ: $F = \dfrac{F_0}{\kappa} = \dfrac{8.1\ \text{N}}{2.0} = \mathbf{4.0}$ N

(c)

- large bodies such as Earth and the Moon are almost exactly electrically neutral, so their electric forces cancel, while gravity is always attractive and adds up over all their mass