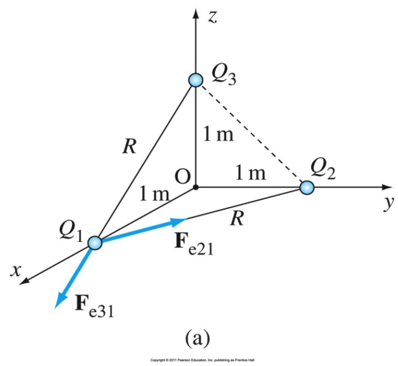
For the three charges in the figure below, calculate the electric potential at points defined by (a) $(0, 0, 2\,\text{m})$ and (b) $(1\,\text{m}, 1\,\text{m}, 1\,\text{m})$, respectively. The charges are $Q_1 = 1\,\mu\text{C}$, $Q_2 = -2\,\mu\text{C}$, $Q_3 = 2\,\mu\text{C}$.



Solution: For this problem we will make use of the formula for voltage from a given point charge

$$V = \frac{Q}{4\pi\varepsilon_0 R},$$

where Q is the point charge value and R is the distance from the point charge to the observation point. We can then use superposition to add up the individual voltage contributions at each observation location.

(a) The observation location is on the z-axis at $(0, 0, 2m)$. The individual voltages are

$$V_1 = \frac{Q_1}{4\pi\varepsilon_0 R_1} = \frac{1\mu C}{4\pi\varepsilon_0\sqrt{(0-1)^2 + (0-0)^2 + (2-0)^2}}$$
$$V_2 = \frac{Q_2}{4\pi\varepsilon_0 R_1} = \frac{-2\mu C}{4\pi\varepsilon_0\sqrt{(0-0)^2 + (0-1)^2 + (2-0)^2}}$$
$$V_3 = \frac{Q_3}{4\pi\varepsilon_0 R_1} = \frac{2\mu C}{4\pi\varepsilon_0\sqrt{(0-0)^2 + (0-0)^2 + (2-1)^2}},$$

which when added together yield $V = V_1 + V_2 + V_3 = 13.95\,\text{kV}$

(b) Similar to part (a), we will calculate each individual voltage and add them together. This time the observation location is at $(1m, 1m, 1m)$, which will change R. As before, the individual voltages are

$$V_1 = \frac{Q_1}{4\pi\varepsilon_0 R_1} = \frac{1\mu C}{4\pi\varepsilon_0\sqrt{(1-1)^2 + (1-0)^2 + (1-0)^2}}$$
$$V_2 = \frac{Q_2}{4\pi\varepsilon_0 R_1} = \frac{-2\mu C}{4\pi\varepsilon_0\sqrt{(1-0)^2 + (1-1)^2 + (1-0)^2}}$$
$$V_3 = \frac{Q_3}{4\pi\varepsilon_0 R_1} = \frac{2\mu C}{4\pi\varepsilon_0\sqrt{(1-0)^2 + (1-0)^2 + (1-1)^2}},$$

which when added together yield $V = V_1 + V_2 + V_3 = 6.35\,\text{kV}$

Answer:

(a) $13.95\,\text{kV}$
(b) $6.35\,\text{kV}$