$$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r} \quad \dots \mathbf{1}$$

$$V_1 = \frac{1}{4\pi\varepsilon_0}\frac{10}{\sqrt{(-4)^2+(-4)^2+2^2}} = \frac{10}{24\pi\varepsilon_0} \quad \dots \mathbf{1}$$

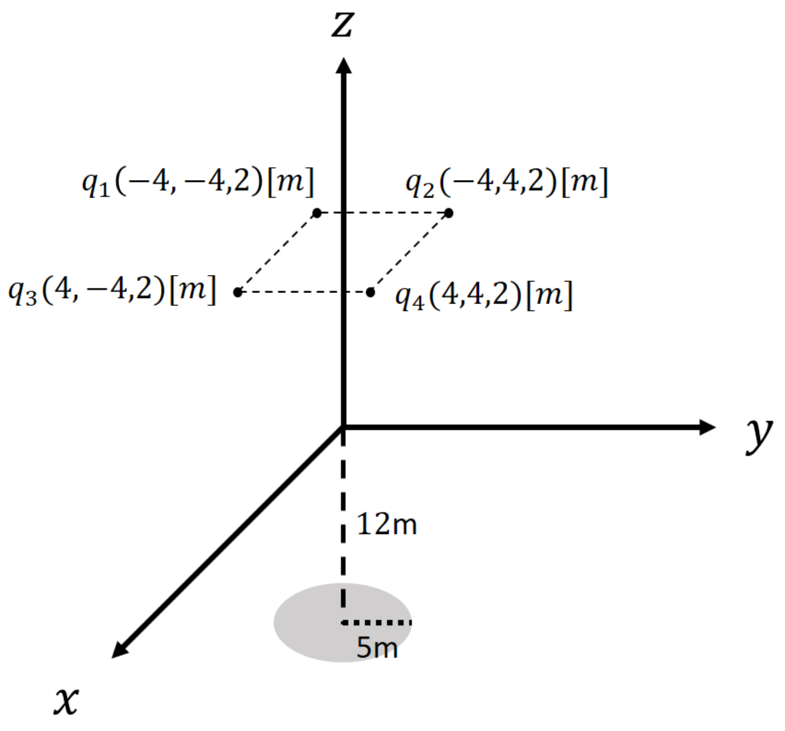
$$V_2 = \frac{1}{4\pi\varepsilon_0}\frac{27}{\sqrt{(-4)^2+4^2+2^2}} = \frac{27}{24\pi\varepsilon_0} \quad \dots \mathbf{1}$$

$$V_3 = \frac{1}{4\pi\varepsilon_0}\frac{9}{\sqrt{4^2+(-4)^2+2^2}} = \frac{9}{24\pi\varepsilon_0} \quad \dots \mathbf{1}$$

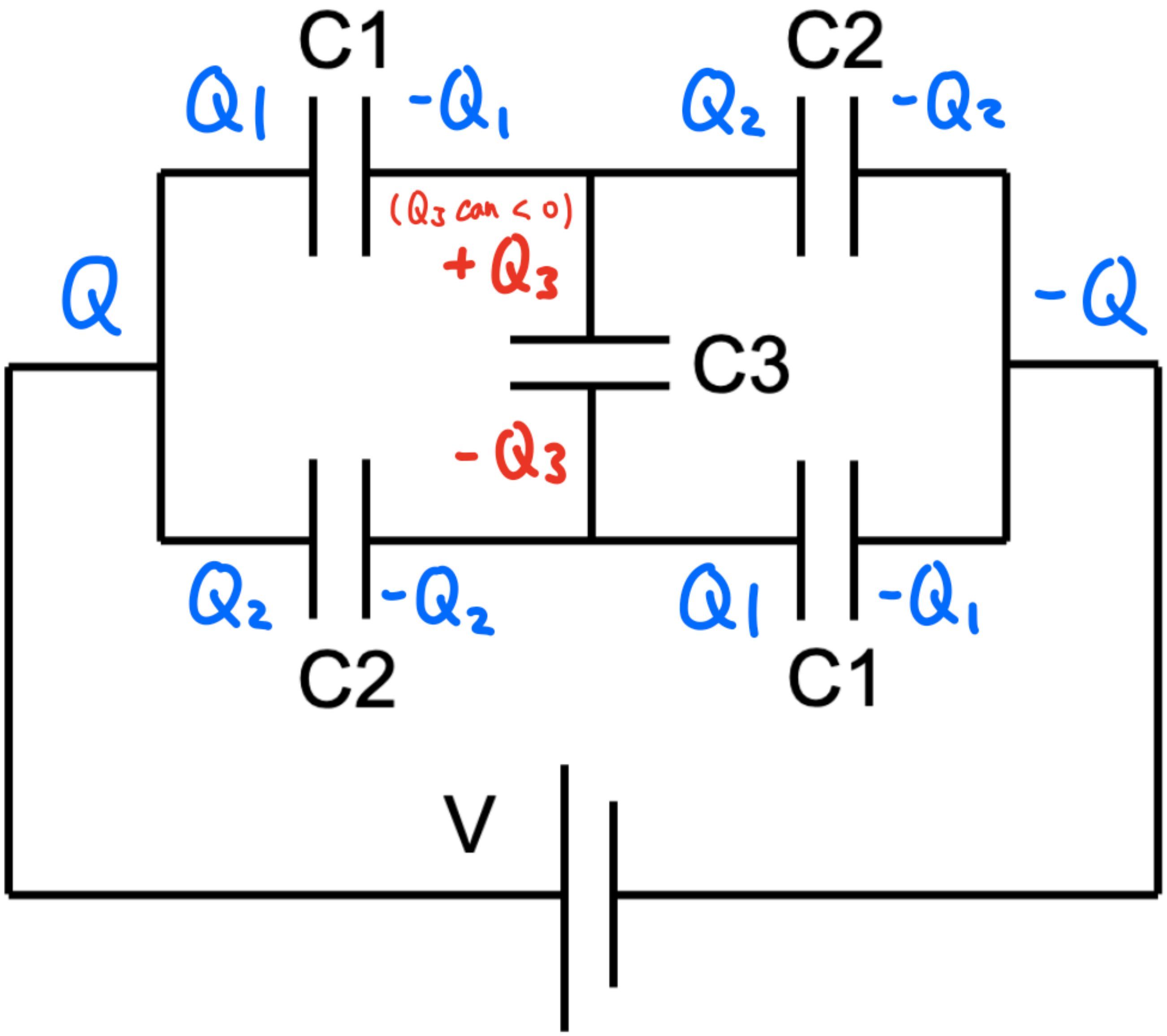
$$V_4 = \frac{1}{4\pi\varepsilon_0}\frac{-6}{\sqrt{4^2+4^2+2^2}} = \frac{-6}{24\pi\varepsilon_0} \quad \dots \mathbf{1}$$

$$V_D = \frac{\sigma}{2\varepsilon_0}\left(\sqrt{z^2+R^2}-z\right) = \frac{10}{6\pi\varepsilon_0} \quad \dots \mathbf{3}$$

$$V_{tot} = \frac{10+27+9+(-6)}{24\pi\varepsilon_0} + \frac{10}{6\pi\varepsilon_0} = \frac{10}{3\pi\varepsilon_0}\ (V) \quad \dots \mathbf{2}$$



Q.2 Figure 2. shows a symmetrical Wheatstone Bridge capacitor. The capacitance of $C1 = 3\ F$, $C2 = 5\ F$ and $C3 = 15\ F$. What is the equivalent capacitance C_{eq} of this circuit when system reaches equilibrium? (10 points)



purpose : $\underline{C_{eq} = \frac{Q}{V}}$ (1)

about Q :

$$\begin{cases} Q = Q_1 + Q_2 \quad \cdots ① & (1) \\ -Q_1 + Q_2 + Q_3 = 0 \quad \cdots ② & (1) \end{cases}$$

about V :

$$\begin{cases} V = V_1 + V_2 \quad \cdots ③ & (1) \\ \quad = 2V_1 + V_3 \quad \cdots ④ \\ \quad = 2V_2 - V_3 \quad \cdots ⑤ \\ V_1 + V_3 - V_2 = 0 \quad \cdots ⑥ & (1) \end{cases}$$

by ② & ⑥ ⇒ reduce to 2 varialbes !

$$\begin{cases} -Q_1 + Q_2 + Q_3 = 0 \\ \frac{Q_1}{C_1} - \frac{Q_2}{C_2} + \frac{Q_3}{C_3} = 0 \end{cases} \Rightarrow \begin{cases} -Q_1 + Q_2 + Q_3 = 0 \\ 5Q_1 - 3Q_2 + Q_3 = 0 \end{cases} \Rightarrow \underline{Q_1 = \frac{2}{3} Q_2 \quad \cdots ⑦} \quad (1)$$

plug ⑦ into (1) ① & (1) ③ ⇒ reduce to 1 varialbes !

$$\begin{cases} Q = \frac{2}{3} Q_2 + Q_2 = \frac{5}{3} Q_2 \\ V = \frac{Q_1}{C_1} + \frac{Q_2}{C_2} = \frac{2}{9} Q_2 + \frac{1}{5} Q_2 = \frac{19}{45} Q_2 \end{cases} \Rightarrow C_{eq} = \frac{\frac{5}{\cancel{3}} \cancel{Q_2}}{\frac{19}{\cancel{45}_{15}} \cancel{Q_2}} = \underline{\frac{75}{19}\ F} \ \# \quad (2)$$