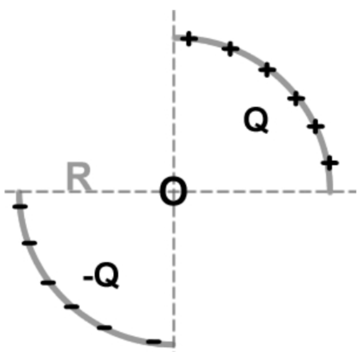
1. Three electric charges $Q_A = q$, $Q_B = -q$, and $Q_C = -2q$ are located at the points A (x = + a, y = 0), B (x = -a, y = 0), and C (x = 0, y = +2a) respectively. What is the value of the electric potential at the origin?

$$E = V_a + V_b + V_c$$
$$V_a = \frac{kQ_A}{r_a} \qquad V_b = \frac{kQ_B}{r_b} \qquad V_c = \frac{kQ_C}{r_c}$$
$$V_a = \frac{kq}{a} \qquad V_b = \frac{-kq}{a} \qquad V_c = \frac{-k2q}{2a}$$
$$V = (\frac{kq}{a}) - (\frac{kq}{a}) - (\frac{-2kq}{2a})$$
$$= \boxed{\frac{-kq}{a}}$$

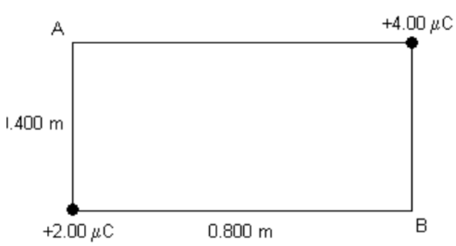
2. Fig. 23-2 shows two arcs of a circle on which charges +Q and -Q have been spread uniformly. What is the value of the electric potential at the center of the circle?



Since each point on the arc is equidistant from the center of the circle, the potential due to each differential element is the same.

The potential due to the arcs is $\frac{kQ}{r}$ and $\frac{-kQ}{r}$ respectively. Since potential is a scalar, the net potential at the center is $\boxed{0}$.

3. Two point charges of magnitude +4.00 μC and +2.00 μC are placed at the opposite corners of a rectangle as shown in Fig. 23-3.



(a) What is the potential at point A due to these charges?

$$E = \frac{kQ_1}{r_1} + \frac{kQ_2}{r_2}$$
$$= \frac{(9 \times 10^9) \cdot (2 \times 10^{-6})}{0.4} + \frac{(9 \times 10^9) \cdot (4 \times 10^{-6})}{0.8}$$
$$= \boxed{9 \times 10^4\ V}$$

(b) What is the potential at point B due to these charges?

$$E = \frac{kQ_1}{r_1} + \frac{kQ_2}{r_2}$$

$$= \frac{(9\times 10^{-6})\cdot(2\times 10^{-6})}{0.8} + \frac{(9\times 10^{-6})\cdot(4\times 10^{-6})}{0.4}$$
$$= \boxed{11.25\times 10^{4}\ V}$$

(c) What is the potential difference between points A and B?

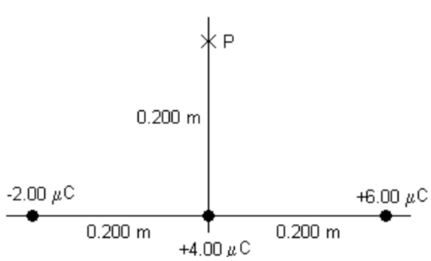
$$\begin{aligned} E &= |V_A - V_B| \\ &= |9\times 10^4 - 11.25\times 10^4| \\ &= \boxed{2.25\times 10^4\ V} \end{aligned}$$

4. The electric potential at the origin of an xy-coordinate system is 40 V. A -8.0-μC charge is brought from x = + to that point. What is the electric potential energy of this charge at the origin?

$$\begin{aligned} E &= -8\times 10^{-6} * 40\ V \\ &= \boxed{-3.2\times 10^{-4}\ J} \end{aligned}$$

5. Three point charges of -2.00 μC, +4.00 μC, and +6.00 μC are placed along the x axis as shown in Fig. 23-4. What is the electrical potential at point P due to these charges?

FIGURE 23-4



$$\begin{aligned} V &= \frac{U}{q} \\ &= \frac{1}{(4\pi\epsilon_0)}\cdot\sum\frac{q_i}{r_i} \\ &= \frac{1}{4\pi\epsilon_0}\cdot\left(\frac{6\times 10^{-6}}{\sqrt{0.2^2+0.2^2}} + \frac{-2\times 10^{-6}}{\sqrt{0.2^2+0.2^2}} + \frac{4\times 10^{-6}}{0.2}\right) \\ &= \boxed{306.86\times 10^3\ V} \end{aligned}$$

6. The electric potential of a charge distribution is given by the equation $V(x) = 3x^2y^2 + yz^3 - 2z^3x$, where x, y, z are measured in meters and V is measured in volts. Calculate the magnitude of the electric field vector at the position (x,y,z) = (1.0, 1.0, 1.0).

$$\begin{aligned} E &= -\Delta V \\ &= -(\hat{i}\frac{\partial}{\partial x} + \hat{j}\frac{\partial}{\partial y} + \hat{k}\frac{\partial}{\partial z})V \\ &= -(\hat{i}\frac{\partial}{\partial x} + \hat{j}\frac{\partial}{\partial y} + \hat{k}\frac{\partial}{\partial z})(3x^2y^2 + yz^2 - 2z3x) \end{aligned}$$

$$= -(6xy^2 - 2z^3)\hat{i} - (6x^2y - z^3)\hat{j} - (3yz^2 - 6z^2x)\hat{k}$$
$$= -(6(1)(1)^2 - 2(1)^3)\hat{i} - (6(1)^2(1) + (1)^3)\hat{j} - (3(1)(1)^2 - 6(1)^2(1))\hat{k}$$
$$= -4\hat{i} - 7\hat{j} - 3\hat{k}$$
$$= \sqrt{(E_x\hat{i})^2 + (E_y\hat{j})^2 + (E_z\hat{k})^2}$$
$$= \sqrt{(4)^2 + (-7)^2 + (-3)^2}$$
$$= \boxed{8.60\ V/m}$$

7. If an electron is accelerated through a potential difference of 500 V between two parallel plates separated by a distance of 2.0 cm. The change in kinetic energy of the electron during this motion is

$$\Delta KE = q\Delta V$$
$$= (1.6 \times 10^{-19}\ C) \cdot (500\ V)$$
$$= 8.0 \times 10^{-17}\ J(\frac{1.0\ eV}{1.6 \times 10^{-19}\ J})$$
$$= \boxed{500\ eV}$$