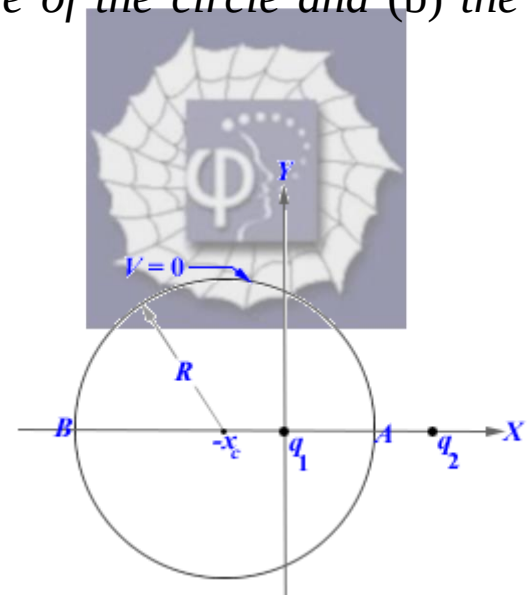
349.

Problem 30.33 (RHK)

A point charge $q_1 = +6e$ *is fixed at the origin of a rectangular coordinate system, and a second point charge* $q_2 = -10e$ *is fixed at* $x = 9.60$ nm, $y = 0$. *The locus of all points in the xy plane with* $V = 0$ *is a circle centred on the x axis. We have to find* (a) *the location* x_c *of the centre of the circle and* (b) *the radius R of the circle.*



Solution:

(a) and (b)

A point charge $q_1 = +6e$ is fixed at the origin of a rectangular coordinate system, and a second point charge $q_2 = -10e$ is fixed at $x = 9.60$ nm, $y = 0$. The locus of all points in the xy plane with $V = 0$ is a circle centred on

the x axis. Let the centre of the circle in the *xy* coordinate system be $(-x_c, 0)$. Let the radius of the equipotential surface be *R*. We will measure all lengths in units of nm. We will use the fact that the points *A* and *B* as shown in the diagram lie on the equipotential $V = 0$. Therefore, we have the conditions

$$\frac{6e}{R - x_c} - \frac{10e}{(9.6 - R + x_c)} = 0, \quad (V = 0 \text{ at } A)$$

or

$$6(9.6 - R + x_c) - 10(R - x_c) = 0,$$

or

$$6 \times 9.6 - 16R + 16x_c = 0. \qquad (1)$$

Similarly, by using the condition that $V = 0$ at *B*, we get

$$\frac{6e}{R + x_c} - \frac{10e}{(R + 9.6 + x_c)} = 0,$$

or

$$6(R + 9.6 + x_c) - 10(R + x_c) = 0,$$

or

$$6 \times 9.6 - 4R - 4x_c = 0. \qquad (2)$$

From equation (1) and (2), we find

$R = 9$ nm, $x_c = 5.4$ nm.