

Answer to Assignment 12

17.16

a)

$$a = \frac{F}{m_e} = \frac{-8.20 \times 10^{-8}}{-9.11 \times 10^{-31}} = 9.00 \times 10^{22} \text{ m/s}^2.$$

b)

$$a = \frac{F}{m_p} = \frac{-8.20 \times 10^{-8}}{1.67 \times 10^{-27}} = -4.91 \times 10^{19} \text{ m/s}^2.$$

17.26

$$E = \frac{F}{q} = \frac{2.00 \times 10^{-5}}{-1.75 \times 10^{-6}} = -11.43 \text{ N/C}.$$

17.49

a)

First, find the electric field at $x = 4.00 \text{ cm}$:

$$E_1 = \frac{k \times -2q}{(3a)^2} = \frac{9 \times 10^9 \times -2 \times 10^{-6}}{(3 \times 10^{-2})^2} = -2.00 \times 10^7$$

$$E_2 = -\frac{k \times q}{(a)^2} = -\frac{9 \times 10^9 \times 1 \times 10^{-6}}{(1 \times 10^{-2})^2} = -9.00 \times 10^7$$

$$E_3 = -\frac{k \times 3q}{(4a)^2} = -\frac{9 \times 10^9 \times 3 \times 10^{-6}}{(4 \times 10^{-2})^2} = -1.69 \times 10^7$$

$$E_4 = -\frac{k \times -q}{(10a)^2} = -\frac{9 \times 10^9 \times -1 \times 10^{-6}}{(10 \times 10^{-2})^2} = 0.09 \times 10^7$$

$$E = E_1 + E_2 + E_3 + E_4 = -12.60 \times 10^7 = -1.26 \times 10^8 \text{ N/C}$$

Then we have the force:

$$F = Eq = -1.26 \times 10^8 \times 2 \times 10^{-9} = -0.252 \text{ N}$$

where the negative character refers to the negative direction.

b)

$$E = -\frac{k \times -2q}{(a-x)^2} - \frac{k \times q}{(5a-x)^2} - \frac{k \times 3q}{(8a-x)^2} - \frac{k \times -q}{(14a-x)^2} = 0, \quad x < a$$

or

$$E = \frac{k \times -2q}{(a-x)^2} - \frac{k \times q}{(5a-x)^2} - \frac{k \times 3q}{(8a-x)^2} - \frac{k \times -q}{(14a-x)^2} = 0, \quad a < x < 5a$$

or

$$E = \frac{k \times -2q}{(a-x)^2} + \frac{k \times q}{(5a-x)^2} - \frac{k \times 3q}{(8a-x)^2} - \frac{k \times -q}{(14a-x)^2} = 0, \quad 5a < x < 8a$$

or

$$E = \frac{k \times -2q}{(a-x)^2} + \frac{k \times q}{(5a-x)^2} + \frac{k \times 3q}{(8a-x)^2} - \frac{k \times -q}{(14a-x)^2} = 0, \quad 8a < x < 14a$$

or

$$E = \frac{k \times -2q}{(a-x)^2} + \frac{k \times q}{(5a-x)^2} + \frac{k \times 3q}{(8a-x)^2} + \frac{k \times -q}{(14a-x)^2} = 0, \quad x > 14a$$

Then

$$E = \frac{2}{(a-x)^2} - \frac{1}{(5a-x)^2} - \frac{3}{(8a-x)^2} + \frac{1}{(14a-x)^2} = 0, \quad x < a$$

or

$$E = -\frac{2}{(a-x)^2} - \frac{1}{(5a-x)^2} - \frac{3}{(8a-x)^2} + \frac{1}{(14a-x)^2} = 0, \quad a < x < 5a$$

or

$$E = -\frac{2}{(a-x)^2} + \frac{1}{(5a-x)^2} - \frac{3}{(8a-x)^2} + \frac{1}{(14a-x)^2} = 0, \quad 5a < x < 8a$$

or

$$E = -\frac{2}{(a-x)^2} + \frac{1}{(5a-x)^2} + \frac{3}{(8a-x)^2} + \frac{1}{(14a-x)^2} = 0, \quad 8a < x < 14a$$

or

$$E = -\frac{2}{(a-x)^2} + \frac{1}{(5a-x)^2} + \frac{3}{(8a-x)^2} - \frac{1}{(14a-x)^2} = 0, \quad x > 14a$$

So $x = 6.07a = 6.07\text{cm}$

17.51

a)

Upward

b)

$$E_1 = 4 \times \frac{1}{\sqrt{2}} \frac{kq}{(\frac{1}{\sqrt{2}}a)^2} = \frac{4 \times 9 \times 10^9 \times 1 \times 10^{-6}}{\sqrt{2} \times 0.5 \times (5 \times 10^{-2})^2} = 2.03 \times 10^7 \text{ N/C}$$