Solution to HW Problems
Chapter 23

104 Phys

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7. Three point charges are located at the corners of an equilateral triangle as shown in Figure P23.7. Calculate the resultant electric force on the 7.00-μC charge.

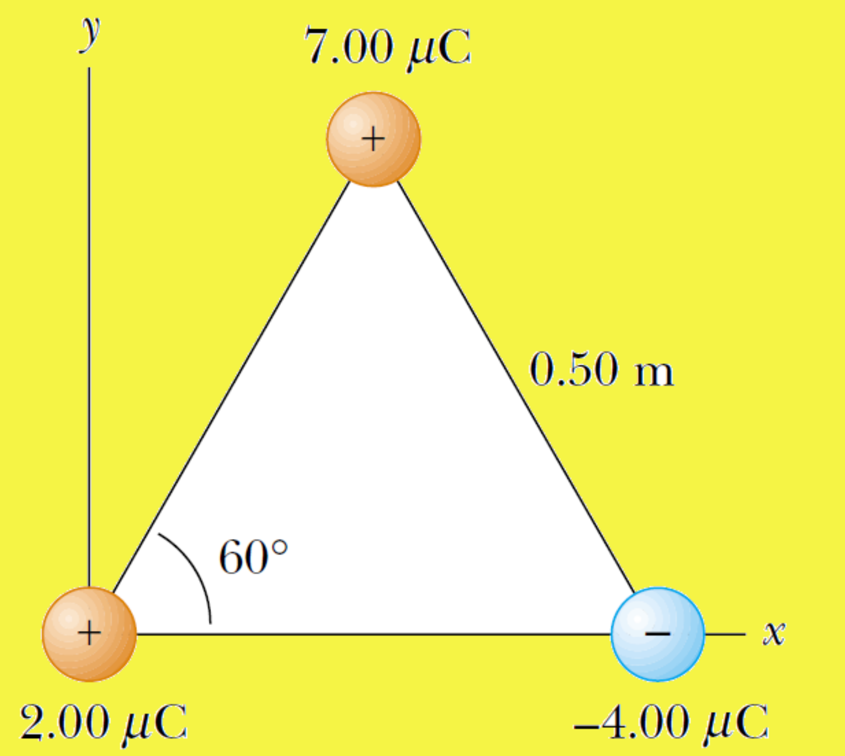

Figure P23.7 Problems 7 and 18.

Chapter 23:

#7/23 : المطلوب: حساب القوة المؤثرة على 7μC

$\because F = k \frac{q_1 q_2}{r^2}$

$\therefore F_1 = 9\times10^{9} \frac{2\times10^{-6} \times 7\times10^{-6}}{0.5^2} = 0.504 N$ (1)

$F_2 = -9\times10^{9} \frac{1\times10^{-6} \times 7\times10^{-6}}{0.5^2} = -1.01 N$ (2)

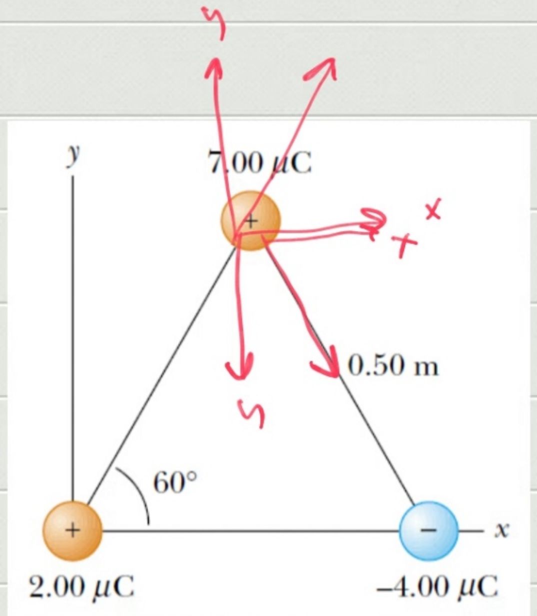

Figure P23.7 Problems 7 and 18.

$F_x = F_{1x} + F_{2x} = 0.504 \cos 60 + 1.01 \cos 60$

$= 0.755 N$ (3)

$F_y = F_{1y} + F_{2y} = 0.504 \sin 60 - 1.01 \sin 60 = -0.436 N$ (4)

$\therefore$ Net force $= [0.755^2 + 0.436^2]^{1/2} = 0.872 N$ -- (5)

at $\tan^{-1} \frac{F_y}{F_x} = \tan^{-1} -\frac{0.436}{0.755} = -30^{\circ} \equiv 330^{\circ}$

9. Two identical conducting small spheres are placed with their centers 0.300 m apart. One is given a charge of 12.0 nC and the other a charge of -18.0 nC. (a) Find the electric force exerted by one sphere on the other. (b) **What If?** The spheres are connected by a conducting wire. Find the electric force between the two after they have come to equilibrium.

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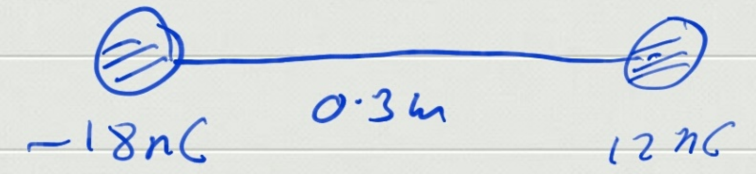
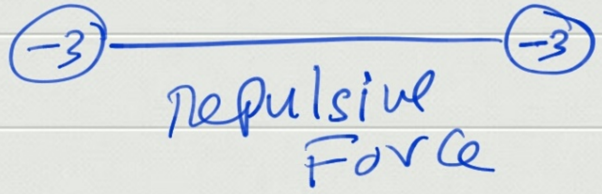
a) $F = K\frac{q_1 q_2}{r^2} = 9\times10^{9} \times \frac{12\times10^{-9} \times (-1)\, 18\times10^{-9}}{0.3^2}$



$\therefore F = -\,2.16 \times 10^{-5}\ N$ (− ⇒ attraction)

b) لو تم توصيل الكرتين بواسطة سلك فإن الشحنتين تتوازنان بحيث
تلغي الشحنة السالبة الموجبة . فـ 12nC تلغي −12nC ويتبقى −6nC
تتوزع هذه الشحنة بشكل متساوي على الكرتين لكل كرة −3nC

$\therefore F = K\frac{q_1 q_2}{R^2} = 9\times10^{9}\ \frac{(-3)\times10^{-9} \times (-3)\times10^{-9}}{0.3^2} = 8.99\times10^{-7}\ N$



15. In Figure P23.15, determine the point (other than infinity) at which the electric field is zero.

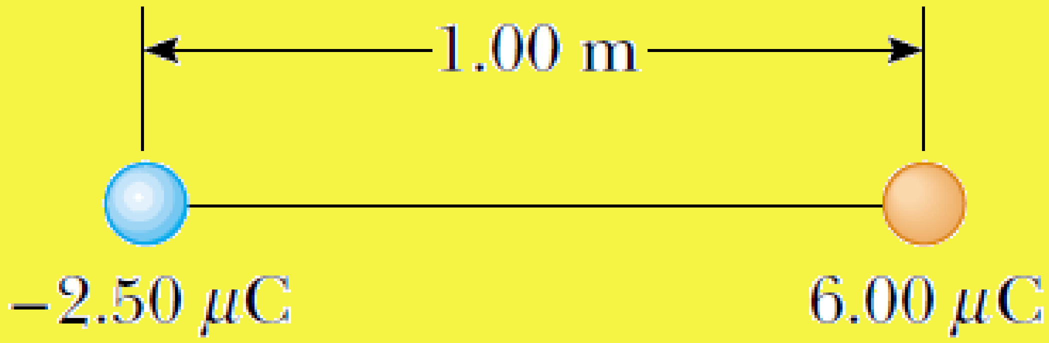


Figure P23.15

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كقاعدة إذا كانت الشحنتان من نفس النوع
++ أو -- يأتي نقطة التعادل تقع بين
الشحنتين. وفي حالة اختلاف الشحنتين +-
← النقطة تقع على الخط / خارج المنطقة بين
الشحنتين وتكون بعيدة عن الشحنة الأكبر من حيث المقدار

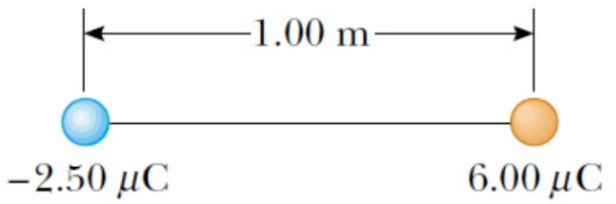


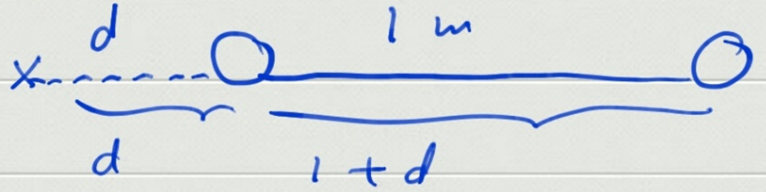
Figure P23.15

7.75

$\because E = k\frac{q}{r}$

$\therefore E_6 = 9\times10^{9} \times \frac{6\times10^{-6}}{(1+d)^2} \leftarrow$ ①

$E_{2.5} = -9\times10^{9} \times \frac{2.5\times10^{-6}}{d^2} \rightarrow$ ②



① + ② = 0

$\rightarrow 9\times10^{9} \times \frac{6\times10^{-6}}{(1+d)^2} = 9\times10^{9} \times \frac{2.5\times10^{-6}}{d^2} \rightarrow 6d^2 = 2.5(1+d)^2$

$\rightarrow 6d^2 = 2.5(1+d^2+2d) \rightarrow 6d^2 = 2.5 + 2.5d^2 + 5d$

$\rightarrow 3.5d^2 - 5d - 2.5 = 0 \rightarrow d = \frac{5 \pm \sqrt{25 + 4\times3.5\times2.5}}{2\times3.5} = +1.82$ m ✓

لا نعتمدها -0.39 m ✗

19. Three point charges are arranged as shown in Figure P23.19. (a) Find the vector electric field that the 6.00-nC and -3.00-nC charges together create at the origin. (b) Find the vector force on the 5.00-nC charge.

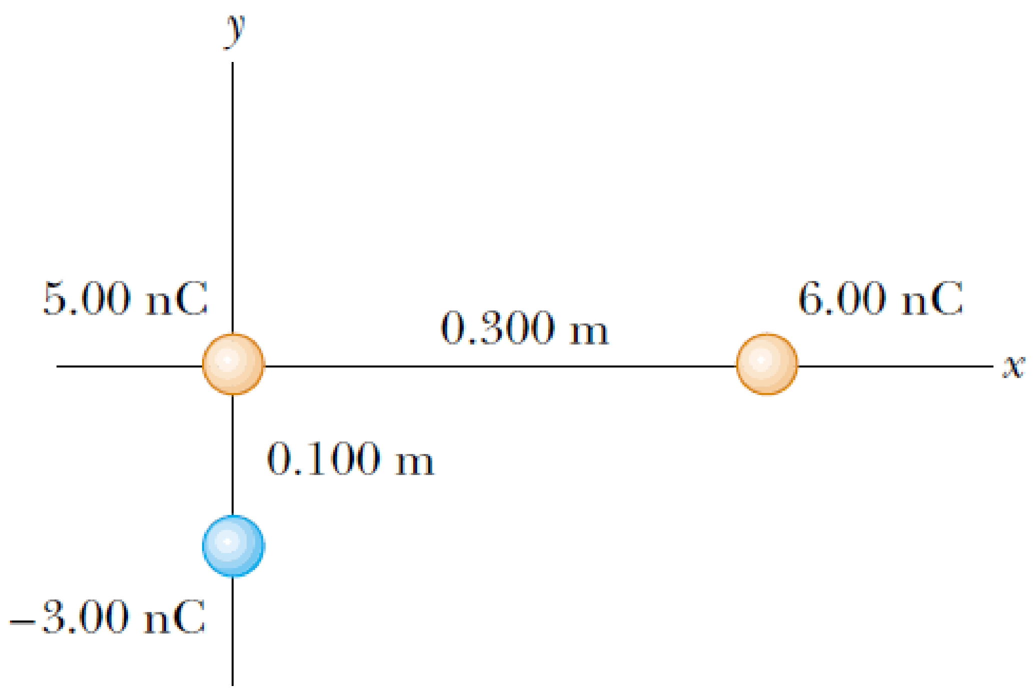


Figure P23.19

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a) $\because E_6 = 9\times10^{9} \times \frac{6\times10^{-9}}{0.3^2} = 600\ N/C \leftarrow$

$E_{-3} = 9\times10^{9} \times \frac{3\times10^{-9}}{0.1^2} = 2700\ N/C \downarrow$

$\therefore \vec{E} = E_6\hat{i} + E_{-3}\hat{j} = -600\hat{i} - 2700\hat{j}$

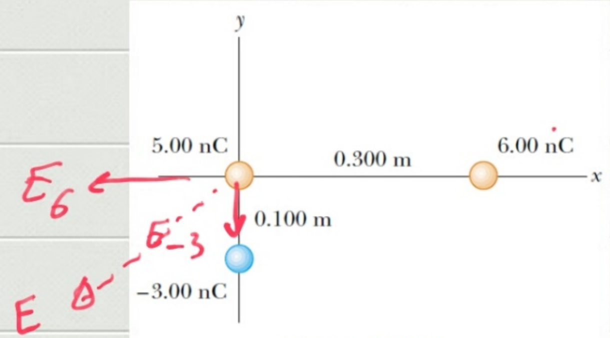

Figure P23.19

b) $\because \vec{F} = q\vec{E}$

$= 5\times10^{-9} \times (-600\hat{i} - 2700\hat{j})$

$= -3\times10^{-6}\hat{i} - 13.5\times10^{-6}\hat{j}\ N.$

or:

$F_6 = 9\times10^{9} \times \frac{6\times10^{-9} \times 5\times10^{-9}}{0.3^2} = 3\times10^{-6}\ N \leftarrow (-)$

$F_{-3} = 9\times10^{9} \times \frac{6\times10^{-9} \times 3\times10^{-9}}{0.1^2} = 13.5\times10^{-6}\ N \downarrow (-)$

$\therefore F = -3\times10^{-6}\hat{i} - 13.5\times10^{-6}\hat{j}\ N$

47. A proton moves at 4.50×10^5 m/s in the horizontal direction. It enters a uniform vertical electric field with a magnitude of 9.60×10^3 N/C. Ignoring any gravitational effects, find (a) the time interval required for the proton to travel 5.00 cm horizontally, (b) its vertical displacement during the time interval in which it travels 5.00 cm horizontally, and (c) the horizontal and vertical components of its velocity after it has traveled 5.00 cm horizontally.

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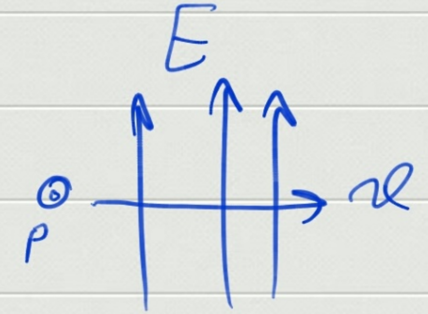
$v = 4.5 \times 10^{5}$ m/s $\qquad E = 9.6 \times 10^{3}$ N/C

a) بالنسبة للحركة الأفقية لاسرعة كما بالعجلة ن



$\because x = vt \rightarrow t = \frac{x}{v} = \frac{5 \times 10^{-2}}{4.5 \times 10^{5}} = 1.11 \times 10^{-7}$ s ①

b) : $\because y = v_{yi} t + \frac{1}{2} a_y t^2$ $\qquad$ and $\because F = ma = qE$

$\rightarrow a_y = qE/m$

$\therefore a_y = \frac{1.6 \times 10^{-19} \times 9.6 \times 10^{3}}{1.67 \times 10^{-27}} = 9.21 \times 10^{11}$ m/s^2 --- ②

$\therefore y = 0 + \frac{1}{2} \times 9.21 \times 10^{11} \times (1.11 \times 10^{-7})^2 = 5.68 \times 10^{-3}$ m $= 5.68$ mm

ⓒ $v_x = 4.5 \times 10^{5}$ m/s $\quad$ no change

$v_y = v_{iy} + a_y t = 0 + 9.21 \times 10^{11} \times (1.11 \times 10^{-7}) = 1.02 \times 10^{5}$ m/s