2024 Sec 4 AP2A Electric Fields

Answers to EX2A

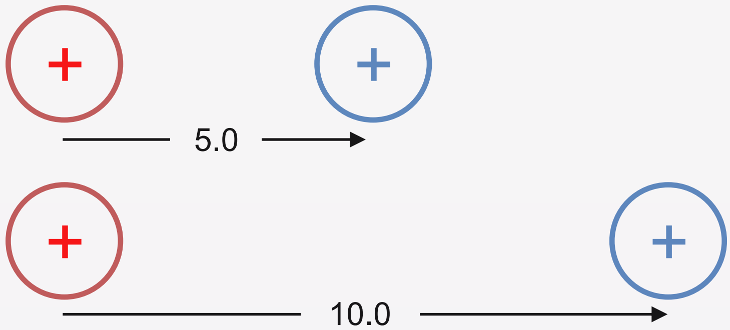
1 **(a)** Since the product of the charges remain constant, then:

$$\begin{aligned} F_1 r_1^2 &= F_2 r_2^2 \\ (100)(d^2) &= (25)(d + 5.0)^2 \\ 4d^2 &= d^2 + 10d + 25 \\ 0 &= 3d^2 - 10d - 25 \\ 0 &= (d - 5)(3d + 5) \end{aligned}$$

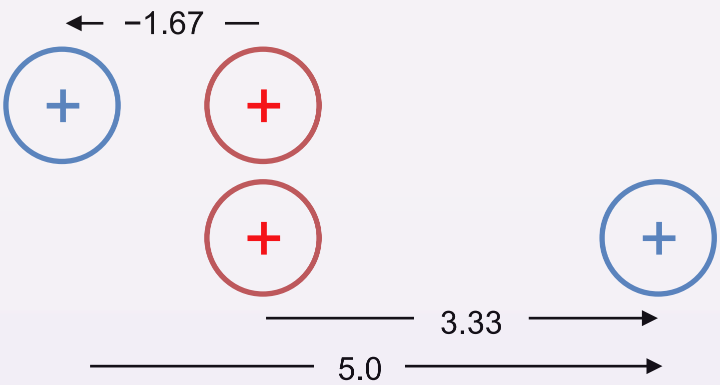
$\rightarrow d = 5.0$ mm (we will ignore the answer $d = -5/3$ mm $= -1.67$ mm)

Note: We could have noticed that the force reduces to 25% of the original force, which implies the distance doubles (ie from 5.0 mm to 10.0 mm)

This is the expected answer and will be the result of the particles mutually repelling each other:



However, another solution exists where the initial separation is −1.67 mm:



Notice one charge (the blue one) is still moved 5.0 mm in the positive direction such that it is twice the distance from the other (red) charge as originally. However, in this case the two charges would not have gotten to the final position by repulsion. Thus this solution was discarded.

(b) $F = |kQq/r^2|$

$100 \times 10^{-6} = (8.99 \times 10^{9})\ Q^2 / (5.0 \times 10^{-3})^2$

$Q = 5.273 \times 10^{-10}$

$= 5.3 \times 10^{-10}$ C (2 sf)

2 $v^2 - u^2 = 2as$

$-(2.5 \times 10^{6})^2 = 2a(60 - 30)(10^{-2})$

$a = -1.0416 \times 10^{13}\ \text{m s}^{-2}$

$ma = Eq$

$E = ma / q$

$= (1.67 \times 10^{-27})(-1.0416 \times 10^{13}) / (1.60 \times 10^{-19})$

$= -108723$

$= -1.1 \times 10^{5}\ \text{N C}^{-1}$ (2 sf)

3 **(a)** Electric field strength

$E = V/d$

$E = 3000 / 0.0050$

$E = 6.0 \times 10^{5}\ \text{V m}^{-1}$

(b) Horizontal displacement $s_x = u_x t + ½a_x t^2$

Where u_x is the horizontal velocity ($3.9 \times 10^{6}\ \text{m s}^{-1}$) and a_x the horizontal acceleration which is zero.

$40 \times 10^{-3}\ \text{m} = (3.9 \times 10^{6}\ \text{m s}^{-1})t$

$t = 1.03 \times 10^{-8}$ s

4 **(a)** The electric field strength due to the charge at R is

$E = |kQ/r^2|$

$E = (8.99 \times 10^9)(7.2 \times 10^{-9})/(0.030)^2 = 71\ 920$ N C^{-1} to the left

The electric field strength due to the charge at S is

$E = |kQ/r^2|$

$E = (8.99 \times 10^9)(3.6 \times 10^{-9})/(0.030)^2 = 35\ 960$ N C^{-1} to the left

Resultant field = $71\ 920 + 35\ 960 = 1.08 \times 10^5$ N C^{-1} to the left

(b) $F = |kQq/r^2|$

$F = (8.99 \times 10^9)\ (7.2 \times 10^{-9})(3.6 \times 10^{-9})/(0.060)^2$

$F = 6.47 \times 10^{-5}$ N to the right