



**2025 Sec 4 AP2A Electric Fields**  
**Answers to EX2A**

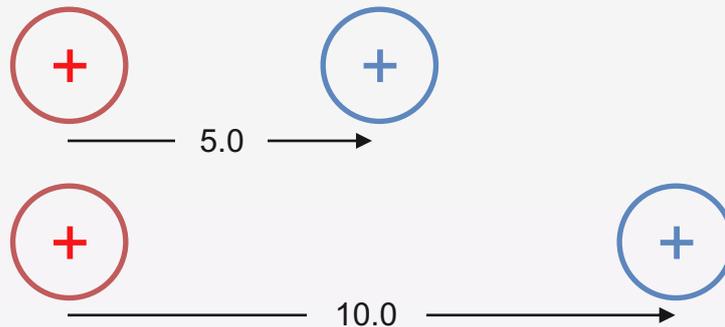
1 (a) Since the product of the charges remain constant, then:

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

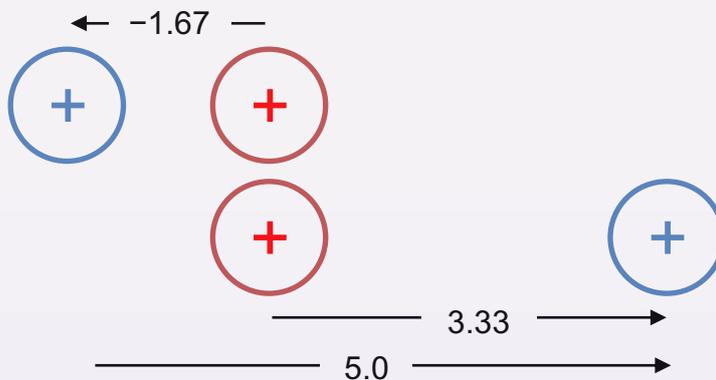
→  $d = 5.0 \text{ mm}$  (we will ignore the answer  $d = -5/3 \text{ mm} = -1.67 \text{ mm}$ )

*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  $-1.67 \text{ mm}$ :*



*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)  $F = |kQq/r^2|$   
 $100 \times 10^{-6} = (8.99 \times 10^9) Q^2 / (5.0 \times 10^{-3})^2$   
 $Q = 5.273 \times 10^{-10}$   
 $= 5.3 \times 10^{-10} \text{ C (2 sf)}$

2  $v^2 - u^2 = 2as$   
 $-(2.5 \times 10^6)^2 = 2a(60 - 30)(10^{-2})$   
 $a = -1.0416 \times 10^{13} \text{ m s}^{-2}$

$ma = Eq$   
 $E = ma / q$   
 $= (1.67 \times 10^{-27})(-1.0416 \times 10^{13}) / (1.60 \times 10^{-19})$   
 $= -108723$   
 $= -1.1 \times 10^5 \text{ N C}^{-1} \text{ (2 sf)}$

3 (a) Consider horizontal motion:  
 $s = ut + 0.5 at^2$   
 $1.27 \times 10^{-3} = (9.55 \times 10^3 \cos \theta) t \text{ ----- (1)}$

$ma = Eq$   
 $a = Eq / m$   
 $= (720)(1.60 \times 10^{-19}) / (1.67 \times 10^{-27})$   
 $= 6.898 \times 10^{10} \text{ m s}^{-2}$

Consider vertical motion (take downwards as positive):

$v = u + at$   
 $v_i \sin \theta = -v_i \sin \theta + at$   
 $2(9.55 \times 10^3) \sin \theta = (6.898 \times 10^{10}) t \text{ ----- (2)}$

Equate (1) and (2) together:

$1.27 \times 10^{-3} / (9.55 \times 10^3 \cos \theta) = 2(9.55 \times 10^3) \sin \theta / (6.898 \times 10^{10})$   
 $\sin 2\theta = 0.9605$   
 $2\theta = 73.85 \text{ or } 106.1$   
 $\theta = 36.92^\circ \text{ or } 53.07^\circ$   
 $\theta = 36.9^\circ \text{ or } 53.1^\circ \text{ (3 s.f.)}$

(b)  $1.27 \times 10^{-3} = (9.55 \times 10^3 \cos 36.92^\circ) t$   
 $t = 1.663 \times 10^{-7} \text{ s}$   
 $= 166 \text{ ns (3 sf)}$

$1.27 \times 10^{-3} = (9.55 \times 10^3 \cos 53.07^\circ) t$   
 $t = 2.213 \times 10^{-7} \text{ s}$   
 $= 221 \text{ ns (3 sf)}$