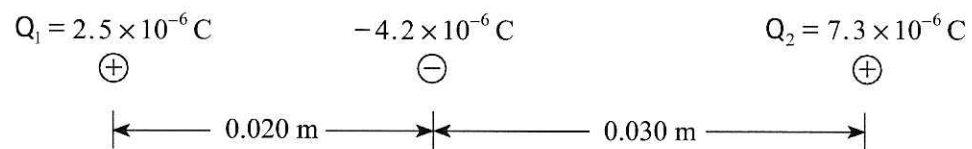
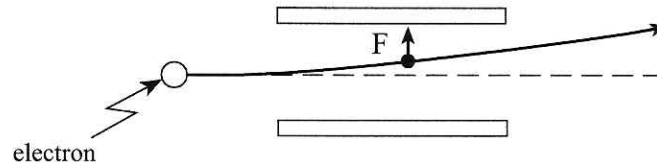


3. A -4.2×10^{-6} C charge is placed between two stationary charges, Q_1 and Q_2 , as shown below.



What is the magnitude and direction of the net force on the -4.2×10^{-6} C charge due to the **two** stationary charges? **(7 marks)**

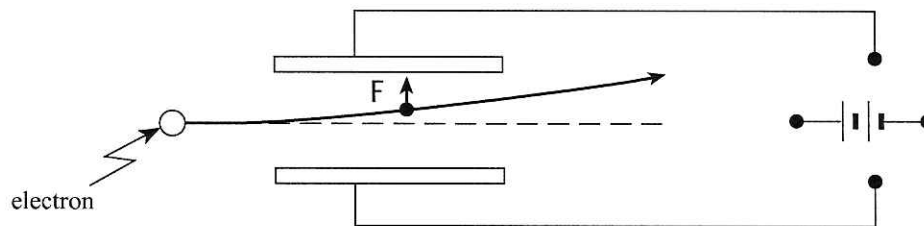
4. An electron passing between parallel plates 0.025 m apart experiences an upward electrostatic force of $5.1 \times 10^{-16}\text{ N}$.



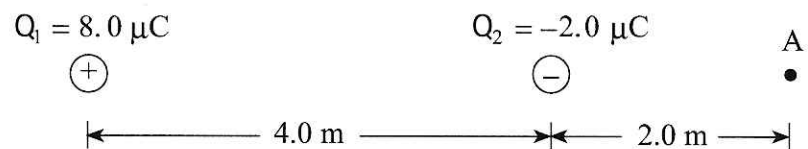
- a) What is the magnitude of the electric field between the plates? **(3 marks)**

- b) What is the potential difference between the plates? **(2 marks)**

- c) On the diagram below draw in the connections to the power supply necessary for the electron to experience this upward force. **(2 marks)**



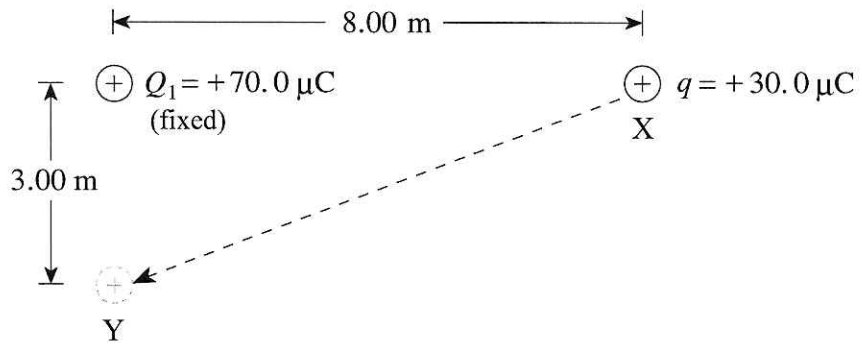
5. Two charges are positioned as shown in the diagram below.



a) Find the magnitude and direction of the electric field at A. (Note: $1.0 \mu\text{C} = 1.0 \times 10^{-6} \text{ C}$)
(4 marks)

b) A charge placed at A experiences a force of $4.0 \times 10^{-3} \text{ N}$ towards the right. What are the magnitude and polarity of this charge?
(3 marks)

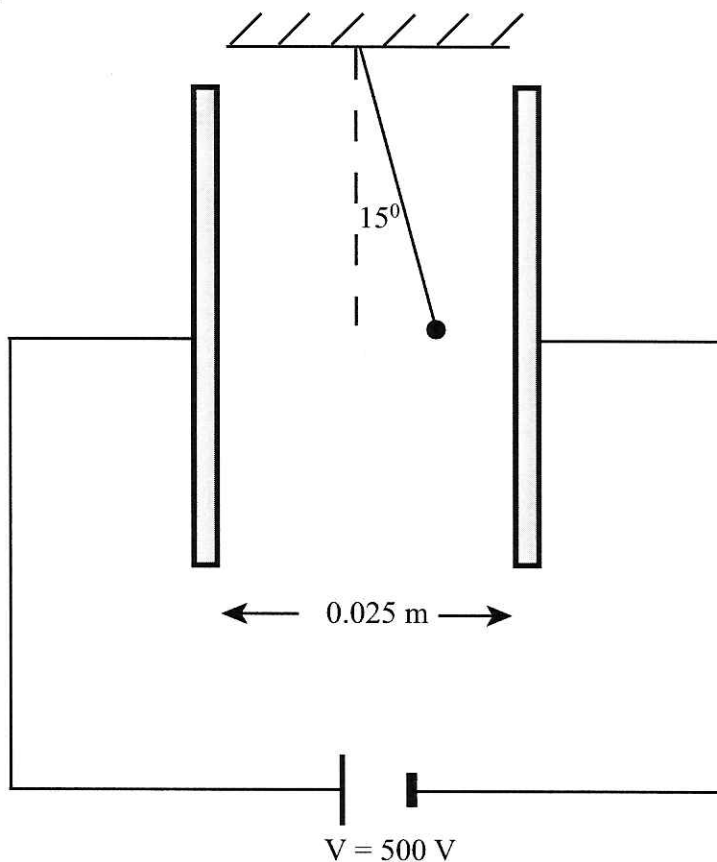
6. A charge q of $30.0 \mu\text{C}$ is moved from point X to point Y.



How much work is done on the $30.0 \mu\text{C}$ charge? ($1 \mu\text{C} = 1 \times 10^{-6} \text{ C}$)

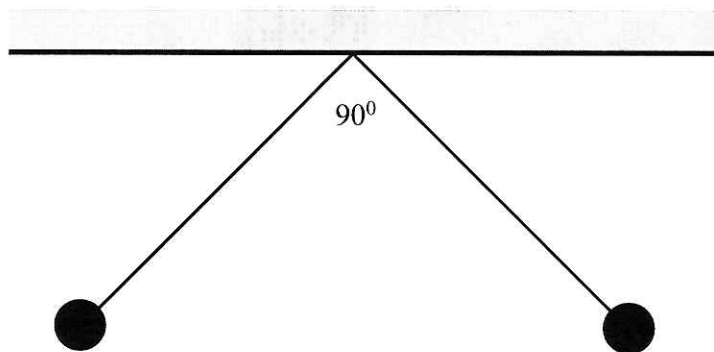
(7 marks)

7. A small 4.0×10^{-3} kg charged sphere is suspended by a light thread between parallel plates, as shown in the diagram below. When the plates are connected to a 500 V source, the thread makes a 15° angle with the vertical.

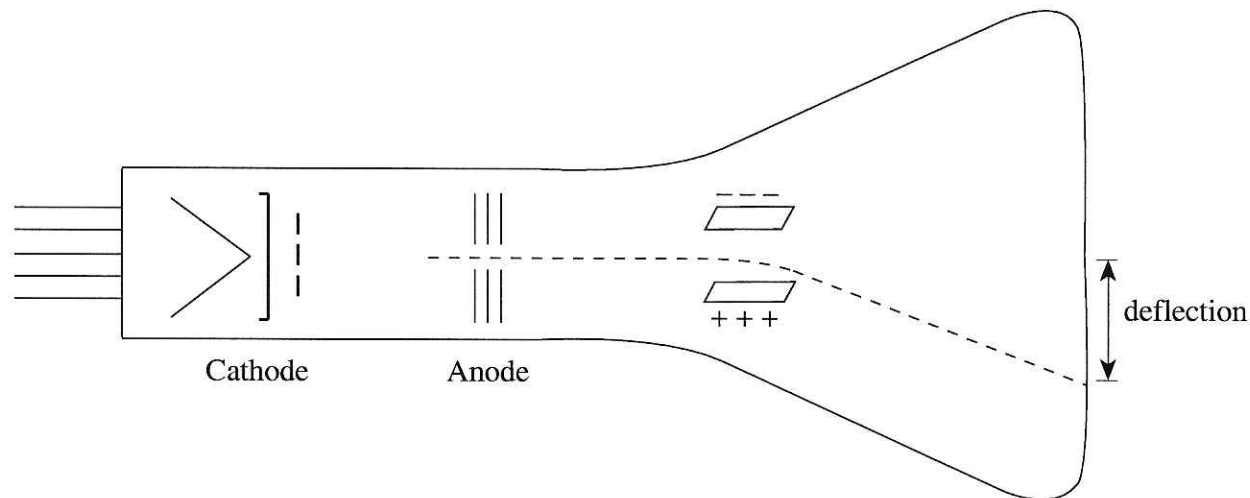


What is the charge on the sphere? (9 marks)

8. Two small, identically-charged conducting spheres each of mass 2.5×10^{-4} kg hang from the same point on insulating threads of length 0.50 m as shown in the diagram below. If the enclosed angle between the threads is 90° , what is the charge on each sphere? **(9 marks)**



9. In a cathode-ray tube, electrons are accelerated from the cathode towards the anode by an accelerating voltage V_a . After passing through the anode, the electrons are deflected by the two oppositely-charged parallel plates.



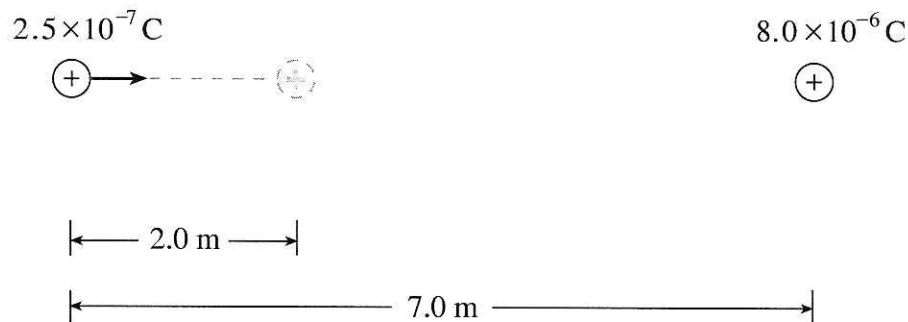
If the accelerating voltage V_a is increased, will the deflection increase, decrease, or remain the same? Using principles of physics, explain your answer. **(4 marks)**

ELECTROSTATICS
PROVINCIAL EXAMINATION ASSIGNMENT
ANSWER KEY / SCORING GUIDE

PART A: Multiple Choice (each question worth ONE mark)

Q	K	Q	K
1.	B	24.	B
2.	B	25.	B
3.	C	26.	B
4.	C	27.	B
5.	A	28.	A
6.	B	29.	A
7.	B	30.	B
8.	C	31.	C
9.	A	32.	A
10.	D	33.	D
11.	C	34.	A
12.	C	35.	A
13.	B	36.	B
14.	C	37.	A
15.	B	38.	C
16.	C	39.	A
17.	D	40.	B
18.	C	41.	D
19.	C	42.	B
20.	B	43.	D
21.	C	44.	A
22.	C	45.	B
23.	A	46.	C

1. a) A $2.5 \times 10^{-7} \text{ C}$ charge is initially located 7.0 m from a fixed $8.0 \times 10^{-6} \text{ C}$ charge. What is the minimum amount of work required to move the $2.5 \times 10^{-7} \text{ C}$ charge 2.0 m closer as shown?



$$W = \Delta E_p \quad \mathbf{2 \text{ marks}} \quad \mathbf{OR} \quad = q\Delta V$$

$$W = \frac{kQq}{5} - \frac{kQq}{7} \quad \mathbf{1 \text{ mark}}$$

$$= .0036 - .0026 \quad \mathbf{1 \text{ mark}}$$

$$W = 1.0 \times 10^{-3} \text{ J} \quad \mathbf{1 \text{ mark}}$$

$$= q \left(\frac{kQ}{r_2} - \frac{kQ}{r_1} \right)$$

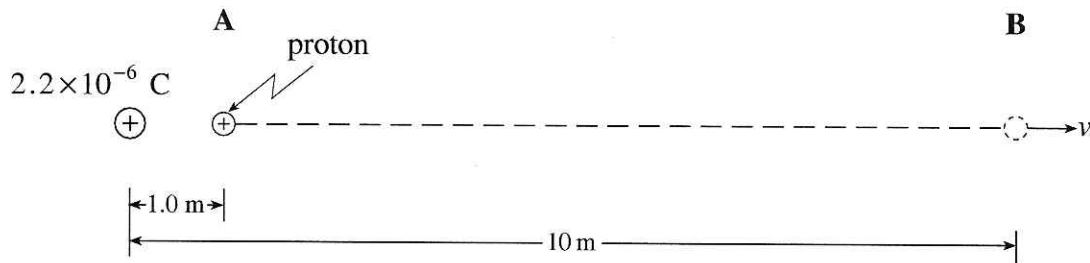
$$= 2.5 \times 10^{-7} \left(\frac{kQ}{5} - \frac{kQ}{7} \right)$$

$$= 1.0 \times 10^{-3} \text{ J}$$

- (b) If the $2.5 \times 10^{-7} \text{ C}$ charge is moved a further 2.0 m closer to the $8.0 \times 10^{-6} \text{ C}$ charge, will the additional work required be less than, the same as or greater than the work required in (a)? Using principles of physics, explain your answer. **(4 marks)**

The work required will be greater than in (a). The force acting on the $2.5 \times 10^{-7} \text{ C}$ charge is greater, therefore the work required to move the same distance will also be greater.

2. A proton is located at **A**, 1.0 m from a fixed $+2.2 \times 10^{-6} \text{ C}$ charge.



- a) What is the change in potential energy of the proton as it moves to **B**, 10 m from the fixed charge? (5 marks)

$$\Delta E_p = \frac{kqQ}{r_2} - \frac{kqQ}{r_1} \quad \leftarrow \text{2 marks}$$

$$\Delta E_p = \left(\frac{9 \times 10^9 (1.6 \times 10^{-19})(2.2 \times 10^{-6})}{10} \right) - \left(\frac{9 \times 10^9 (1.6 \times 10^{-19})(2.2 \times 10^{-6})}{1.0} \right) \quad \leftarrow \text{2 marks}$$

$$\Delta E_p = -2.9 \times 10^{-15} \text{ J} \quad \leftarrow \text{1 mark}$$

- b) If the proton started from rest at **A**, what would be its speed at **B**? (2 marks)

$$\Delta E_p = E_k = \frac{1}{2} mv^2 \quad \leftarrow \text{1 mark}$$

$$2.9 \times 10^{-15} = \frac{1}{2} (1.67 \times 10^{-27}) v^2 \quad \leftarrow \frac{1}{2} \text{ mark}$$

$$v = 1.9 \times 10^6 \text{ m/s} \quad \leftarrow \frac{1}{2} \text{ mark}$$