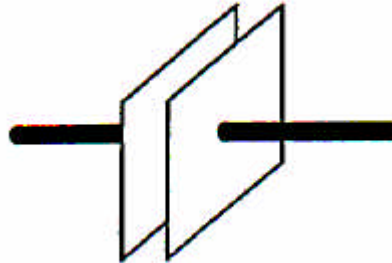


## Chapter 16

### Multiple choice and quick questions

1. The diagram shows a pair of insulated, charged, parallel plates. There is a uniform electric field in the central region between the plates.



Which of the statements about the central region between the plates is/are correct?

- 1: The potential is constant in the region  
2: There is a uniform potential gradient in the region  
3: Equipotentials are evenly spaced in the region

**A** 1, 2 and 3      **B** 1 and 2 only      **C** 2 and 3 only ✓      **D** 1 only

2. An electron is moved in an electric field from a point P to a point Q. The value of the electric field strength  $E$  and the potential  $V$  at P and Q are given below.

	$E/\text{NC}^{-1}$	$V/\text{V}$
P	$2 \times 10^4$	$8 \times 10^3$
Q	$2 \times 10^4$	$2 \times 10^3$

The charge on the electron is  $1.6 \times 10^{-19} \text{ C}$

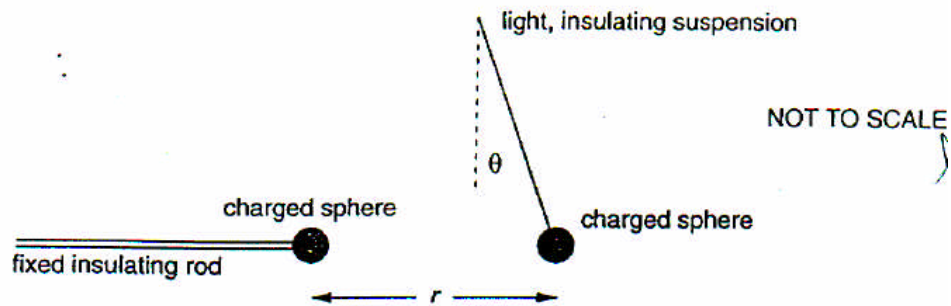
Using only the data given, which one of **A** to **D** below can be found for the electron when at P?

- A** the force on the electron ✓  
**B** the momentum of the electron  
**C** the kinetic energy of the electron  
**D** the total energy of the electron

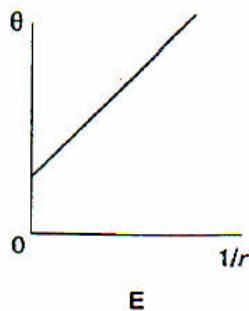
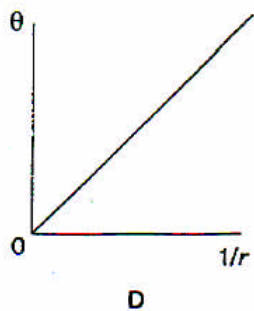
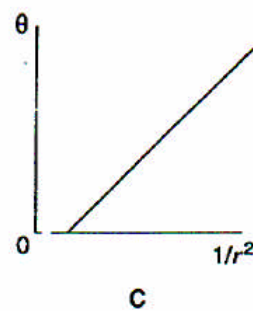
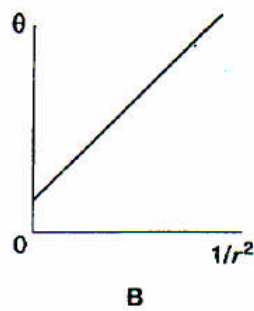
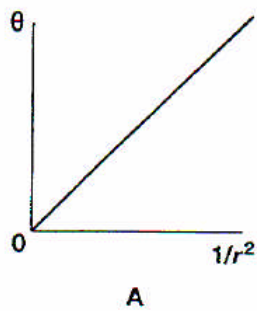
3. Which one of **A** to **D** below is the energy required in eV to move the electron from P to Q?

**A** zero      **B**  $5 \times 10^3$       **C**  $6 \times 10^3$  ✓      **D**  $1 \times 10^7$

4. The diagram shows apparatus used to investigate the electrostatic force between two identical small conducting spheres whose centres are a distance  $r$  apart. For small angles of deflection,  $\theta$  is proportional to the horizontal force acting on the hanging sphere. The spheres have equal positive charge.



Which one of the graphs below **A** to **E** would you expect from the experiment? [A]



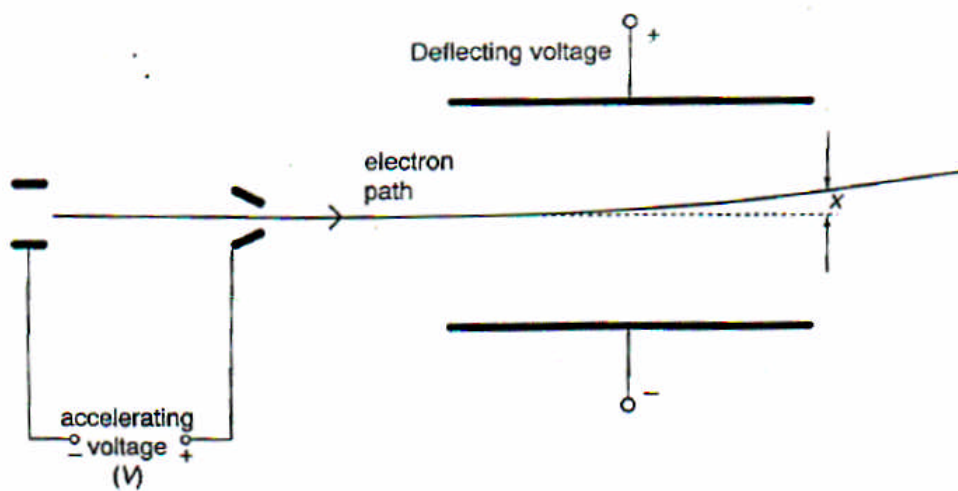
5. When a uniform horizontal electric field is introduced, acting from left to right, which one of the graphs above **A** to **E** would you now expect from the experiment? [B]
6. Differently charged ions of several isotopes are all being accelerated in the same uniform electric field.

Which one of the ions **A** to **D** below has the greatest acceleration?



7. The diagram shows part of an evacuated tube in which a stream of electrons from an electron gun passes between a pair of parallel deflecting plates.

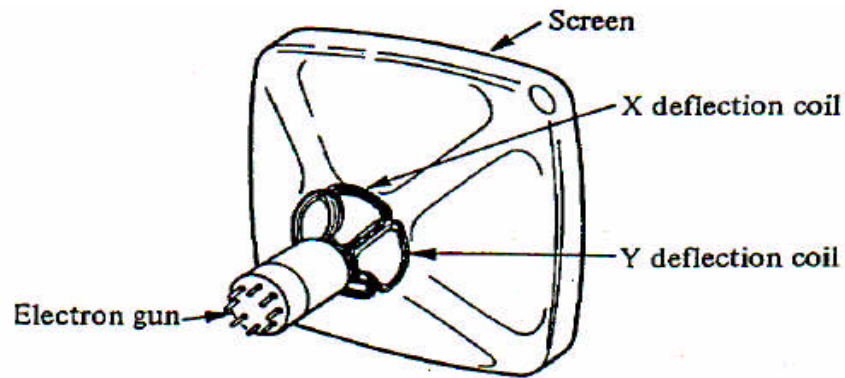
The vertical displacement of the electron beam as it leaves the parallel plates is  $x$ .



Which one of **A** to **E** below will not change the displacement  $x$  of the beam as it leaves the parallel plates?

- A** increasing the accelerating voltage
  - B** increasing the deflecting voltage
  - C** increasing the distance between the electron gun and the deflecting plates ✓
  - D** increasing the distance between the two deflecting plates
  - E** increasing the length of the deflecting plates
8. When the accelerating voltage is  $V$  the speed of the electrons emerging from the gun is  $v$ . Which one of **A** to **E** is the speed of the electrons when the accelerating voltage is doubled?
- A**  $\sqrt{v}$
  - B**  $v$
  - C**  $v\sqrt{2}$  ✓
  - D**  $2v$
  - E**  $4v$

9. This question is about the motion of electrons in a monochrome television tube.



Electrons are accelerated to high speeds as they move through a large potential difference.

- (i) Show that acceleration through a p.d. of 10kV should give electrons a speed of about  $6 \times 10^7 \text{ m s}^{-1}$ .

$$eV = \frac{1}{2} m v^2$$

$$\therefore v = \sqrt{\frac{2 \times 1.6 \times 10^{-19} \times 10 \times 10^3}{9.11 \times 10^{-31}}} = 5.9 \times 10^7 \text{ m s}^{-1} \approx 6 \times 10^7 \text{ m s}^{-1}$$

- (ii) State one assumption you made in order to calculate this speed.

All electrical PE becomes KE.

No relativistic mass increase.

10. This question is about the motion of charged particles in magnetic fields.

- (a) Explain why a charged particle moving with constant speed  $v$  perpendicular to a uniform magnetic field of strength  $B$  will follow a circular path.

$F = qvB$  where  $F$ ,  $v$ ,  $B$  are mutually perpendicular hence  $F$  always at right angles to  $v$ , the condition for circular motion.

- (b) Show that for a particle of mass  $m$  and charge  $q$  the radius of the circular path is given by the expression:

$$r = \frac{mv}{Bq}$$

$$qvB = \frac{mv^2}{r}$$

$$\therefore r = \frac{mv}{Bq}$$

- (c) Hence, show that the frequency of this circular motion, known as the cyclotron frequency, is given by the expression:

$$f = \frac{qB}{2\pi m}$$

$$v = \frac{\text{distance}}{\text{time}}$$

$$\text{time} = \frac{1}{f}$$

$$\therefore v = 2\pi r f$$

$$\text{and } r = \frac{mv}{Bq} \text{ (part b)}$$

$$\therefore f = \frac{Bq}{2\pi m}$$