Point Charges & Electric Potential

Question paper 6

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Electric Fields
Sub Topic	Point Charges & Electric Potential
Paper Type	Theory
Booklet	Question paper 6

Time Allowed: **50 minutes**

Score: **/41**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** Newton's law of gravitation applies to point masses.

(i) State Newton's law of gravitation.

.....

.....

..... [2]

(ii) Explain why, although the planets and the Sun are not point masses, the law also applies to planets orbiting the Sun.

.....

..... [1]

(b) Gravitational fields and electric fields show certain similarities and certain differences. State one aspect of gravitational and electric fields where there is

(i) a similarity,

.....

..... [1]

(ii) a difference.

.....

.....

..... [2]

2 Negatively-charged particles are moving through a vacuum in a parallel beam. The particles have speed v.
The particles enter a region of uniform magnetic field of flux density 930 μT. Initially, the particles are travelling at right-angles to the magnetic field. The path of a single particle is shown in Fig. 7.1.

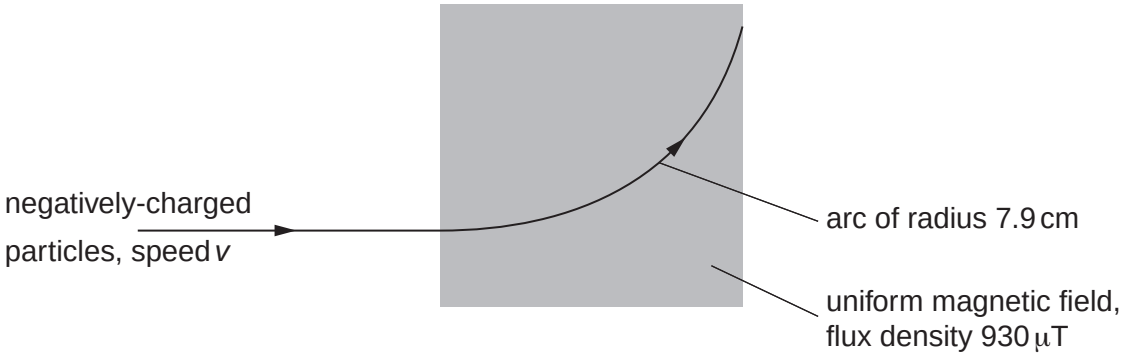

Fig. 7.1

The negatively-charged particles follow a curved path of radius 7.9 cm in the magnetic field.

A uniform electric field is then applied in the same region as the magnetic field. For an electric field strength of 12 kV m^{-1}, the particles are undeviated as they pass through the region of the fields.

(a) On Fig. 7.1, mark with an arrow the direction of the electric field. [1]

(b) Calculate, for the negatively-charged particles,

(i) the speed v,

v = ... m s^{-1} [3]

(ii) the ratio $\frac{\text{charge}}{\text{mass}}$.

ratio = ... C kg^{-1} [3]

3 A proton is moving with constant velocity *v*. It enters a uniform magnetic field that is normal to the initial direction of motion of the proton, as shown in Fig. 8.1.

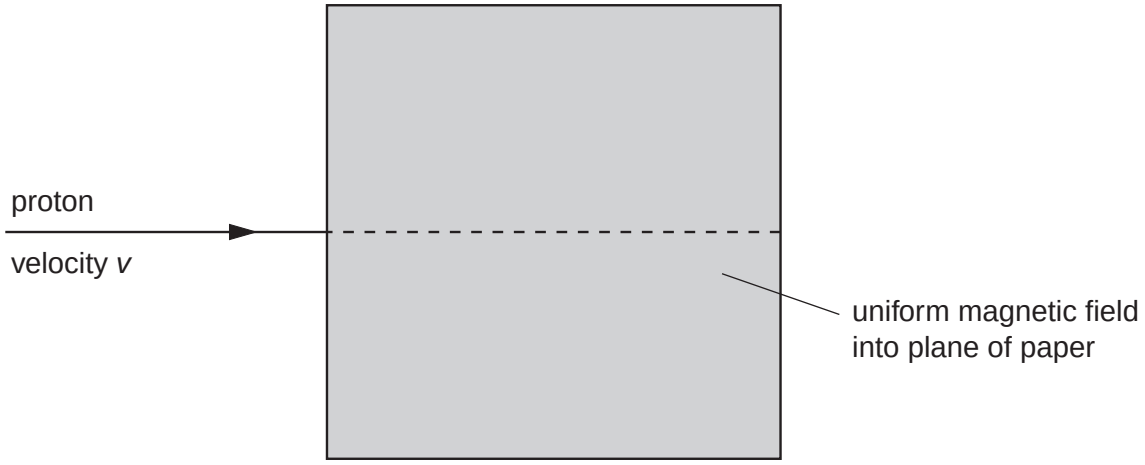

Fig. 8.1

A uniform electric field is applied in the same region as the magnetic field so that the proton passes undeviated through the fields.

(a) On Fig. 8.1, draw an arrow labelled E to show the direction of the electric field. [1]

(b) The proton is replaced by other particles. The electric and magnetic fields remain unchanged.

State and explain the deviation, if any, of the following particles in the region of the fields.

(i) an α-particle with initial velocity *v*

.....

.....

.....

..... [3]

(ii) an electron with initial velocity 2*v*

.....

.....

.....

..... [3]

4 **(a)** An electron is accelerated from rest in a vacuum through a potential difference of 1.2×10^4 V.
Show that the final speed of the electron is 6.5×10^7 m s^{-1}.

[2]

(b) The accelerated electron now enters a region of uniform magnetic field acting into the plane of the paper, as illustrated in Fig. 5.1.

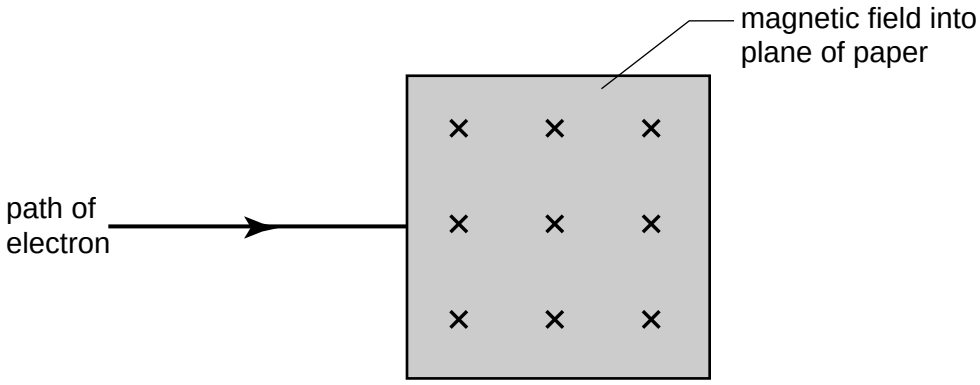

Fig. 5.1

(i) Describe the path of the electron as it passes through, and beyond, the region of the magnetic field. You may draw on Fig. 5.1 if you wish.

path within field: .....

.....

path beyond field: .....

..... [3]

(ii) State and explain the effect on the magnitude of the deflection of the electron in the magnetic field if, separately,

1. the potential difference accelerating the electron is reduced,

.....

.....

..... [2]

2. the magnetic field strength is increased.

.....

.....

..... [2]

5 **(a)** A charged particle may experience a force in an electric field and in a magnetic field.

State two differences between the forces experienced in the two types of field.

1. ....

.....

2. ....

.....[4]

(b) A proton, travelling in a vacuum at a speed of $4.5 \times 10^6\,\text{m s}^{-1}$, enters a region of uniform magnetic field of flux density 0.12 T. The path of the proton in the field is a circular arc, as illustrated in Fig. 6.1.

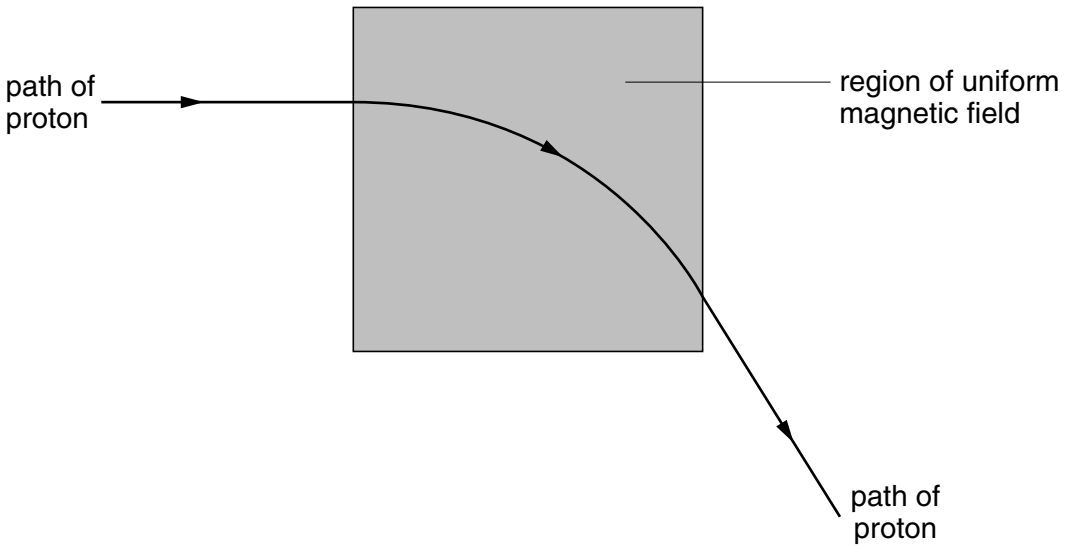

Fig. 6.1

(i) State the direction of the magnetic field.

.....

(ii) Calculate the radius of the path of the proton in the magnetic field.

radius = ... m
[4]

(c) A uniform electric field is now created in the same region as the magnetic field in Fig. 6.1, so that the proton passes undeviated through the region of the two fields.

(i) On Fig. 6.1 mark, with an arrow labelled E, the direction of the electric field.

(ii) Calculate the magnitude of the electric field strength.

field strength = ... $V\,m^{-1}$
[3]

(d) Suggest why gravitational forces on the proton have not been considered in the calculations in **(b)** and **(c)**.

.....

.....[1]