Magnetic Fields

Have a go at the following exam questions.

OCR, G485, Jan 11

3 Fig. 3.1 shows part of an accelerator used to produce high-speed protons. The protons pass through an evacuated tube that is shown in the plane of the paper.

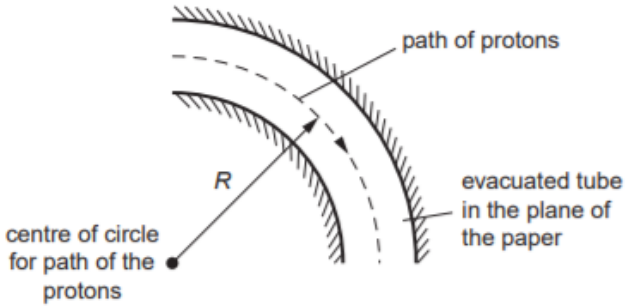

Fig. 3.1

The protons are made to travel in a circle of radius R by a magnetic field of flux density B.

(a) State clearly the direction of the magnetic flux density B that produces the circular motion of the protons.

..... **[1]**

(b) Show that the relationship between the velocity v of the protons and the radius R is given by $v = \frac{BQR}{m}$ where Q and m are the charge and mass of a proton respectively.

[1]

(c) Calculate the magnetic flux density B of the magnetic field needed to keep protons in a circular orbit of radius 0.18 m. The time for one complete orbit is 2.0×10^{-8} s.

B = ... T **[3]**

(d) Explain why the magnetic field does not change the speed of the protons.

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.....

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..... **[2]**

[Total: 7]

2 **(a)** Define *torque of a couple*.

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..... **[1]**

(b) Fig. 2.1 shows a current-carrying square coil placed in a uniform magnetic field.

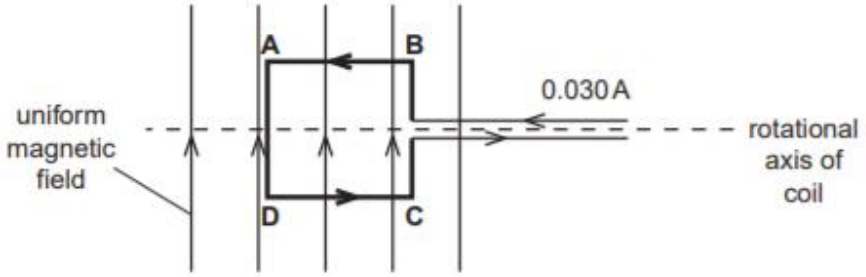

Fig. 2.1

The length of each side of the coil is 0.015 m. The plane of the coil is parallel to the magnetic field. The magnetic field is at right angles to the section **AB** of the coil and has magnetic flux density 0.060 T. The current in the coil is 0.030 A.

(i) Use Fleming's left-hand rule to determine the direction of the force on section **AB** of the coil.

..... **[1]**

(ii) The current-carrying coil will rotate because it experiences a torque. With the coil in the position shown in Fig. 2.1, calculate

1 the force experienced by the length **AB**

force = ...N **[1]**

2 the torque experienced by the coil.

torque = ... N m **[2]**

(c) Fig. 2.2 shows the path of a positive ion of oxygen-16 inside a mass spectrometer.

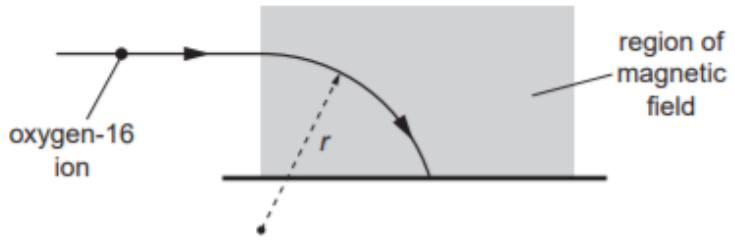

Fig. 2.2

The shaded area in Fig. 2.2 represents a region of uniform magnetic field of flux density 0.14 T. The direction of the magnetic field is out of the plane of the paper. The ion has a speed of $4.5 \times 10^6\,\text{m s}^{-1}$ and it enters the region at right angles to the magnetic field. While the ion is in the magnetic field, it describes a circular arc of radius r. The force experienced by the ion in the magnetic field is 2.0×10^{-13} N.

(i) Calculate the charge Q of the ion.

$Q =$ ..... C **[2]**

(ii) The mass of the ion is 2.7×10^{-26} kg. Calculate the radius r of the circular path.

$r =$ ..... m **[3]**

(iii) In Fig. 2.2, the oxygen-16 ion is replaced by an oxygen-18 ion. The oxygen-18 ion has the same speed and charge. Explain why this ion describes an arc of greater radius.

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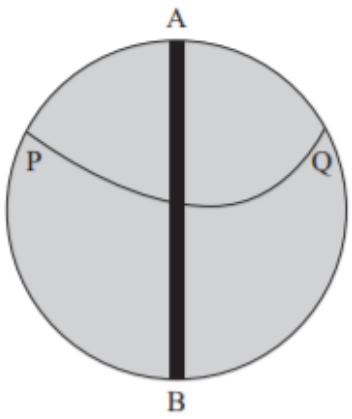
..... **[2]**

[Total: 12]

***11** The diagram shows the track of a charged particle in a magnetic field. The field is at right angles to the plane of the paper and its direction is out of the plane of the paper. AB is a thin sheet of lead that the particle passes through.



Work out the direction of movement of the particle and the sign of the charge of the particle. Explain clearly how you reached your conclusions.

(4)

(Total for Question 11 = 4 marks)