A. Key Concepts

1. Where do cosmic rays come from?
2. Explain how cosmic rays interact with the Earth's atmosphere.
3. What is solar wind?
4. Why do charged particles in the Earth's magnetic field follow a helical path?
5. What equation is used to find the force on a charge in a magnetic field.

B. Past Paper Practice

1. A particle of mass *m* and charge *q* is fired with speed *v* into a magnetic field of uniform magnetic induction *B*. The particle enters the field at point X and follows a semi-circular path, before leaving the field at point Y, a shown in figure 11.

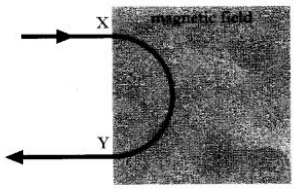

Figure 11

a) Show that the radius *r* of the semi-circular path is given by **2**

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

b) Using the above relationship, show that the time taken for the particle to follow the semi-circular path in the magnetic field is independent of the speed of particle. **3**

c) An electron with speed $2 \cdot 0 \times 10^6 ms^{-1}$ is fired, as shown in Figure 11, into a magnetic field of uniform magnetic induction $5 \cdot 0\ mT$. **2**
Calculate the time during which the electron is in the magnetic field.

2. A positively charged particle travelling at $2{\cdot}29 \times 10^6$ ms^{-1} enters a magnetic field of uniform magnetic induction 2·50 T as shown in Figure 6A.

The direction of the magnetic field is out of the page. The particle follows a semi-circular path before exiting the field. The circular orbit has a radius of 13.9 mm

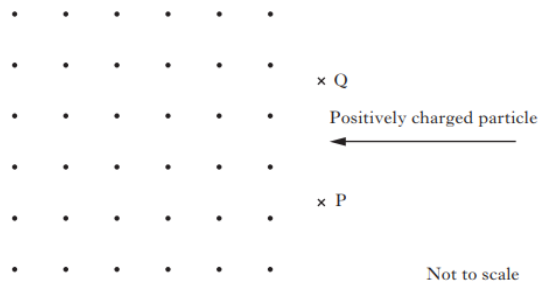

Figure 6A

a) **1**

i. State whether the particle will exit the field at point P or point Q

ii. Show that the charge to mass ratio of the particle is given by **1**

$$\frac{q}{m} = \frac{v}{rB}$$

Where the symbols have their usual meaning.

iii. The radius of the path taken by the particles is 19·0 mm.
Use information from the data sheet to identify the charged particle.
You must justify you answer with a calculation.

iv. Calculate the time between the particle entering and leaving the magnetic field. **2**

v. An identical particle travelling at twice the speed of the original particle enters the field at the same point. **1**
How does the time spent in the magnetic field by this particle compare with the original? Justify your answer.