8 Force-fields may be represented using lines that have direction.

(a) State

(i) what is meant by *field of force*,

.....

.....[1]

(ii) how, using lines of force, changes in the strength of a force-field are represented.

.....

.....

.....[2]

(b) Conventionally, arrows on field lines define the direction of a force acting on an object.

State the property of the object that experiences a force in this direction for

(i) a gravitational field,

…….[1]

(ii) an electric field,

…….[1]

(iii) a magnetic field,

…….[1]

(c) A proton, travelling in a vacuum at a constant velocity of 4.5×10^6 m s^{-1}. It enters a region of uniform magnetic field of flux density 1.2 T. The direction of the magnetic field is out of the plane of the paper. Initially the proton is travelling at a right-angle to the magnetic field, as shown in Fig. 8.1.

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

radius = …… m [2]

(ii) On Fig. 8.1 draw the path of the proton through, and beyond, the region of magnetic field.

drawn to

Fig 8.1 [4]

(d) A uniform electric field is now created in the same region as the magnetic field in Fig. 8.1, so that the proton passes undeviated through the region of the two fields.

(i) On Fig. 8.1 mark, with an arrow labelled E, the direction of the electric field. [1]

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

field strength = …… V m^{-1} [2]

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

……..…….....

……..…….[1]

(a) The proton in **(d)** is replaced by other particles. The electric and magnetic fields remain unchanged.

Without any further calculation, state and explain the deviation, if any, of the following particles in the region of the fields.

(i) an electron entering the region with twice the velocity.

……..…….....

……..…….[2]

(ii) an alpha particle (helium nucleus) entering the region with the same velocity.

……..…….....

……..…….[2]