Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Q1.

A metal aircraft with a wing span of 42 m flies horizontally with a speed of 1000 km h^{-1} in a direction due east in a region where the vertical component of the flux density of the Earth's magnetic field is 4.5×10^{-5} T.

(a) Calculate the flux cut per second by the wings of the aircraft.

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(b) Determine the magnitude of the potential difference between the wing tips, stating the law which you are applying in this calculation.

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_____

(c) What would be the change in the potential difference, if any, if the aircraft flew due west?

_____

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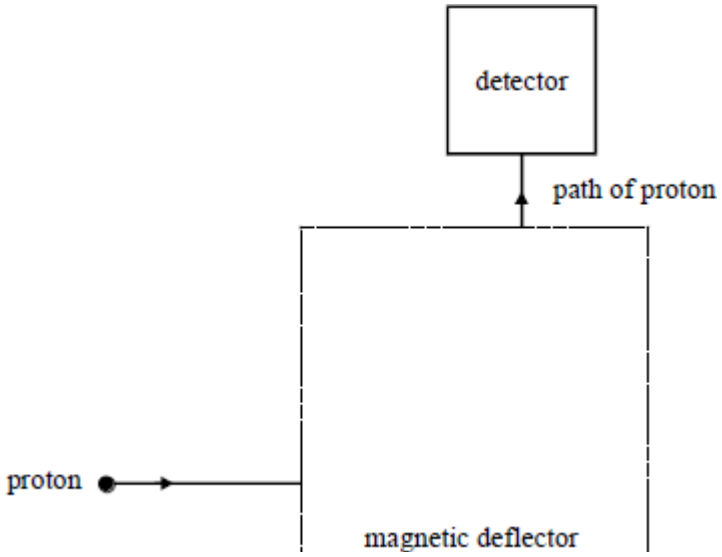
(Total 6 marks)

Q2.

The diagram shows an arrangement in a vacuum to deflect protons into a detector using a magnetic field, which can be assumed to be uniform within the square shown and zero outside it.

The motion of the protons is in the plane of the paper.



(a) Sketch the path of a proton through the magnetic deflector. At any point on this path draw an arrow to represent the magnetic force on the proton. Label this arrow F.

(2)

(b) State the direction of the uniform magnetic field causing this motion.

_____

(1)

(c) The speed of a proton as it enters the deflector is 5.0×10^6 m s^{-1}. If the flux density of the magnetic field is 0.50 T, calculate the magnitude of the magnetic force on the proton.

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(2)

(d) If the path were that of an electron with the same velocity, what **two** changes would need to be made to the magnetic field for the electron to enter the detector along the same path?

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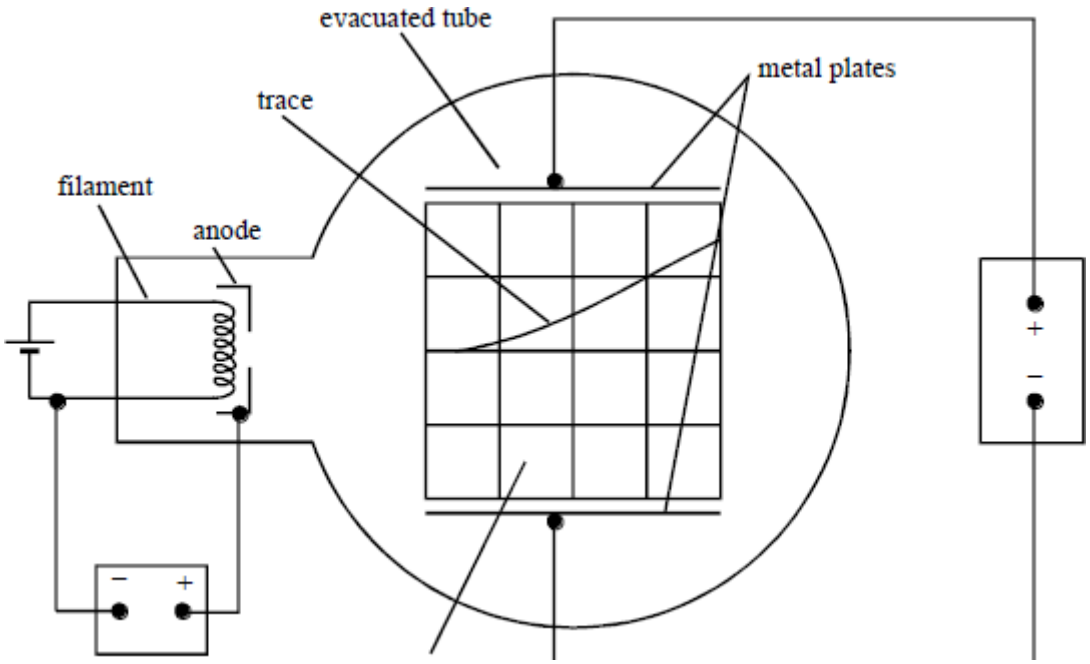
(2)

(Total 7 marks)

Q3.

A narrow beam of electrons is directed into a uniform electric field created by two oppositely-charged parallel metal plates at right angles to the field lines. A fluorescent screen is used to make the beam give a visible trace.



(a) (i) Explain why the beam curves towards the positive plate.

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(ii) How does the trace show that, on entry to the electric field, all the electrons have the same speed?

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(3)

(b) The beam is produced as a result of accelerating electrons between the filament and a metal anode.

(i) Explain why the wire filament must be hot.

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(ii) Write down an equation relating the speed of the electrons, v, to the potential difference, V_A, between the anode and the filament.

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_____

(2)

(c) The deflection of the beam due to the electric field can be cancelled by applying a suitable uniform magnetic field *in* the same region as the electric field.

(i) What direction should the magnetic field be in to do this?

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(ii) Write down an equation relating the speed of the electrons v to the plate voltage V_p, the plate separation d, and the magnetic flux density B necessary to make the beam pass undeflected between the plates.

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(iii) The following measurements were made when the beam was undeflected.

V_A = 3700 V V_p = 4500 V d = 50 mm B = 2.5 mT

Use the two equations you have written down and the given data to calculate the specific charge, e/m, of the electron.

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(5)
(Total 10 marks)