8 **(a)** Fig. 8.1 shows a diagram of an electron gun.

Electrons are emitted from a hot cathode. The electric field between the cathode and the anode accelerates the electrons through an accelerating potential difference (p.d.).

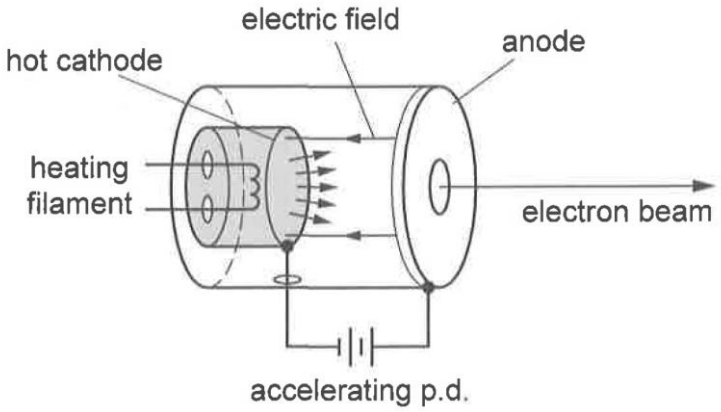

Fig. 8.1

(i) Explain what is meant by an electric field.

……..

…… [1]

(ii) Explain why the electron gun in Fig. 8.1 must be in a vacuum.

……

……..

……..

…… [2]

[Turn over

(iii) The kinetic energy of the electrons increases by 5.68×10^{-16} J between leaving the cathode and reaching the anode.

Calculate the accelerating p.d..

accelerating p.d. = …… V [2]

(iv) Suggest why the electrons reaching the anode have a range of speeds.

……..

……..

……..

……..…… [2]

(b) A uniform magnetic field is produced using a coil of 1500 turns of insulated wire, tightly wound on a non-magnetic tube to make a solenoid of mean radius 22 mm, as shown in Fig. 8.2. The wire itself has radius 0.86 mm and is made of a material of resistivity 1.7×10^{-8} Ω m. The coil is connected to a supply of e.m.f. 12 V and negligible internal resistance.

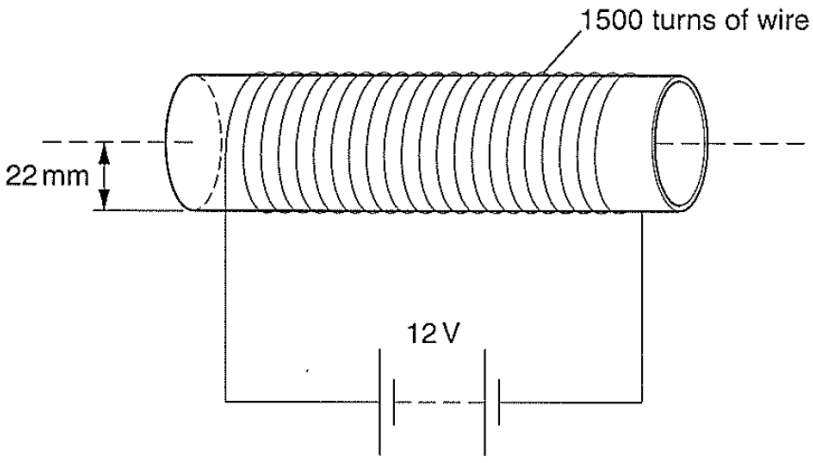

Fig. 8.2

Calculate

(i) the total length of the 1500 turns of wire in the coil,

length = ... m [1]

(ii) the total resistance of the coil,

resistance = ... Ω [2]

(iii) the current in the coil.

current = ... A [2]

(c) The magnetic flux density in the solenoid is measured using a current balance. The current balance is a U-shaped piece of stiff wire ABCDEF pivoted at BE, as shown in Fig. 8.3.

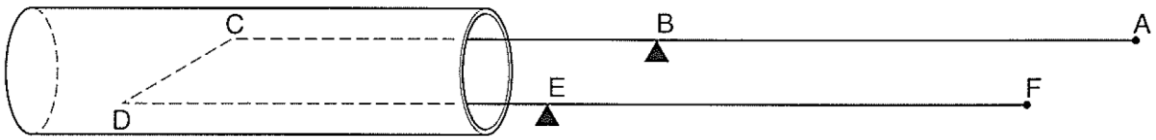

Fig. 8.3

When in use, there is a turning force on the stiff wire caused by a current in CD.

(i) Explain why the current in CD causes a turning effect.

.....

.....

..... [2]

[Turn over

(ii) Explain why currents in CB and DE do not contribute to the turning force.

.....

..... [1]

(iii) CD has length 25 mm, CB and DE each have length 106 mm.

The stiff wire is first balanced when there is no current in it. A current of 4.9 A is then passed through CD and, in order to rebalance the stiff wire, a force of 5.7×10^{-4} N is applied at a distance of 77 mm from the pivot, as shown in Fig. 8.4. which is the side view of the balance.

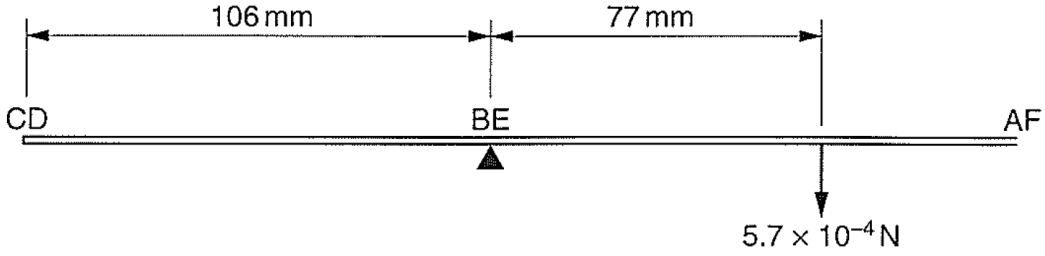

Fig. 8.4 (side view)

1. State the direction of the current in CD

direction = …….. [1]

2. Calculate the magnetic flux density in the solenoid. Give the full name of the unit for magnetic flux density.

magnetic flux density = ……

full name of unit = …….. [4]

[Total: 20]