

AQA

A Level

A Level Physics

Electromagnetism 1

Name:

M M E

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Total Marks: /30

1. A parallel-plate capacitor is made using two perfectly overlapping $5\text{ m} \times 5\text{ m}$ plates separated by a vacuum.

Total for Question 1: 12

(a) Sketch the magnetic field lines associated with the following:

i. A solenoid. Indicate the direction in which charge carriers are moving.

[2]



ii. The Earth.

[1]



iii. Two 'north' poles adjacent to each other.

[1]



- (b) Which one of the following is correct? [1]
- 1 T=1 NAm⁻¹
 - 1 T=1 Nm⁻¹A⁻¹
 - 1 T=1 N⁻¹m⁻¹A⁻¹

- (c) A 4.0 cm length of copper wire, carrying a current of 3.0 A, is placed obliquely inside a uniform field of flux density $B = 0.4$ T. It experiences a force of 10 mN. Calculate the angle between the wire and the field, given that the force experienced by the wire is proportional to $\sin \theta$, where θ is the angle between the wire and the field. [3]

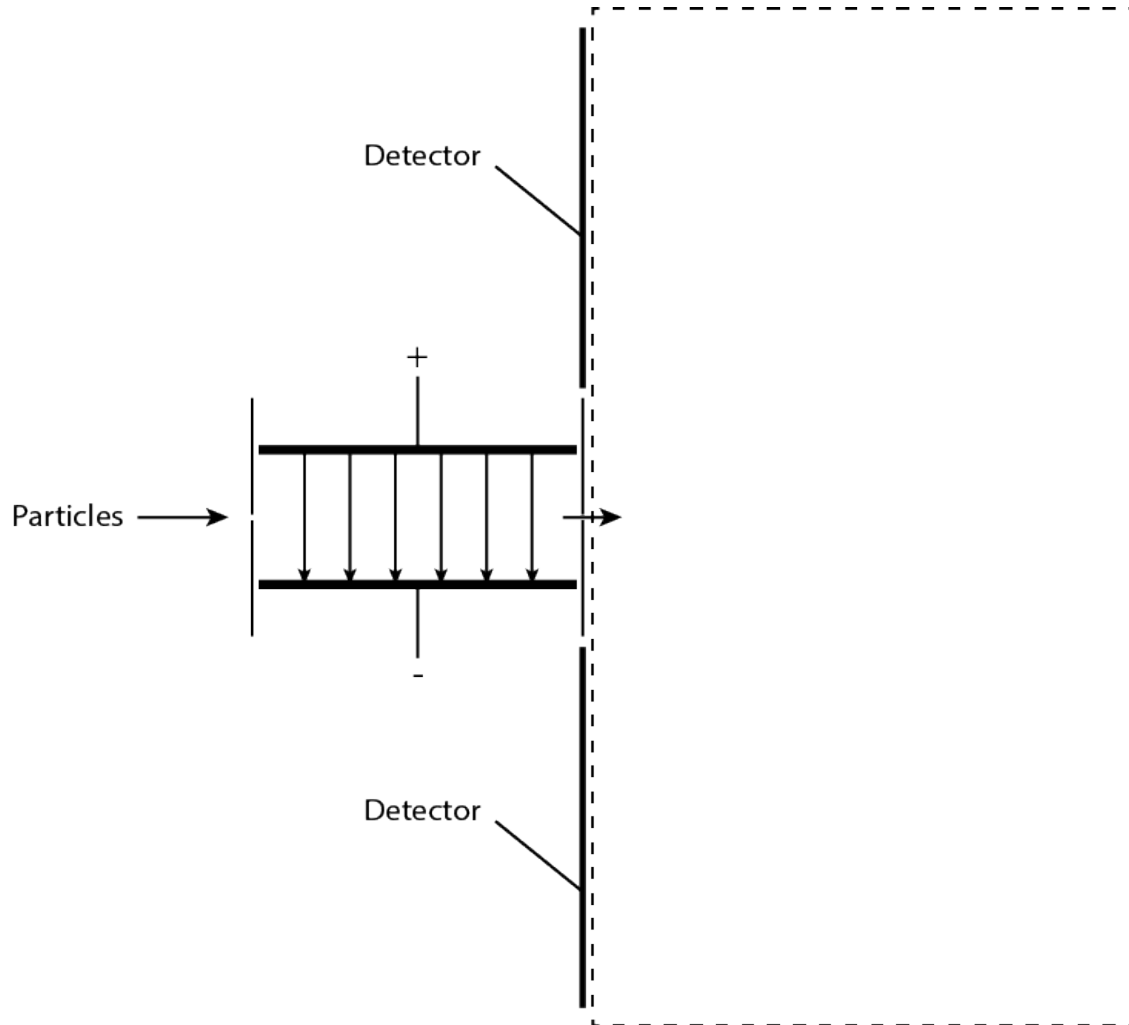
- (d) Two magnets, with a 5 cm length of copper wire between them, are placed atop a digital balance. The wire is perpendicular to the direction of the magnetic field and is connected to an ammeter and a power supply. Measurements from the digital balance are recorded for different currents. By plotting a graph of the induced force (the change in the weight of the setup) against the current, calculate the magnetic flux density.

[4]

Current / A	Mass / g
0	4000.0
2	4001.2
4	4003.1
6	4005.2
8	4007.0
10	4008.8

2. A velocity selector, illustrated in the plot below, uses both electric and magnetic fields to select charged particles with a specific velocity. The electric field is present in the region between the two plates, across which the potential difference is 1 kV and the separation is 2 cm. The magnetic field, with a flux density of $B = 0.5 \text{ T}$, is present both in the velocity selector and in the region indicated by the dashed line.

Total for Question 2: 18



- (a) Indicate on the diagram the direction of the magnetic field.

[1]

- (b) By balancing the forces associated with the electric field and the magnetic field, calculate the velocity of the particles that escape through the right hand hole. [4]

After leaving the selector, the particles are being subjected only to the forces associated with the magnetic field.

- (c) What effect will this have on the particles' motion? Justify your answer. [2]

This scenario is exploited in mass spectrometers, which are used to measure the masses and relative abundances of different atomic species in a sample.

- (d) Suggest why is it important that all particles are travelling with the same speed when they enter the mass spectrometer. [1]

- (e) Sketch, on the diagram above, the paths taken by the following particles: [2]
- i. A negatively charged particle with a high mass.
 - ii. A negatively charged particle with a low mass.
 - iii. A positively charged particle with a high mass.
 - iv. A positively charged particle with a low mass.

- (f) Calculate the radius of curvature of the following paths: [2]
- i. A singly ionised sodium atom (atomic mass = 23).

- ii. A singly ionised potassium atom (atomic mass = 39). [2]

- (g) Calculate their separation when they reach the detector. [2]

- (h) If the potassium atom had been given a positive charge of $+1e$, would your answer to the previous part change? If so, quantify the change. [2]