Past-paper walk-through

Magnetic Fields ▪ 12.1

eXercise

Questions in this set

- 2026 Q3

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 3

2026 ▪ Q3

The following information applies to parts A and B.

In Experiment 1, scientists want to collect data that can be graphed to determine the magnitude B_0 of an external, uniform magnetic field. The field is directed into Figure 1 in the region between identical, parallel, conducting plates that are connected to a power supply of variable emf $\mathcal{E}$. The plates are a known distance d apart, where d is much smaller than the dimensions of the plates.

[Figure 1: A power supply (with terminals $+$ and $-$) connected by wires to a rectangular "Device" box, which emits particles with speed v toward the region between two horizontal parallel plates (upper plate labelled at right as "Plate", lower plate unlabeled) separated by a known distance d. Between the plates, an array of "$\times$" symbols indicates a uniform magnetic field B_0 directed into the page. A "Motion

Question 3

Detector" (shaded square) is positioned to the right of the plates, in line with the gap between them. Note: Figure not drawn to scale.]

In each trial, a device emits small, charged spheres with speed v through the region between the plates. $\mathcal{E}$ is varied until the spheres move undeflected toward a motion detector. The scientists can vary v between trials. Gravitational effects are negligible.

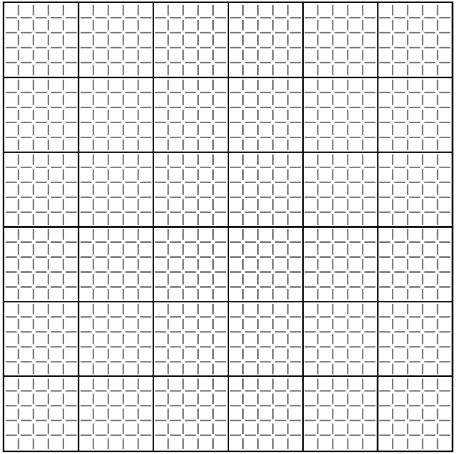
In addition to the equipment shown in Figure 1, the scientists also have access to a voltmeter. The scientists do not have access to other measuring tools, devices, sensors, or equipment.

(a)(i) Part A

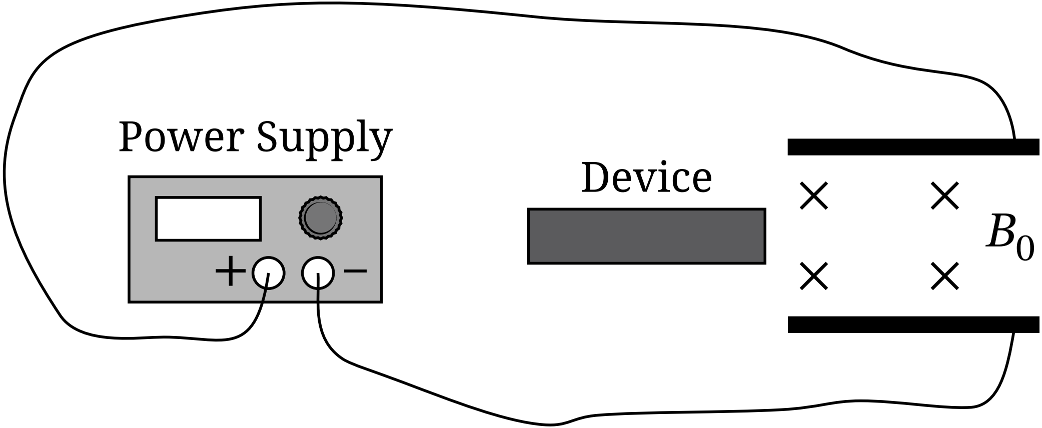
Indicate quantities that could be measured using the available equipment that would allow the scientists to determine B_0 by using a linear graph.

(a)(ii) Briefly **describe** a method to reduce experimental uncertainty for the measured quantities indicated in part A (i).

Question 3



Question 3



Question 3

Table 1

B (T)	r (m)
0.04	1.8
0.06	1.2
0.14	0.5
0.16	0.4
0.20	0.3

Question 3

2026 ▪ Q3

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Question 3

In each trial, a device emits small, charged spheres with speed v through the region between the plates. $\mathcal{E}$ is varied until the spheres move undeflected toward a motion detector. The scientists can vary v between trials. Gravitational effects are negligible.

In addition to the equipment shown in Figure 1, the scientists also have access to a voltmeter.

The scientists do not have access to other measuring tools, devices, sensors, or equipment.

(b)(i) Part B

Indicate what quantities the scientists could graph on the horizontal and vertical axes to create a linear graph that can be used to determine B_0. Clearly indicate which quantity corresponds to each axis.

(b)(ii) Briefly **describe** the relationship between B_0 and one feature of the graph from part B (i). Your answer may include an equation that relates B_0 and the indicated feature of the graph.

Question 3

2026 ▪ Q3

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Question 3

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(c)(i) The following information applies to parts C and D.

In Experiment 2, scientists want to use a graph to determine the mass m of identical, charged particles that are emitted from a device. Each particle has charge $Q = +6.4 \times 10^{-19}$ C.

In each trial, a particle is emitted with speed $v_0 = 3.0 \times 10^6$ m/s toward a region of external, uniform magnetic field of variable magnitude B. The radius r of the path along which the particle moves while in the field, shown in Figure 2, is recorded.

Question 3

[Figure 2: A particle of mass m and charge Q enters from the left with velocity v_0 (dashed horizontal arrow) into a rectangular region filled with dots representing a uniform magnetic field B directed out of the page. Inside the field region, a dashed curved arc (a semicircular path) curves the particle's trajectory, with a double-headed arrow labelled r marking the radius of the circular path.]

In subsequent trials, B is increased and the resulting r is recorded. Gravitational effects are negligible. Collected data are provided in Table 1.

Table 1

B (T)	r (m)
0.04	1.8
0.06	1.2
0.14	0.5
0.16	0.4
0.20	0.3

Part C

Question 3

Label the axes of the grid provided with measured or calculated quantities. Include units, as appropriate. The graphed quantities should yield a linear graph that can be used to determine m.

(c)(ii) On the grid, **create** a graph of the quantities indicated in part C (i).

- **Label** the vertical and horizontal axes with numerical scales.
- **Plot** the corresponding data points on the grid.
- Table 2 is provided in your booklet for scratch work, but the table will not be scored.

[A blank labelled grid (square grid ruling) is provided for the student to label axes, choose numerical scales, and plot the data points from Table 1, with blank lines above and below the grid for writing the "Quantity (units, if appropriate)" for each axis.]

(c)(iii) **Draw** a best-fit line for the data graphed in part C (ii).

Question 3

2026 ▪ Q3

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Question 3

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(d) Part D

Calculate m from the best-fit line drawn on the grid.