Question 3

The following information applies to parts A and B.

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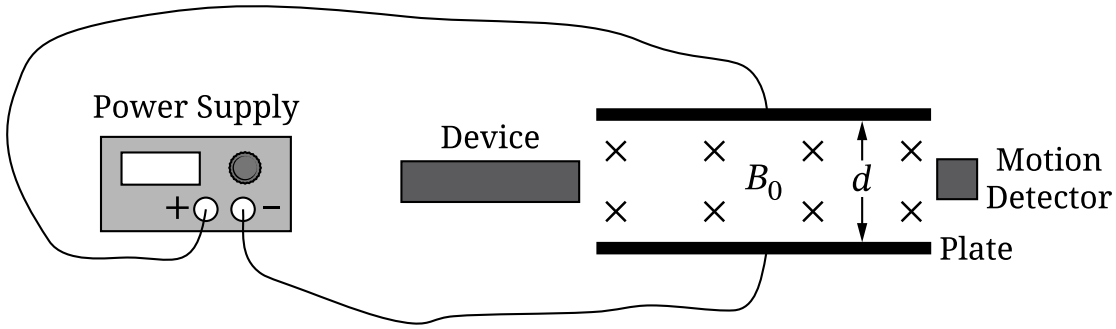
3. In Experiment 1, scientists want to collect data that can be graphed to determine the magnitude B_0 of an external, uniform magnetic field. The field is directed into Figure 1 in the region between identical, parallel, conducting plates that are connected to a power supply of variable emf $\mathcal{E}$.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

Figure 1



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.

Part A

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

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

Part B

i. **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.

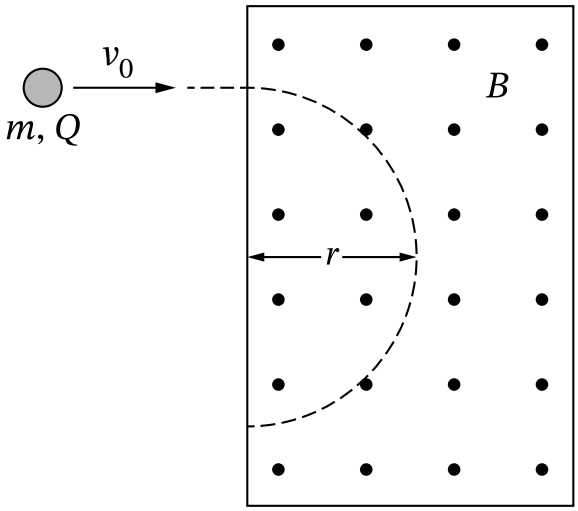
ii. Briefly **describe** the relationship between B_0 and one feature of the graph from part B (i). Your answer may include an equation that relates B_0 and the indicated feature of the graph.

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.

Figure 2



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

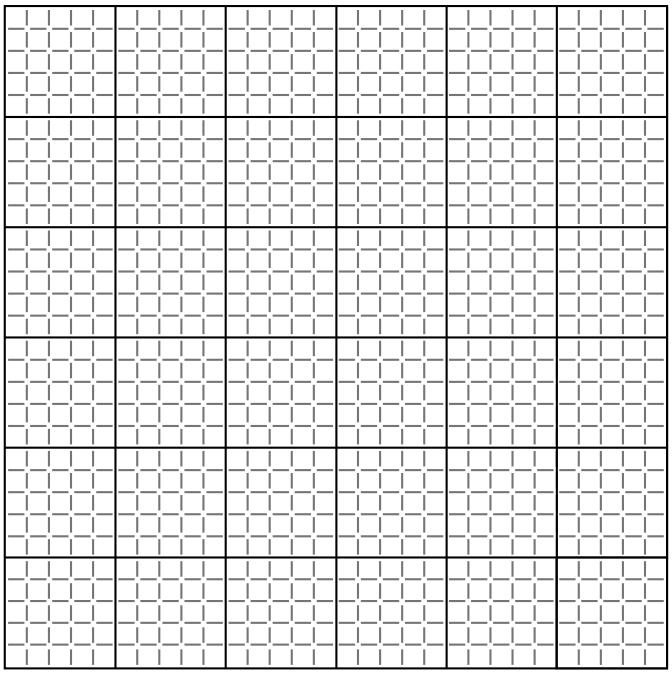
i. **Label** the axes of the grid provided with measured or calculated quantities. Include units, as appropriate. The graphed quantities should yield a linear graph that can be used to determine m.

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.

Quantity (units, if appropriate)

_____ _____



Quantity (units, if appropriate)

_____ _____

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

Part D

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