

This is an example answer. There are other ways to plan/write an answer to this question.

Plan

Question is worth 12 marks. Dividing by 2 (because it is double-marked) and subtracting 2 (for communication) gives 4, so 4 main points.

I will use two points to answer each dot point. Since the second dot point is a 'hence' I will mention each of the components in the second half of the answer.

1: List main components

dees, electromagnets, outer container, ion source

2: Descriptions

hollow metal semicircles

coils of wire with current

sealed and air removed

gives hydrogen atoms charge

3: How a cyclotron speeds up ions

dees oppositely charged therefore electric field between

ion source places ion in electric field, which does work on it

4: Relate to high energies

magnetic field gives ion circular motion

alternating current so ion crosses repeatedly, high speed (energy)

Parts of the answer in brackets may not be required but are correct and relevant. Since the question asks specifically about 'ions' not just one ion, I will use that wording.

Extended Response Example Question
Motion of Charged Particles in Electric and Magnetic Fields

- Describe the four main components of a cyclotron
- Hence describe how a cyclotron accelerates ions to high energies

The four main components of a cyclotron are the dees which are hollow metal semicircles connected to an alternating current, the electromagnets which are current-carrying coils above and below the dees, the outer container which is sealed and evacuated, and the ion source which gives hydrogen ions a positive or negative charge.

The dees are oppositely charged, which creates an electric field in between them (but not inside them). The ion source places ions in the electric field, which does work on them, speeding them up (giving them kinetic energy). The electromagnets create a magnetic field (at right angles to the ions' velocity) which causes a centripetal force on the ions. Therefore the ions travel in circular motion inside the dees and return to the electric field. The electric field is alternating, so the ions gain energy each time they cross. There is no air in the container, so this process is able to be repeated (at larger and larger circles of motion) until the ions have high energies.