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| **Lesson Number: 24.3** |
| **Lesson Title: Charged particles in circular orbits** |
| **Specification Reference** | **3.7.5.2** |
| **Learning Objectives** |
| Force on charged particles moving in a magnetic field, *F* = *BQv* when the field is perpendicular to velocity.Direction of force on positive and negative charged particles.Circular path of particles; application in devices such as the cyclotron. |
| **Opportunities for Assessment** |
| Page 405 questions |
| **Starter:** | Slide #1 enables a discussion about CERN and the projects done there – circular paths are needed both to steer the particles and to analyse the results |
| **Main:** | Slide #2 introduces the idea that particles will follow circular orbits in magnetic fields. The diagram also allows the use of Flemming’s left hand rule to describe the motion of the charges. Note the circle and dot represents the magnetic field coming out of the pictureSlide #3 is a mathematical derivation of the formula to calculate the radius of the circle described by a charged particle moving in a magnetic fieldSlides #4 and #5 explain two uses of this technology; the aurora on planet Earth are a nice research topic |
| **Plenary:** | Slide #6 is a summary |

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| **Homework:** | Page 405 questions; research CERN and particle accelerators |
| **Differentiation / Extension / S&C** |
| Extended research on why particles make spirals in accelerator experiments |
| **Numeracy / Literacy** | **SMSC / Fundamental British Values** |
| Derivation of formula | CERN and other experiments that require international collaboration and team work |
| **RESOURCES:** |
| Optional Demo:* Helmholtz coils demonstration
 |
| **Risk Assessment** e.g. CLEAPSS card reference |
| Helmholtz coils use high voltages and precautions must be made to ensure live circuitry cannot be touched, including the use of fully insulated high voltage wiresThe laboratory RCCD system should be tested prior to high voltage equipment being used. |
| **Working Scientifically (HSW)** |
| Page 404 – The cyclotron / Mass Spectrometer |

Pictures courtesy of:

Slide #1 – Ryan Boyles, CERN - [https://www.flickr.com/photos/136478526@N02/22386330902](https://www.flickr.com/photos/136478526%40N02/22386330902)

Slide #2 – Wikipedia

Slide #5 - Devon Fyson [Public domain or Public domain], via Wikimedia Commons