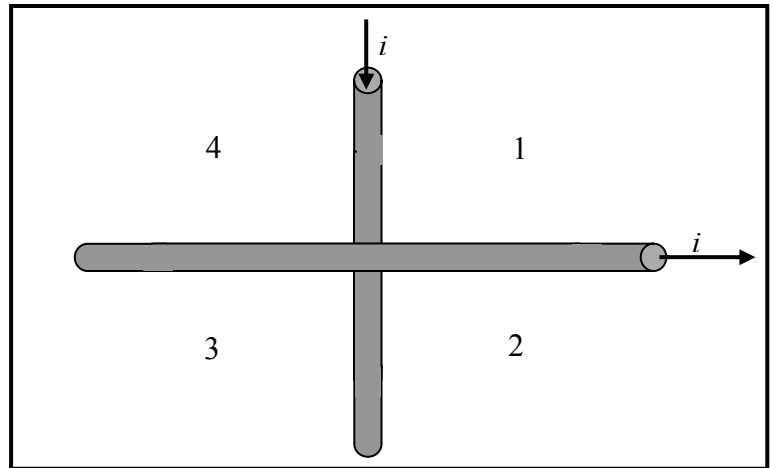


# Workshop Tutorials for Technological and Applied Physics

## ER7T: Magnetic Fields

### A. Qualitative Questions:

1. Two fixed wires cross each other perpendicularly so that they do not actually touch but are close to each other as shown in the figure. Equal currents  $i$  exist in the wires, in the directions indicated.



- In what region(s) will there be points of zero net magnetic field?
- If the wires are free to move, describe what happens when the currents are sent through both of them.

2. Oscillator circuits are used to produce electronic tones, for example in battery powered doorbells, they are used in timing devices and have many other useful applications. They are often made using capacitors and inductors.

- How is energy stored in a capacitor?
- How is energy stored in an inductor?
- Draw a diagram showing the magnetic field due to an inductor. Show how the fields from all the individual loops of wire add to give the resultant field.
- Why does a circuit containing an inductor and capacitor act as an oscillator?

### B. Activity Questions:

#### 1. Magnets and magnetic fields

Use the iron filings to investigate the field lines of the magnets.

How do these field lines compare to the magnetic field lines of the Earth?

Many animals such as pigeons and some fish have a magnetic sense which allows them to use the Earth's magnetic field to navigate.

#### 2. Magnetic field around a current carrying wire – Oersted's experiment

Use the compasses to find the direction of the magnetic field at different points around the wire.

Draw a diagram showing the field around the wire.

What happens when you swap the connections and change the direction of the current?

#### 3. Solenoid

Draw a diagram showing the magnetic field in and around the solenoid.

Are there any points where the magnetic field is zero?

How does the magnetic field vary inside the solenoid?

#### 4. The magnetic force - pinch effect

Turn on the power supply and observe what happens to the wires.

How can you make them repel instead of attracting?

Draw a diagram showing the field, current and forces on the wires.

### C. Quantitative Questions:

1. In the inside of a TV set an electron is accelerated by a potential difference of 20 kV in an evacuated tube. It is then passed through a uniform magnetic field of 100 mT which deflects it to the desired position on the screen.

a. Draw a diagram showing the path of the electron as it passes from the electron source to the screen.

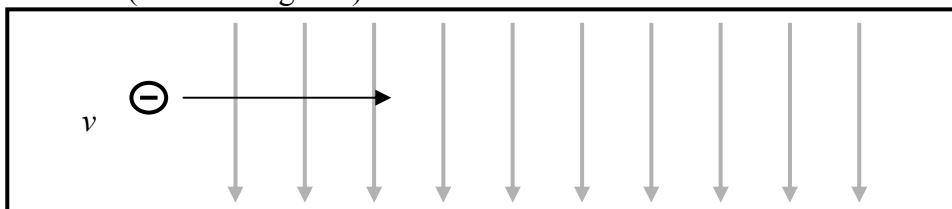
The energy of subatomic particles is often measured in electron volts, because these are a convenient size. For every volt it is accelerated by, an electron gains 1 electron volt (eV) in kinetic energy, where  $1\text{eV} = 1.6 \times 10^{-19}\text{ J}$

b. After passing through the accelerating potential, what is the kinetic energy of the electron in eV? (Assume it started with negligible kinetic energy.) What will be its kinetic energy in joules?

c. What is the speed of the electron just before it enters the magnetic deflecting field?

d. What will be the radius of curvature of its path in the field?

e. If the electron is travelling from left to right in the tube, and the field is directed down, which way will the electron be deflected? (Draw a diagram.)



2. As part of Sydney's preparations for the Olympic games, Redfern station was upgraded. Consider a builder standing in the station area above the platforms. One of the high voltage lines which power the trains is 2 m directly beneath him, carrying a current of 100 A. The power lines run approximately north-south and the current is southwards. The builder is using a magnetic compass to find north to make sure that the new entrance to platform 10 faces the right way.

a. What is the magnetic field due to the power cable where the builder is standing?

b. If the horizontal component of the Earth's magnetic field is  $20\ \mu\text{T}$  in Redfern, which way will the compass needle point? (Is there going to be a problem with his compass reading and hence the positioning of the platform entrance?)