WJEC England Physics A Level

SP C3 09 : Magnetic Fields

Practical notes

1. Investigation of the Force on a Current in a Magnetic Field

Equipment:

- Wire
- 2 clamp stands
- 2 identical magnadur magnets, attached to a metal cradle
- Mass balance
- Variable power supply
- Ruler
- Ammeter

Method:

1. Set up the mass balance with the magnets in the metal cradle on top, and zero the balance.
2. Clamp the wire between the two clamp stands and position it so it lies between the magnets (across the middle of the metal cradle).
3. Attach the wire to the variable power supply.
4. Turn on the power supply and record the current, I, (from the ammeter) and the mass, m, displayed on the mass balance.
5. Adjust the voltage so the current changes incrementally and record the values of I and m.
6. Measure the length of wire between the magnets, L. Do this by measuring the length of the magnets as this will be the length of wire affected.
7. Calculate the force associated with each mass by multiplying each value by g (as weight = mg).
8. Plot a graph of F against I and calculate the gradient.
9. Calculate the magnetic field strength, B, by dividing the gradient by L.

Theory:

F = BIL so by rearranging to make B the subject, B=F/IL F/I is the gradient of the force-current graph so B=gradient/L

2. Investigation of Magnetic Flux Density Using a Hall Probe

Equipment:

- Solenoid
- Electric leads
- DC Power Supply (such as a lab powerpack)
- Rheostat
- Ammeter
- Hall probe
- Voltmeter

Method:

1. Throughout this experiment, the current flow should be constant - this is achieved by monitoring the current value displayed by the ammeter and changing the rheostat where necessary to ensure that the value is constant.
2. Place the Hall probe into a known, uniform magnetic field, ensuring that the probe is perpendicular to the field lines - record the voltage reading produced on the voltmeter.
3. Place the Hall probe into the centre of the solenoid, again ensuring that the probe is perpendicular to the fields, and note down the second voltage reading.

Calculations:

- Using the value of the known field (B_1), and the two voltage values (V_1 and V_2), the magnetic flux density of the solenoid (B_2) can be calculated using:

$$B_2 = \frac{B_1}{V_1} V_2$$

- This equation holds because at constant current, the Hall voltage is proportional to the magnetic flux density of the field that the probe is placed in.

Notes and Improvements:

- An extension to this experiment would be to take readings of the field strength at different distances along the solenoid. A graph of field strength against distance could then be drawn to show the variation of the field at the ends of the solenoid.
- Different solenoid diameters could be compared to see have the magnetic field strength changes.

Safety:

- The equipment can get hot over time so turn off the power supply when readings aren't being taken.