Magnetic flux density

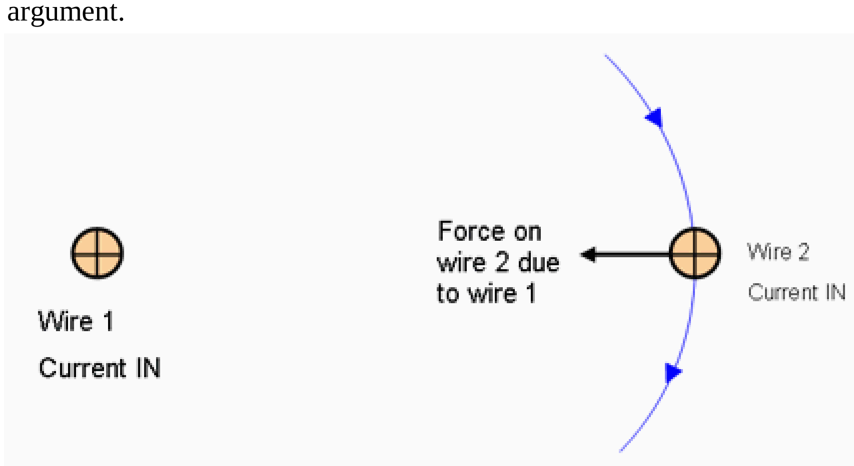
Magnetic flux density (B) in conductor

Students will probably know that electric and gravitational fields are defined as the force on unit charge or mass. So by comparison, **B = F/IL**, and this gives a way of defining the 'magnetic field strength'. Physicists refer to this as the **B**-field or magnetic flux density which has units of N A^{-1} m^{-1} or tesla (T). A field of 1T is a very strong field. The field between the poles of the Magnadur magnets that are used in the above experiment is about 3 ´ 10^{-2} T while the Earth's magnetic field is about 10^{-5} T.
If your specification requires, you will need to develop the 'angle factor' seen in the experiment into the mathematical formula:

F = BIL sin q .

For the mathematically inclined, it can be shown that the effective length of the wire in the field (i.e. that which is at right angles) is L sin q. If students find this difficult, then it can be argued that the maximum force occurs when field and current are at right angles, q = 90^o (sin q = 1), and that this falls to zero when field and current are parallel, q = 0^o (sin q = 0).

Discussion: Formal definitions
Some specifications require a formal definition of magnetic flux density and/or the tesla. The strength of a magnetic field or magnetic flux density B can be measured by the force per unit current per unit length acting on a current-carrying conductor placed perpendicular to the lines of a uniform magnetic field. The SI unit of magnetic flux density B is the tesla (T), equal to 1 N A^{-1} m^{-1}. This is the magnetic flux density if a wire of length 1m carrying a current of 1 A as a force of 1 N exerted on it in a direction perpendicular to both the flux and the current. Study of the force between parallel conductors leading to the definition of the ampere may be required. Students may already have seen the effect in your initial experiments but this may need to be repeated here. The effect can be explained by considering the effect of the field produced by one conductor on the other and then reversing the argument.



The force between parallel conductors forms the basis of the definition of the unit of current, the ampere. A formal definition is not usually required but students should realize that in a current balance (such as was used above) measurement of force and length can be traced back to fundamental SI units (kg, m, s) leaving the current as the only 'unknown‟. Some students are likely to be interested in the formal definition which is "that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible cross-section, and placed 1m apart in a vacuum, would produce a force of 2 ´ 10^{-7} Newton per metre of length".