**Resonance in a wire**

When a wire under tension oscillates at its resonant frequency (f), the resonant frequency depends on the tension in the wire (T), the mass per unit length of the wire (μ) and the length of the wire (l).

 f = (1/2l) √(T/μ) for the fundamental frequency

The following straight forward set up, see figure 1, can be used to verify this relationship.

 **Apparatus:**

 Two Westminster Kit magnets and yoke, 1.5 m 28 swg bare copper wire (diameter 0.38 mm), four 50g slotted masses and a 50 g carrier to take the slotted masses, 50 Hz ac low voltage supply, 12 V, 24 W lamp bulb (provides a suitable resistance so a current of between 1 – 2 A passes through the wire), connecting wires and croc clips. It helps to clamp the wire between two pieces of plywood to enable the position of end A of the wire to be known precisely. 1 cm diameter doweling is suitable with a 1mm hole drilled along the diameter at one end to define the point at the other end of the wire (B), this defines the length of wire oscillating.

**Figure 1**

Method

Set up the apparatus as shown in **figure 1**. Switch on the power pack and adjust the voltage so the lamp only just lites. Make sure the magnets are such that a north and south pole are facing each other. This ensures the wire passes through a uniform magnetic field. Move the doweling up and down the wire to find the length where the wire starts to oscillate in the fundamental node. Adjust the position of the magnet so it is at the antinode. The length AB corresponds to l in the formula. The tension in the wire can be changed by adding more slotted masses and the relationship between the tension and length investigated for a given diameter of copper wire and frequency. The frequency was kept constant as a low voltage ac supply was used so the frequency was 50Hz. The mass per unit length can be found by measuring the mass of length of wire under investigation, using a top pan balance, and dividing this value by the length of the wire which can be measure using a metre stick.

Other possible investigations

The diameter of copper wire can be changed and the resonant length found for a given frequency and tension.

If a signal generator is used the frequency can be changed and the resonant length found for a given wire and tension. To avoid damage to the signal generator insert an ammeter in series with the light bulb so the current is kept well below the maximum current the signal generator can provide.

Health and safety

If the wire is at eye level safety glasses must be worn as the wire is under tension.