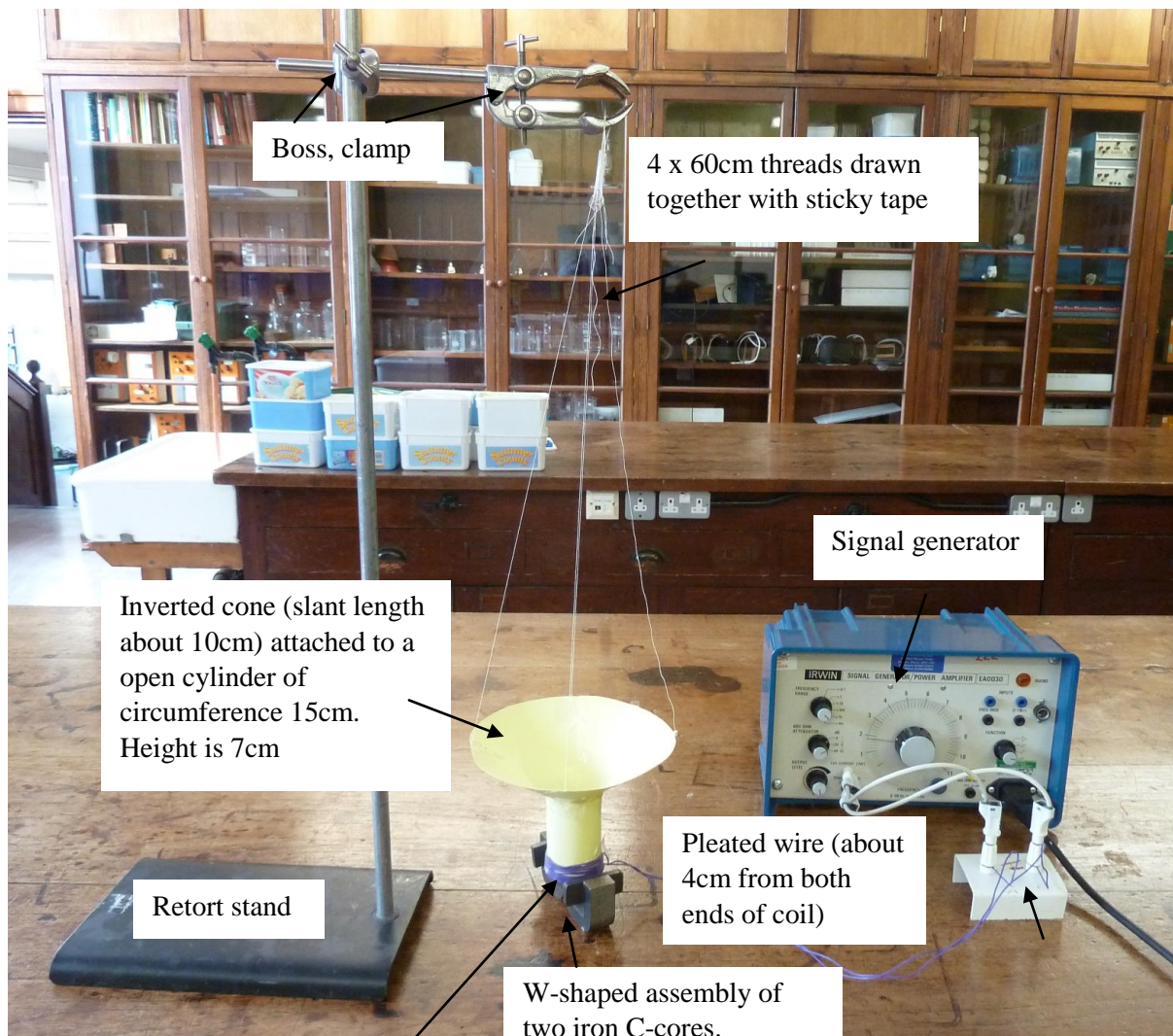


## Do-it-yourself loudspeaker (Electromagnetism practical)

AF 9/3/2017 Winchester College Physics Department.

### Scope

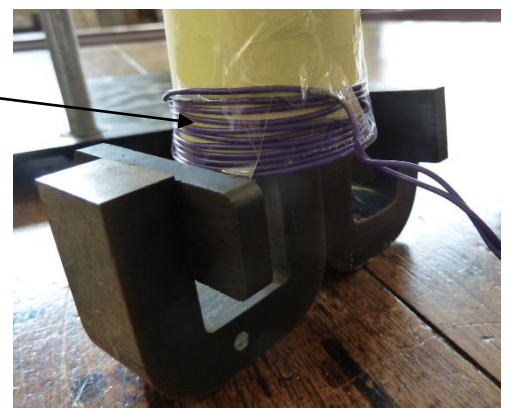
A loudspeaker is essentially a suspended cone which is oscillated in such a way that the resulting movement of air transmits an audible sound wave. The movement of the cone is achieved via the *Lorentz force*. A coil of wire is wrapped around a cylinder attached to the cone, and placed between poles of a magnet. An electrical signal equivalent to the required sound waveform is passed through the coils. The magnets exert a force on the current carrying wires, resulting in motion of the cone. The direction that the force acts can be explained by *Fleming's Left hand Rule*.



About 220cm of tightly coiled wire, held onto cylinder via sticky tape.

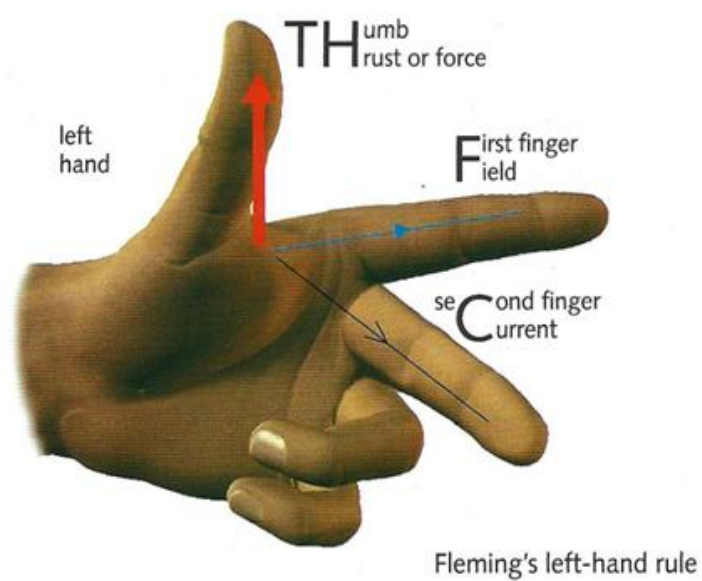
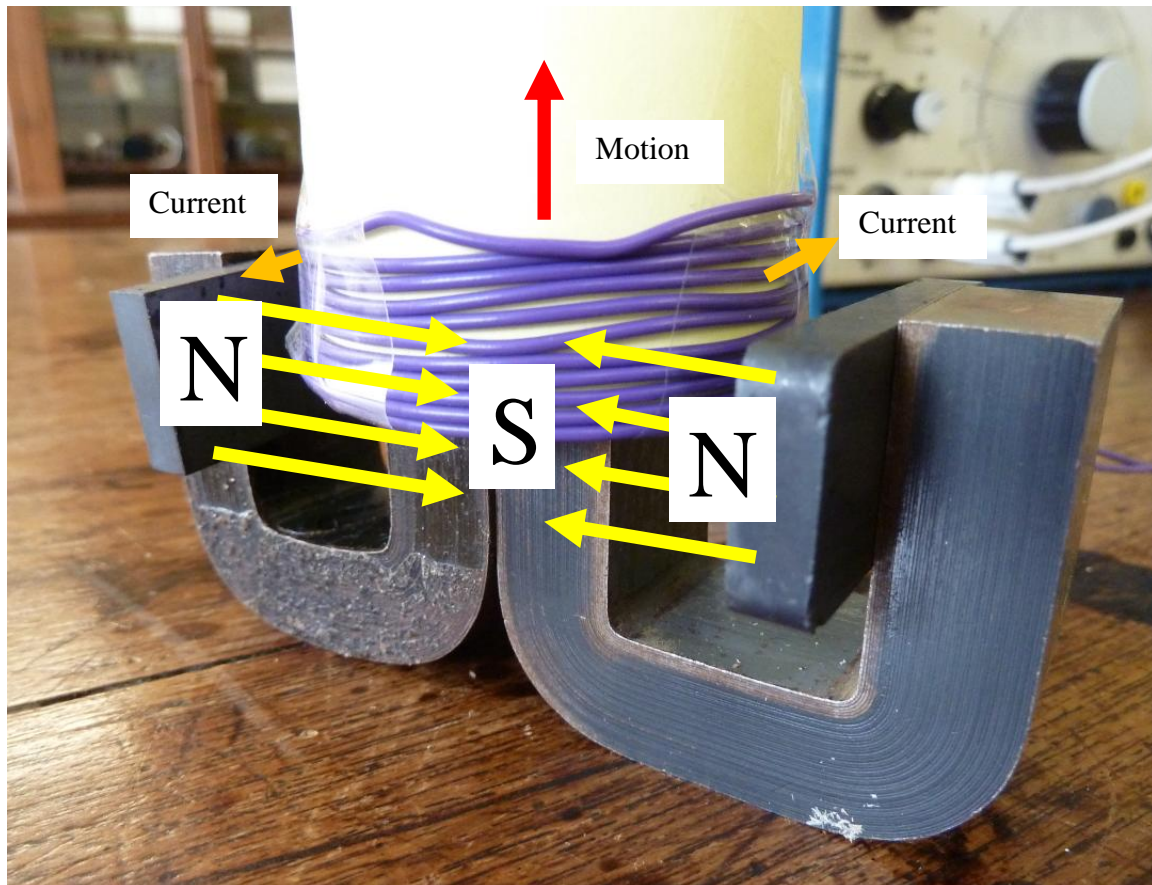
W-shaped assembly of two iron C-cores. Magnadur magnets attached to the sides

Cylinder with coiled wire (and pleat of 40cm ends) suspended over two ends of iron C-cores. The magnadur magnets and placed on either end. The idea is the inner part of the W is one flavour of magnetic pole, and the inside face of the magnadurs is the opposite pole.



## Physics

*Fleming's Left Hand Rule* explains why the loudspeaker moves. The motion (up and down) is at right angles to *both* the magnetic field and the current (which crosses the face of the magnet). The current varies with the electrical signal, and hence the speaker cone moves in the same fashion, since the applied magnetic field strength and direction does not change.





## Equipment

Signal generator + power lead

3m of insulated wire (1cm stripped at both ends). Inner 220cm wound round cylinder.

Metre ruler for measuring wire and thread

Two-terminal block

Wire cutter/strippers

Scissors

Lots of adhesive tape, ideally on a spool dispenser

Standard lab wires and plugs for connecting terminal block to signal generator

Optional 3.5mm mp3 player connector

(A4) card template for loudspeaker cone and base

2 x magnadur magnets

2 x C shaped iron cores

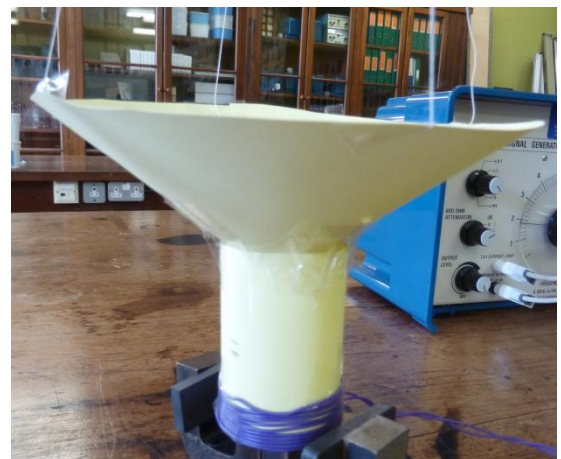
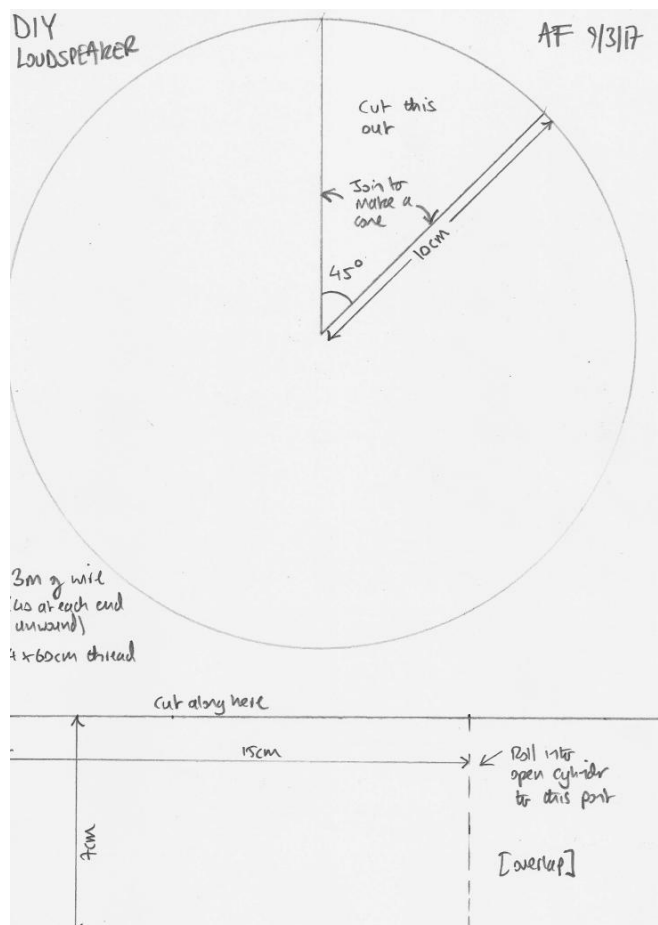
4 x 60cm of thread

Retort stand plus boss and clamp

## Instructions

For maximum success, it is suggested the teacher assemble the equipment *with* the students step-by-step in a follow-my-lead way.

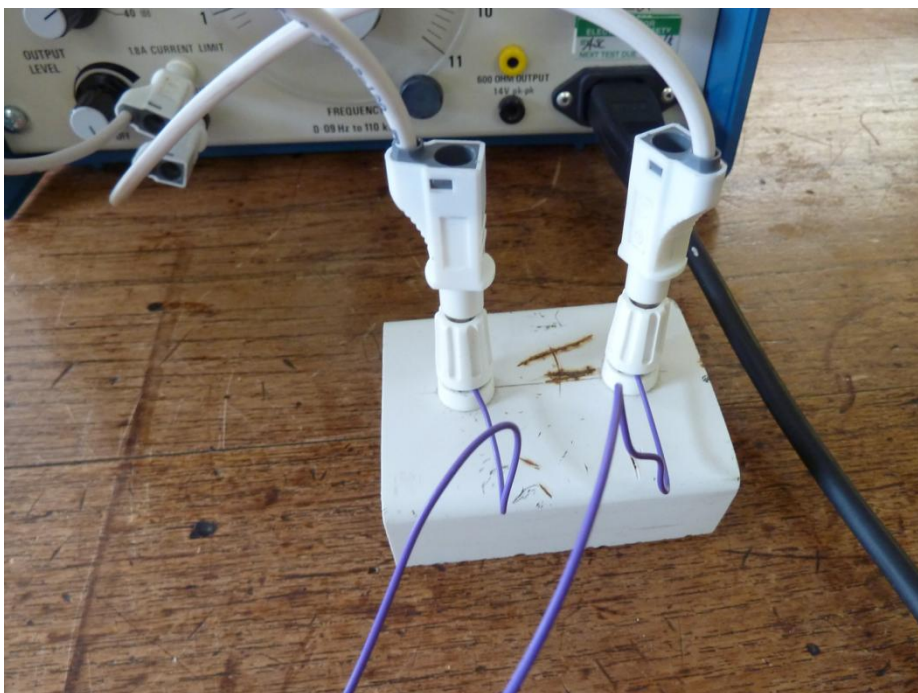
1. Cut out cone from A4 template. (See separate document). Use sticky tape to join the sides.
2. Cut out open cylinder from 7cm wide strip at the base of the card template. Roll until one edge meets the dashed line. This means the circumference of the cylinder is about 15cm. Use sticky tape to hold down the overlap.
3. Use sticky tape to carefully join the cylinder to the tip of the cone. Make sure this is a good contact. Sticking tape tangentially can help here!



4. Using the ruler, measure out 3m of wire. Measure 40cm from one end, and then coil tightly, starting from the base of the cylinder until about 40cm of wire is left. Use sticky tape to keep the coils in place.

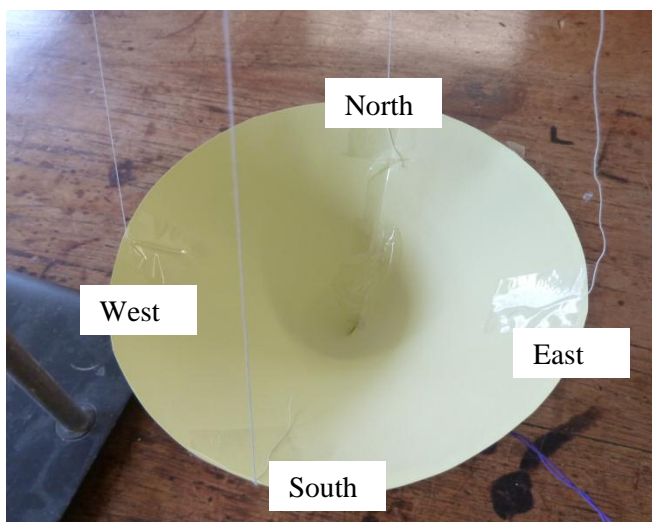


5. Pleat the free wires and strip about 1cm from each end. Attach these to the terminal block. The pleated wires should hang vertically from the cylinder. Again, use sticky tape to make sure the wires don't pull the loudspeaker sideways.

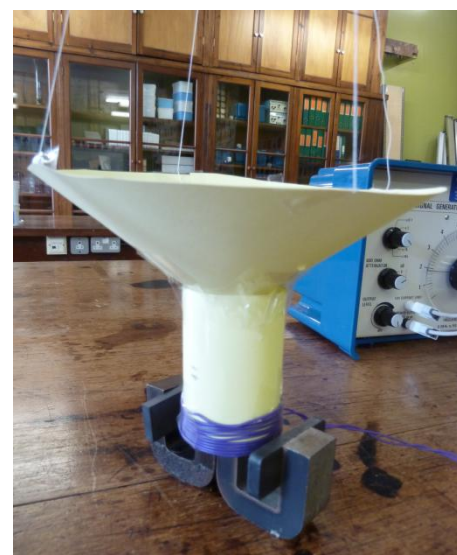
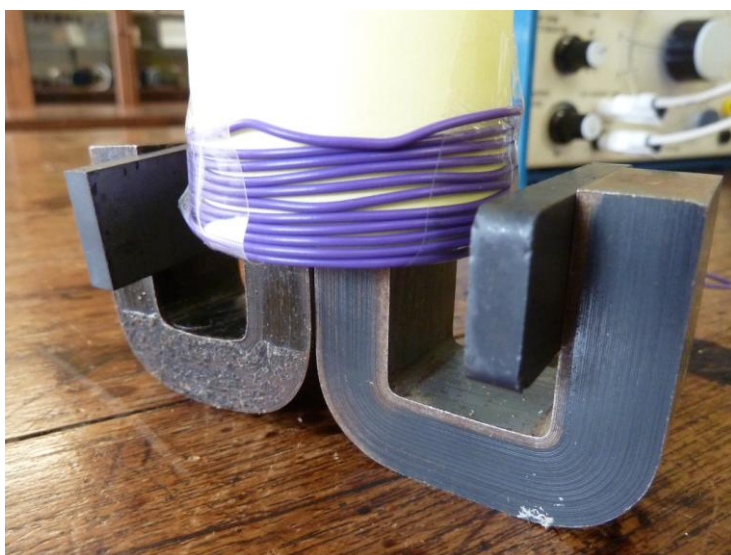




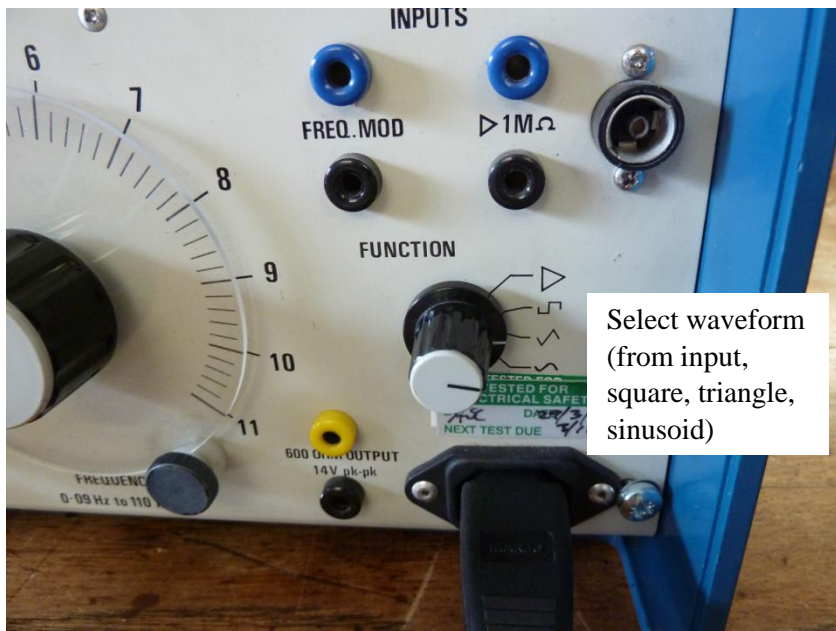
6. Using the metre rule, measure out 4 x 60cm of thread. Stick each at North, West, East, South positions (i.e. 90 degree separations) on the inner edge of the flared end of the cone.
7. Draw the four threads together by hand and hang from your fingers until there is equal tension and the loudspeaker hangs vertically. (Note the coiled cylinder faces downwards, the flared cone upwards). This may require some dexterity! Once achieved, use sticky tape to wrap round the top. If you are particular adept, you might even be able to make a loop above the tape to help hang the device from the retort stand....



8. Hang the system vertically from a retort stand. Set up the W shaped C-care and magnadur magnets (see diagram below) and gently lower the loudspeaker such that the coils overlap with the magnets. You will want about 5mm clearance between the bottom of the cylinder and the top of the iron cores. Make sure the loudspeaker hangs freely and is not touching the cores or magnets.



9. Wire up the terminal block to the signal generator and then plug this in. Gradually increase the current until you here a sound. Note low frequencies (less than 100Hz) will result in significant motion of the loudspeaker. This might be an opportunity to make a joke about enormous speakers installed in small cars by people who like wearing tracksuits. Higher frequencies (up to about 2000Hz) should make an audible whine.
10. If you have the additional connector, use the kit to attach an mp3 player. AC/DC's *Back in Black* is a recommended track. The speaker should jump to the drum beat.





Using the signal generator as an amplifier of a signal from an mp3 player

