

JUNIOR ENGINEERING PROJECTS

AEROGLIDE

The BMFA Aero Glide is a simple glider made from card and wood. It enables the pupils to understand the forces on an aircraft and the principles of flight. The practical effects of balance and the centre of gravity are introduced. Adjustable control surfaces enable the model to be optimised to obtain the best flights. It is an ideal project for a competition for the best flight. Only scissors, felt tip pens and glue are required for this project



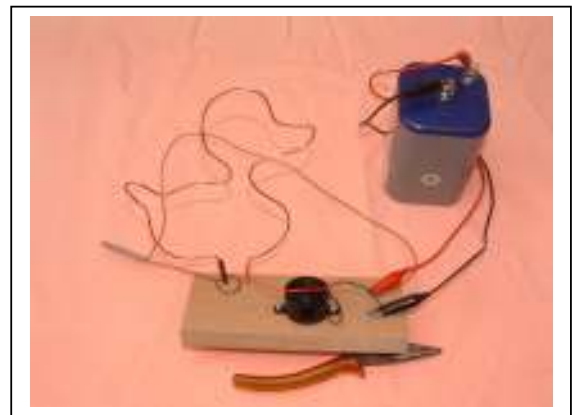
COMPASS

The construction of the Compass is simple, requiring no special tools and results in a workable instrument. The properties of magnets are demonstrated in a practical way. The pupils have to magnetise the compass needle and understand how to construct the points of the compass from first principles. The project can be developed into mapping an area using triangulation for the more advanced pupils.



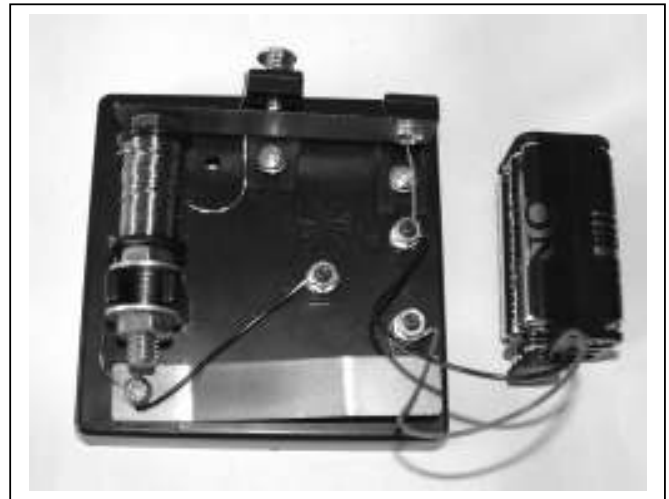
STEADY HAND GAME

The Steady Hand Game gives a "fun" way of making and understanding an electrical circuit. It is a popular project particularly before the School Fete where the children can use it as a "side show". The properties of conductors and insulators can be discussed and the usual warnings about the dangers of electricity can be reviewed. High voltages can give us a nasty shock but voltages less than about 10 are perfectly safe.



MORSE KEY AND BUZZER

The Morse key and Buzzer project introduces electromagnetism and circuits together with communication and codes. In this circuit, when the key is pressed, current flows through the coil and pulls the armature towards the coil. This causes it to leave contact with the pointed screw and so break the circuit, releasing the armature which then springs back to contact the pointed screw and make the circuit again. This “make and break” process is what generates the buzz. Samuel Morse was aware of the growing need to send messages quickly over 100s of miles, for example as railways developed across America. He heard about electromagnetism and realised this could be used for sending messages and developed his famous Morse code using long and short pulses in different combinations.



SLIDE RULES

Until quite recently –the 1960 s - the slide rule was the universal calculating tool used by engineers and many scientists but has been totally superseded by the electronic calculator. Slide rules have a number of advantages –they do not require electricity- their accuracy of about three significant figures is usually all that is required. However they have the great disadvantage that one has to work out the position of the decimal place, a nuisance and source of error. The explanation of how it works is most likely to be beyond the comprehension of most of the pupils but its use is certainly not. Several children have described it as “cool” when shown how to use it.



Slide rule for addition



Slide rule for multiplication

SOFT SOLDERING PRACTICE

Soft soldering is generally used to join two similar or different metals together where the strength of the joint is not very important. A low melting point leadless solder (less than 300degrees C) is used to make the joint and bridge the gap between the components. It is used extensively for making electrical connections.

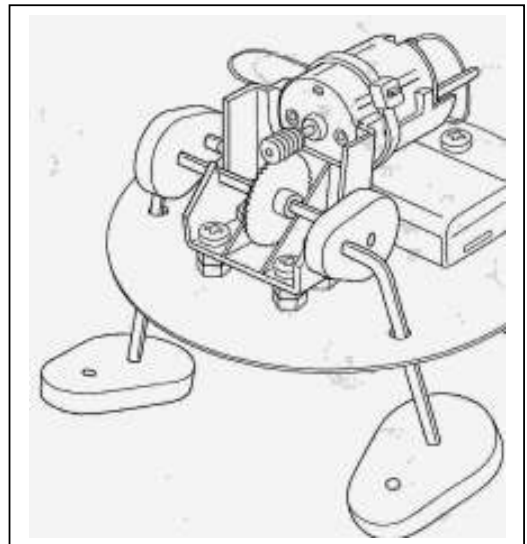
The surfaces to be joined have to be absolutely clean for the solder to bond and a flux, usually a resin, is used to keep the surfaces clean and dissolve any surface oxide which may develop whilst they are heated.

The pupils get practice soldering various shapes in copper wire – for the girls, a piece of ribbon is included which can be used to make the object into a pendant



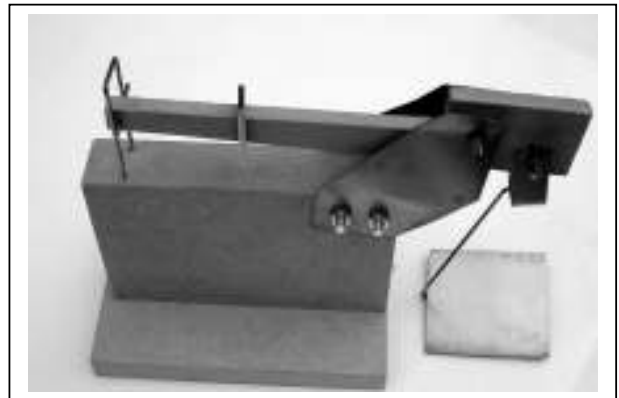
ROBOT DUCK

The battery-operated electric motor is of the DC type using permanent magnets enabling it to be reversed by changing the battery polarity. The children can experiment with this before the duck is assembled. The worm and wheel reduces the speed of the motor to that of the gearbox shaft. The gear ratio is equal to the number of teeth on the gearwheel divided by the number of threads or "starts" of the worm. The rotation of the shaft is converted to the "up and down" motion of the duck's legs with cranks (called cams in the instructions). The legs go through and pivot about the base-plate making the feet to rotate moving from side to side as well as up and down. The rotation of the feet causes the duck to "walk". It can walk "forwards" or "backwards" by changing the direction of rotation of the shaft.



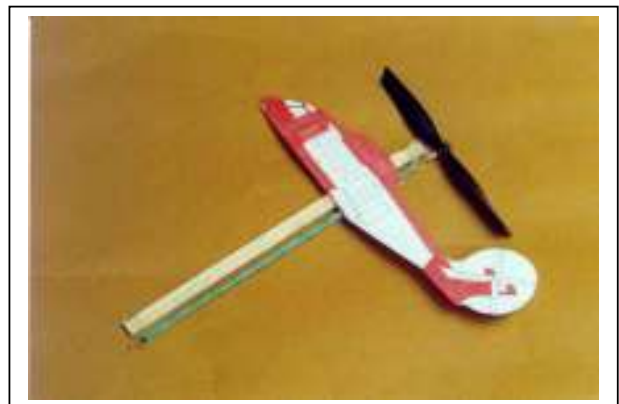
STEEL YARD BALANCE

Weighing machines either compare the weight of the object against a standard or measure its gravitational force. This balance is of the comparative type where the turning force of each arm of the beam exerts a bending force or moment which is in equilibrium when equal. The bending moment is the product of the force and distance to the pivot point. In a conventional balance the lengths of the arms are equal and so gives a direct comparison between the weights on the two arms. However we are making a comparative balance called a "steelyard" where the moment on one side of the pivot is adjusted to be equal to that of the other by moving a "jockey weight".



HELICOPTER

The forces on a helicopter are similar to a fixed wing aircraft but in this case the lift is provided by the rotor and opposes the weight of the craft. The rotor blades are like rotating wings generating lift but require power to drive them. The engine driving the rotor produces a turning force to rotate it causing an equal and opposite force on the helicopter fuselage. This is resisted by the thrust of the small propeller on its tail. By controlling this thrust the aircraft can remain stationary or rotate in either direction. In the case of the model, the reaction of the rotor is taken by the air resistance of the fuselage causing it to rotate but at a much slower speed than the rotor.



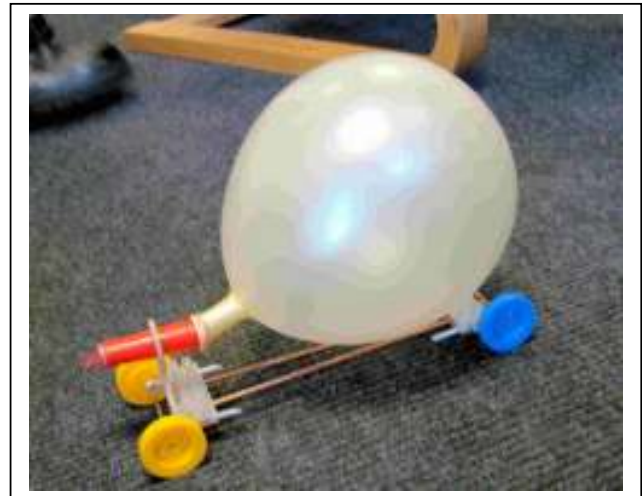
FUSE TESTER

This project introduces electrical current, voltage and resistance, circuits and diodes. It also introduces the practical use of printed circuit boards and the soldering of components to them. It explains how a diode is like a resistor but only works when the current flows in one direction. "Light emitting diodes" or LEDs are diodes which light up when passing a current. The parallel circuit shows how a larger current flows in the path of least resistance and if the fuse is good will pass a current lighting the green LED. A small current actually passes through the red LED but not sufficient to light it up. When a dud fuse is used then all the current flows through the red LED and nothing through the green.



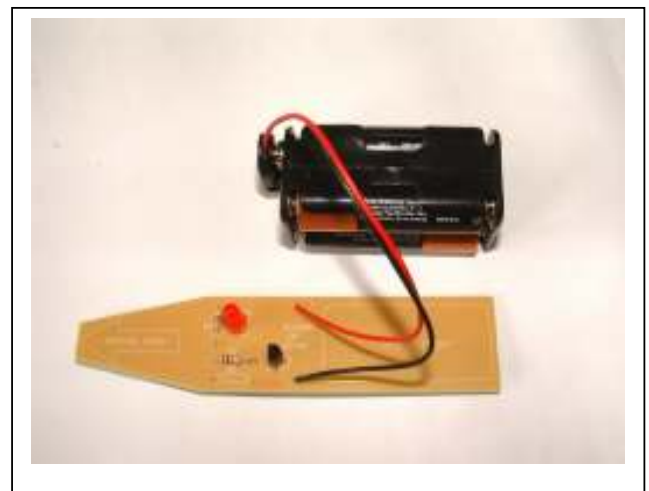
BLOODHOUND JET CAR

A team of British Engineers is attempting to raise the land speed record to 1000 miles per hour (or 1633 km per hour) in 2011. The car will be travelling faster than sound covering about four football pitches every second. This is a private venture sponsored by the MOD, The Royal Academy of Engineers and a number of firms and is aimed to inspire British schoolchildren to consider engineering as a career. The rocket is the first source of power and accelerates the car up to part speed after which the jet engine, which is much easier to control, provides that extra thrust to get the car to its top speed. In our model air is discharged from the balloon through the nozzle at the back of the car and, like the Bloodhound, it will only travel for a short distance.



MOISTURE TESTER

The Moisture Sensor measures the resistance between two electrodes and causes the LED to light if this falls below a fairly high value. It is sensitive enough to activate the LED if there is moisture between the electrodes and it can be used to show we have an electrical resistance in our own bodies especially if the contact points are dampened. It uses a transistor, a diode with an additional connection called the "Base" which controls it. The transistor is activated when a very small voltage at the "Base" causes it to pass current and light the LED and it is this function that is used in the project.



Notes

- 1) A term's kits are supplied at the beginning of each term. The projects may be carried out in any order but an order is suggested which allows the pupils to develop their skills with the tools gradually and follows a sequence in the understanding of the principles.
- 2) For logistic reasons it may be necessary to change the models supplied in the kit deliveries.
- 3) A Health and Safety session should be held between two of the early models but probably will not take as much time as one meeting. Reminders should be given before each session involving soldering.