Pathfinder Honour:
Trainer's Notes

Electricity

Instructions to Trainers / Instructors of this Honour

Thankyou for being involved with this Honour. These notes have been developed to assist in teaching / instructing this honour. We recognise that there is much more information available and we are grateful that you should share your expertise.

Please remember that Honours are designed to develop our Pathfinders in many ways; their interests, their knowledge and their relationship with their Saviour and Creator. Your enthusiasm and creativity will have a huge impact on those doing the honour.

To complete an Honour, the following (where applicable) must be completed satisfactorily:
- Physical and Practical Requirements.
- Honour Workbook.
- Honour Assessment Sheet. *(On SPD Honour Website but Leader's level access is required)*

Additional Reference Material

Any reference books on basic electricity principles

Acknowledgements

Wikibooks: http://en.wikibooks.org/wiki/Adventist_Youth_Honors_Answer_Book/Vocational/Electricity
This site provided much useful material for the updated layout of this honour, but be aware that material on any Wikibooks site is beyond the control of the SPD.

Please refer to the text of these notes for other acknowledgements.

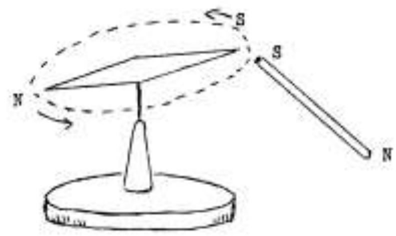
Electricity Honour

REQUIREMENT 1: Be able to explain and illustrate an experiment by which the laws of electrical attraction and repulsion are shown.

The history of the discovery of magnetism is interesting. In Asia Minor, Greeks first found an abundance of rock that had the power of attraction for iron filings and small pieces of rock fragments of the same material. This rock formation became known as the lodestone. It was a good many centuries before anyone in Europe noticed that the magnetic property of a lodestone was concentrated in two small spots near the ends. The discovery developed and today we have magnetised needles instead of lodestone. We call them magnetic compasses.

It was many years after people had known that magnets would attract things, before they learned that magnets sometimes repel things.

Let us take an illustration:
If we bring the south seeking or S-pole of a magnet near the S-pole of a suspended magnet, the poles repel each other. (See diagram) If we bring the two N-poles together, they also repel each other. But if we bring an N-pole towards the S-pole of the moving magnet, or an S-pole toward the N-pole, they attract each other.
In summary:
<u>Like poles repel</u> each other. <u>Unlike poles attract</u> each other.



Incidentally, experiments show that these attractive or repulsive forces between magnetic poles vary inversely as the square of the distance between the poles.

In 1820 Hans Christian Oersted of Denmark discovered that electric current passing through a wire created a magnetic field around the wire while the current was running. This is the basis on which electric motors and generators work.

REQUIREMENT 2: Explain the difference between a direct and an alternating current, and describe the uses to which each is adapted. Give a method of determining which kind flows in a given circuit.

Before we begin this explanation we need to understand some essential terms used in the study and application of electricity.

A simple illustration is water flowing in a pipe. **Amperes** (ie Amps) can be considered as the amount (ie volume) of water flowing in the pipe. **Volts** can be considered as the pressure of water. If we need more water, we can increase the pressure and use the same pipe. Alternatively, we can keep the same pressure, but use a larger diameter pipe.

Direct current (ie DC current) simply means ‘one way’ current. The electric current (ie the electrons) in a DC circuit only flows one way and its voltage is constant. Consider our pipe illustration. If the pipe is connected to a water tank, the water flows only in one direction. Batteries produce only DC current. One terminal is called the Positive terminal while the other is called the Negative terminal. For example, a ‘healthy’ car battery operates at a little over 12 Volts, while a D cell in your torch operates at about 1.5 volts.

Most electronic devices such as computers run on DC current. Also, DC current is used for refining metals such as aluminium. Huge amounts of electricity are used

Electricity Honour

An Alternating Current (ie AC current) changes its direction continuously. This is the electricity which usually powers our homes and factories. It is produced mechanically at the power station by rotating 'generators' which are driven by turbines. In Australia, the electricity in an average home is 240 volts AC at 50 Hertz. This means that the current changes direction 50 times each second; from positive 240 volts, to zero volts, to negative 240 volts, to zero volts and back to positive 240 volts. AC current can be transmitted long distances at very high voltages.

Determining which kind of electricity flows in a circuit

Electrical systems whose power supply is from a mains supply (they have a cord and plug).
The main systems (ie motors, transformers etc) will be AC current (240 Volts if in Australia).
NOTE: CHECKING OUT THESE SYSTEMS IS FOR TRAINED PROFESSIONALS ONLY. DO NOT FIDDLE.

Electrical systems whose power supply is from a battery.
These systems will be DC in practically all cases. Cheap multimeters are available with self-correcting electronics. For example; if the positive (ie red) probe of the instrument is placed on the 'negative' wire / terminal instead of the 'positive', a negative voltage will be displayed.

Alternatively, dip both bare wires into a jar containing saline (ie salt) solution. The wire generating the most bubbles is the negative wire of the circuit. The bubbles are hydrogen.

REQUIREMENT 3: Make a simple electromagnet or connect a bell or light with a battery using an in-line switch.

Electromagnets

An iron core, surrounded by a coil of wire, is called an electro-magnet. If it is made of soft iron, its magnetism can be controlled at will. Such an electro-magnet is a magnet only when current flows through its coil. When the current is stopped, the soft iron core loses almost all of its magnetism.

The strength of an electro-magnet depends on the product of the current (amperes) and the number of loops of wire (turns) of the coil (the ampere turns).

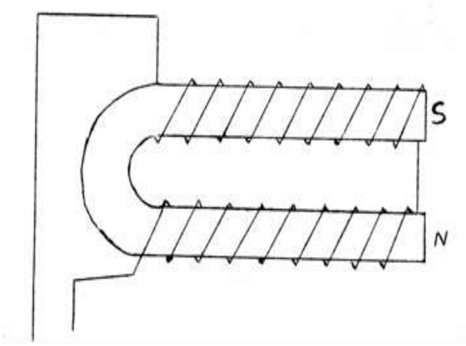


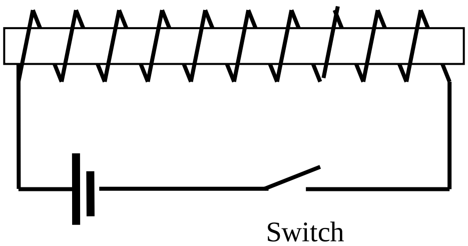
Diagram of an electro-magnet.

Constructing a Simple Electromagnet

Wrap a length of thin, insulated wire around a length of round, 'soft' steel. A large nail is OK, but it will tend to retain some magnetism when the current is switched off. Make each turn as close as possible to its adjoining neighbours.

Briefly connect to a small battery, say a 1.5 volt torch battery. DO NOT USE A LARGE BATTERY SUCH AS USED IN MOTOR VEHICLES. IT COULD OVERHEAT THE WIRES AND CREATE A BURNING HAZZARD.

You can install a switch or simulate a switch by disconnecting the battery.
The ends of the round steel become a magnet.

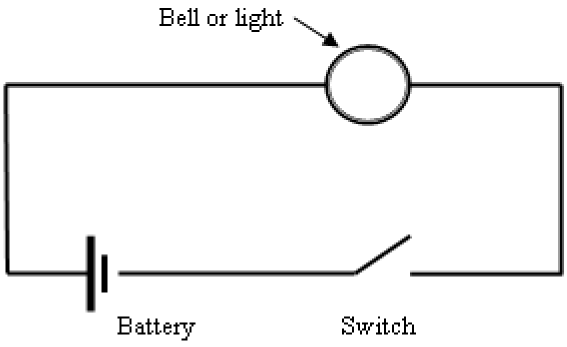


Schematic of a simple electromagnet

Electricity Honour

Connecting a bell or light with a battery using an in-line switch.

A simple circuit may be constructed as per the schematic diagram shown opposite.



REQUIREMENT 4: Make and run a simple electric motor from a kit or take apart an electric motor and identify the parts and explain how it works.

Small electric motors can be obtained from hobby / electronic stores. Even windscreen washer motors / pumps are relatively inexpensive from 'cheap' spare-parts stores and can be used to make excellent projects. In Australia, Dick Smith Electronics has a range of small, inexpensive motor / electronic kits: See: http://www.dicksmith.com.au/cgi-bin/dse.storefront/

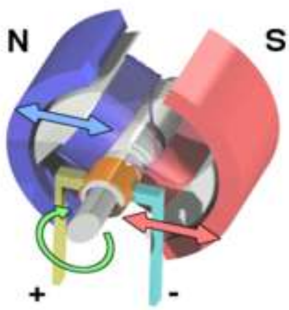
The following notes are based on: http://en.wikibooks.org/wiki/File:Electric_motor_cycle_2.png

The simple DC motor has a rotating armature in the form of an electromagnet with two poles. Attached to the armature is a 'rotating switch' called the commutator. It reverses the direction of the electric current twice every cycle, so that the poles of the electromagnet push and pull against the permanent magnets on the outside of the motor. As the poles of the armature electromagnet pass the poles of the permanent magnets, the commutator reverses the polarity of the armature electromagnet. During that instant of switching polarity, inertia keeps the simple motor going in the proper direction. (See the diagrams below.)

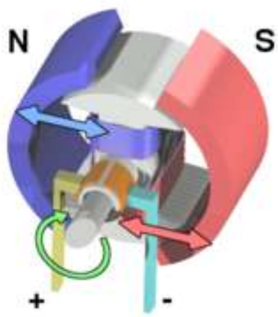
<u>Simple DC electric motor.</u>

When the blue coil on the armature is powered by an electric current, a 'north seeking' magnetic field is generated around the armature (ie the rotating part).

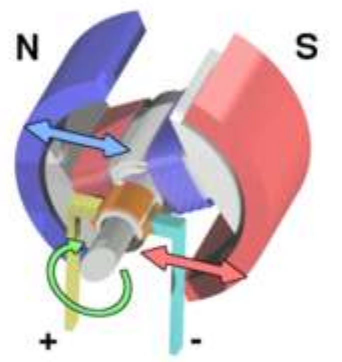
The left side of the armature is pushed away from the left magnet (which is also 'north seeking' and also coloured blue) towards the right, causing rotation in a clockwise direction..



The armature continues to rotate.



When the armature becomes horizontally aligned, the commutator reverses the direction of current through the coil, reversing the magnetic field. The process then repeats.



REQUIREMENT 5: Make a simple battery cell.
The diagram was developed by the authors. The following text is based on:
http://en.wikibooks.org/wiki/Adventist_Youth_Honors_Answer_Book/Vocational/Electricity

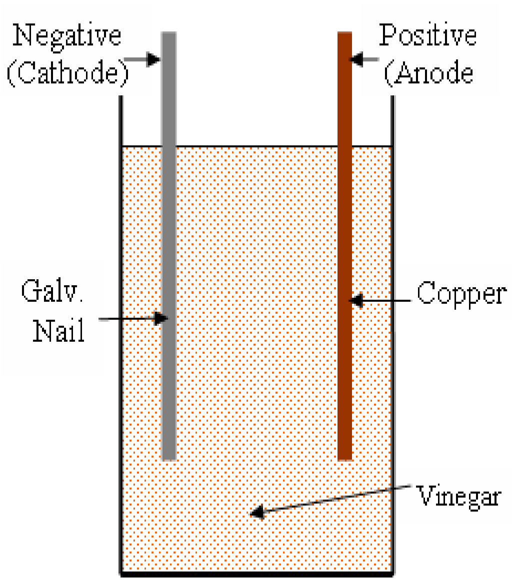
A battery cell can be made by placing a galvanised (zinc-plated) nail and a copper wire in a small container (glass or plastic jars are OK) filled with vinegar.

Do not let the zinc and copper terminals touch one another. They can be held apart by punching small holes in the container's lid and inserting them through these holes (Note that the lid must be made from plastic, not metal).

It might help to brighten the nail and the copper with sandpaper or emery cloth first. A cell constructed like this will generate about 0.8 volts. The copper wire will be the positive terminal (anode) and the zinc plated nail will be the negative terminal (cathode).

Connect multiple cells in series to form a battery and boost the voltage. When doing this, be sure to connect the positive terminal of one cell to the negative terminal of the other.

Connect multiple cells in parallel to boost the current capacity (necessary to light up a bulb). To do this, connect all the nails together with one wire and connect all the copper terminals together with another wire.



A Simple Battery

Electricity Honour

REQUIREMENT 6: Show how to splice electrical wires effectively.

Effective methods of splicing electrical wires are shown below.

Splicing Electrical Wires: Tee Joint

Correct

The wrap-around wire has been flattened to give a greater contact area

Incorrect

Reduced contact area creates greater resistance to the flow of electricity.

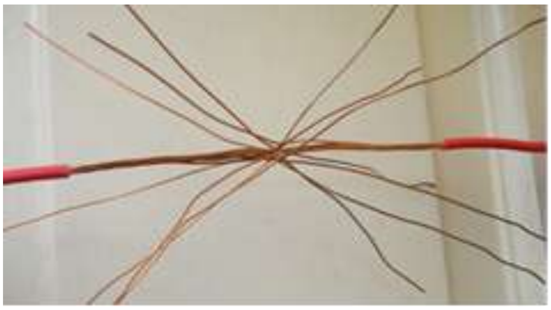
Splicing a Straight Joint

This method is used for joining wires. It is very strong.

Step 1

Strip the insulation and flare the strands of both wires.

Step 2



Cross over the strands and begin to wrap the strands around those of the opposite wire.

Step 3

Wrap successive strands tightly on each side of the joint. See detail of strand overlap on right.

Detail of strand overlap. The next wire covers the bent horizontal part, increasing the strength of the joint.

Step 4 The completed joint.

Electricity Honour

REQUIREMENT 7: Explain the use and application of electrical safety devices used to protect electrical systems and to reduce the risk of electrocution.

Electrical safety devices can be categorised into two broad groups:

Overload Protection

Fuses and circuit breakers are designed to protect electrical circuits from overload.

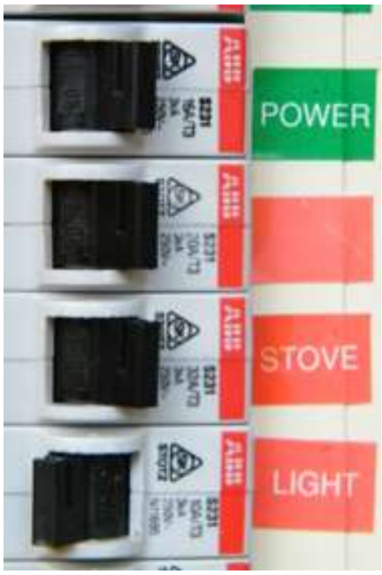
The current is shut off when the amount of current exceeds a preset limit.

A selection of three fuses used in motor vehicles is shown to the right. These fuses come in ratings from 5 Amps up to about 35 Amps The fuse material can be seen on the outside of the lowest fuse. When the rated current capacity is exceeded, the fuse material melts (ie 'blows') thus breaking the circuit.

With circuit breakers, excessive current 'trips' the circuit breaker and the current ceases to flow

It can be seen that the circuit breaker protecting the lighting circuit of the typical household circuit breakers has 'tripped' as the black switch toggle is to the left.

When a fuse 'blows' or circuit breaker 'trips' the first thing to do is to determine the cause.



Typical Circuit Breaker

Earth Leakage Devices

Earth Leakage Devices are designed to protect people from electrocution. They come in a variety of names: ELCBs (Earth Leakage Circuit-Breakers), RCDs (Residual Current Devices), GFIs (Ground Fault Interrupts), or CBRs (Core Balance Relays) to name a few.

In Australia, domestic current is at 240 Volts and, exposure to this by critical parts of the human body for even short periods of time, can be fatal.

Typical Earth Leakage Device

The basic principle of earth leakage devices is that current entering an electrical appliance (or tool etc) should be exactly the same as current leaving that appliance. If there is a fault – or someone touches some exposed part of the appliance – the circuit is broken. It only takes from about 10 to 100 milliamps for an earth leakage device to trip. This happens in a time of from 40 to 100 milliseconds from when a fault current is sensed.

Installation of these safety devices are not only strongly recommended, but are mandatory by many government authorities.

Electricity Honour

REQUIREMENT 8: Demonstrate the first things to do in the event of a person becoming insensible due to electric shock. This is before first aid or medical attention is administered.

Note to trainers of this honour.
Being proficient and up-to-date with First Aid is a complex issue in many countries. As the focus of this honour is on basic electricity knowledge, thorough knowledge of the 'first steps' (but not First Aid) is essential. Play-acting various scenarios is strongly recommended.

STEP 1. Appraise the Situation
Quickly appraise the situation calmly and methodically: what has happened; what are the dangers; what is the best way to get help etc etc. A quick prayer helps.

STEP 2. Control the Danger and Seek Help
In many situations, controlling the danger and seeking help happen at the same time.

If others are with you, send someone immediately to get help. If not, use your God-given voice to shout for help.

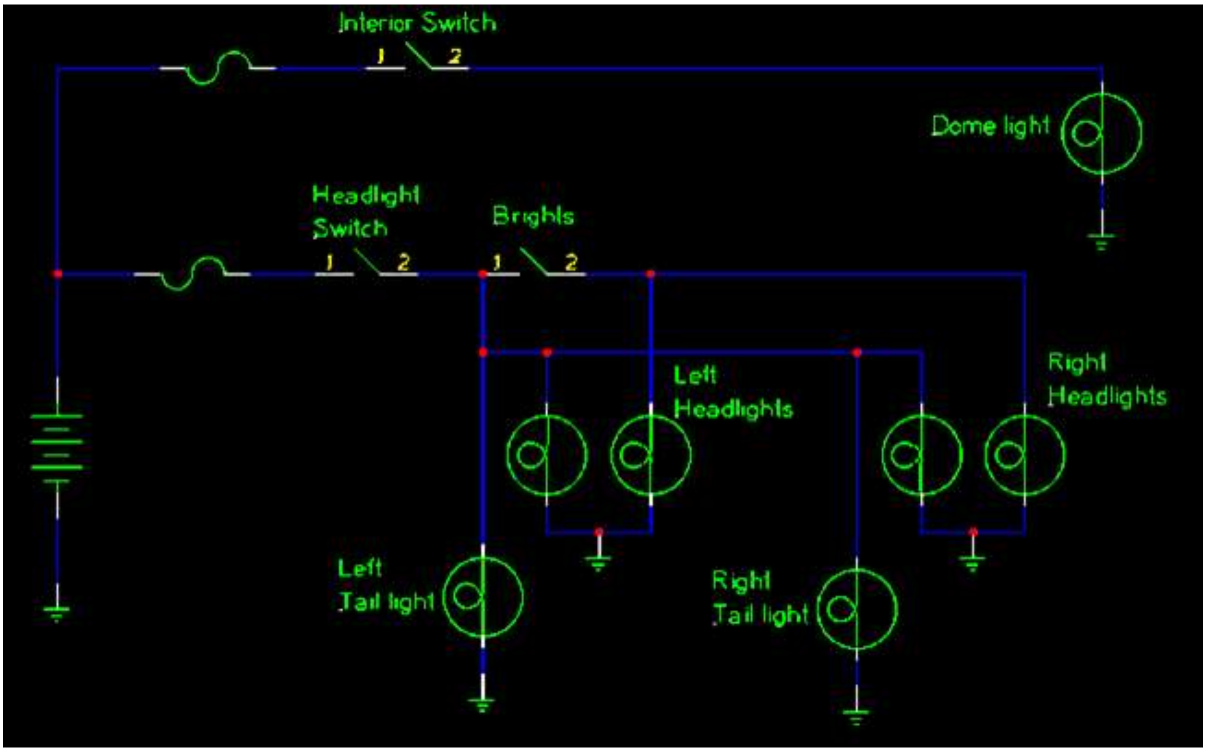
Controlling the danger depends on the situation. You don't want any more victims – yourself or passers-by. Don't touch the victim until you are certain the electricity is off. Keep people away from the danger area. If sensible, remove the danger of the electrical current. It may be as simple as switching off the current or pulling out a plug.

IMPORTANT: IF UNCERTAIN, CONTACT RESCUE SERVICES (OR COMPETENT PERSONS) IMMEDIATELY. DO NOT TAKE RISKS OF INJURY TO YOURSELF OR OTHERS.

For the next steps, please refer to recognised bodies such as St Johns, Red Cross etc

REQUIREMENT 9: Understand the main elements of a simplified diagram of a lighting system of an automobile.

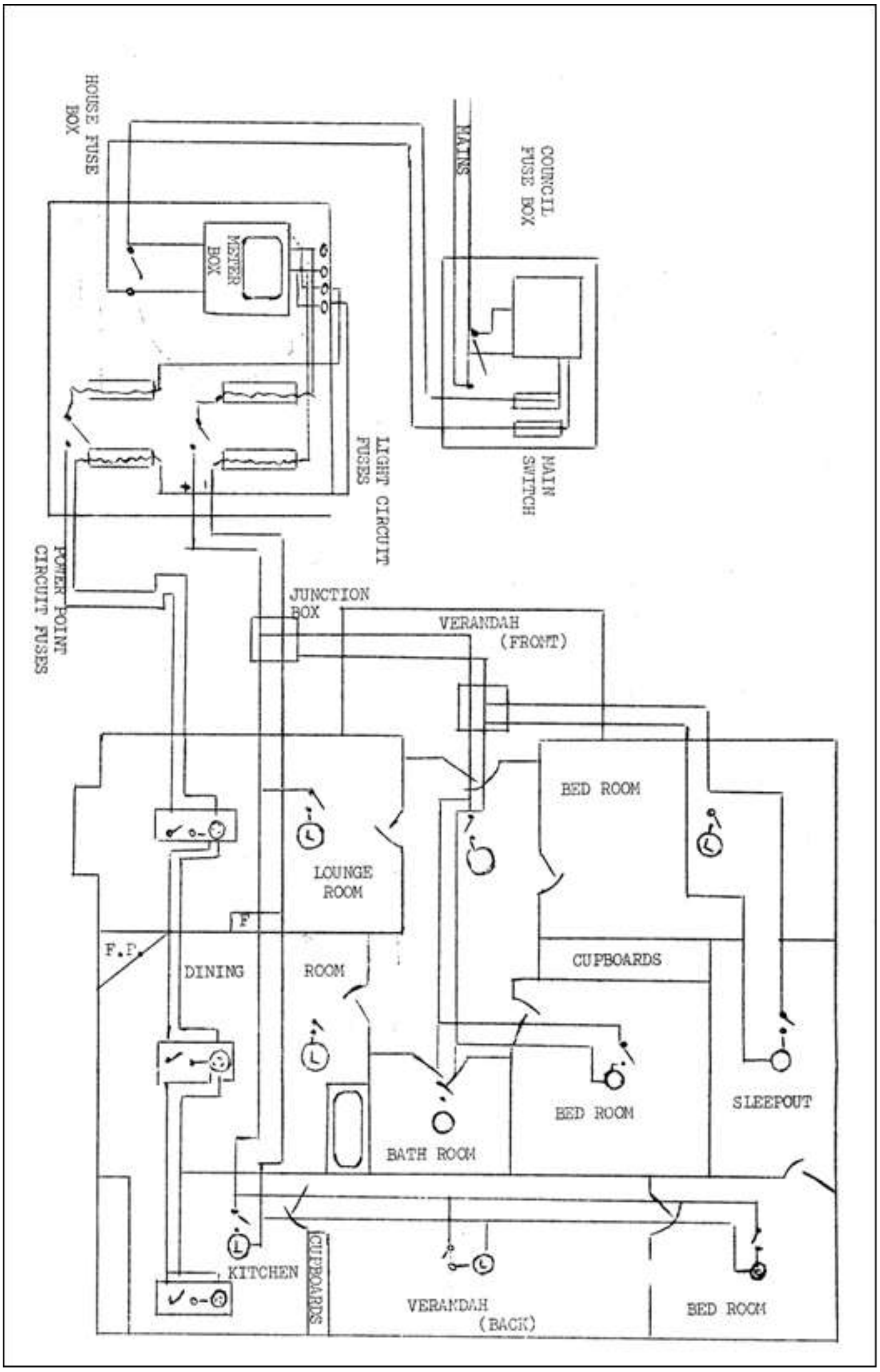
Source: http://en.wikibooks.org/wiki/Adventist_Youth_Honors_Answer_Book/Vocational/Electricity



Electricity Honour

REQUIREMENT 10: Understand the main elements of a simplified diagram showing the lights, switches, and convenience (ie power) outlets controlled by each fuse or circuit breaker in a house.

As this is a Level 2 honour, only an understanding of the functions of key elements is required – for example: circuits (light, power, stove, electric hot water etc), earthing, fuse/circuit breakers, typical locations of wiring, switches: Please see Electricity Honour Workbook.



Electricity Honour

REQUIREMENT 11: Discuss a typical residential electricity bill and comment on the various tariff levels, 'add-on costs' and any benefits or special deals. Verify the amount charged on an electricity bill.

Comment: The 'Read an electric meter correctly' component of the General Conference requirement is not required in the South Pacific Division due to the progressive installation of electronic electricity meters.

Trainers are asked to discuss a typical electricity account applicable to their area.