**Current, Voltage and Resistance**

Isn't electricity great. Mind you it's pretty bad news if the words don't mean anything to you...

1) **CURRENT** is the **flow of electrons** round the circuit.
2) **VOLTAGE** is the driving force that pushes the current round. Kind of like "electrical pressure".
3) **RESISTANCE** is anything in the circuit which **slows the flow down**.
4) **THERE'S A BALANCE**: the **voltage** is trying to **push** the current round the circuit, and the **resistance** is opposing it — the relative sizes of the voltage and resistance decide **how big** the current will be:

- If you increase the **VOLTAGE** — then **MORE CURRENT** will flow.
- If you increase the **RESISTANCE** — then **LESS CURRENT** will flow.

**It's Just Like the Flow of Water Around a Set of Pipes**

1) The **current** is simply like the **flow of water**.
2) **Voltage** is like the pressure provided by a **pump** which pushes the stuff round.
3) **Resistance** is any sort of **constriction** in the flow, which is what the pressure has to **work against**.
4) If you **turn up the pump** and provide more **pressure** (or "voltage"), the flow will **increase**.
5) If you put in more **constrictions** ("resistance"), the flow (current) will **decrease**.

**In Metals the Current is Carried by Electrons**

1) Electric current will only flow if there are **charges** which can **move freely**.
2) Metals contain a "sea" of free electrons (which are negatively charged) and which **flow throughout the metal**.
3) This is what allows **electric current** to flow so well **in all metals**.

**But Electrons Flow the Opposite Way to Conventional Current**

We normally say that current in a circuit flows from **positive to negative**. Also, electrons were discovered long after that was decided and they turned out to be **negatively charged** — unlucky. This means they actually flow from **−ve to +ve**, opposite to the flow of "conventional current".

**In Electrolytes, Current is Carried by Both +ve and −ve Charges**

1) **Electrolytes** are **liquids** which contain charges which can **move freely**.
2) They are either **ions** dissolved in water, like salt solution, or **molten ionic liquids**, like molten sodium chloride.
3) When a voltage is applied the **positive** charges move towards the **−ve**, and the **negative** charges move towards the **+ve**. This is an **electric current**.

**AC Changes Direction but DC Doesn't**

- **Direct current** keeps flowing in the same direction all the time.
- The **CRO trace** is a horizontal line.
- **Alternating current** keeps reversing its direction back and forth.
- The **CRO trace** is always a wave.

You need to **learn** these CRO traces — I've not put them in cos they're pretty.

**Understanding currents — easy as pie...**

This page is all about electric current — what it is, what makes it move, and what tries to stop it. This is the most basic stuff on electricity there is. You realise that you'll never be able to learn anything else about electricity until you know this stuff — don't you? Just checking.

---

Section One — Electricity and Magnetism
The Standard Test Circuit

This is without doubt the most totally bog-standard circuit the world has ever known. So know it.

The Ammeter
1) Measures the current (in Amperes) flowing through the component.
2) Must be placed in series.
3) Can be put anywhere in series in the main circuit, but never in parallel like the voltmeter.

The Voltmeter
1) Measures the voltage (in Volts) across the component.
2) Must be placed in parallel around the component under test — NOT around the variable resistor or the battery!
3) The proper name for "voltage" is "potential difference" or "p.d."

Five Important Points
1) This very basic circuit is used for testing components, and for getting V-I graphs for them.
2) The component, the ammeter and the variable resistor are all in series, which means they can be put in any order in the main circuit. The voltmeter, on the other hand, can only be placed in parallel around the component under test, as shown. Anywhere else is a definite no-no.
3) As you vary the variable resistor it alters the current flowing through the circuit.
4) This allows you to take several pairs of readings from the ammeter and voltmeter.
5) You can then plot these values for current and voltage on a V-I graph, like the ones below.

Four Hideously Important Voltage-Current Graphs

V-I graphs show how the current varies as you change the voltage. Learn these four real well:

Resistor
The current through a resistor (at constant temperature) is proportional to voltage.

Different Wires
Different wires have different resistances, hence the different slopes.

Filament Lamp
As the temperature of the filament increases, the resistance increases, hence the curve.

Diode
Current will only flow through a diode in one direction, as shown.

Calculating Resistance: \( R = \frac{V}{I} \) (or \( R = \frac{1}{\text{gradient}} \))

For the straight-line graphs the resistance of the component is steady and is equal to the inverse of the gradient of the line, or \( 1/\text{gradient} \). In other words, the steeper the graph, the lower the resistance.

If the graph curves, it means the resistance is changing. In that case R can be found for any point by taking the pair of values \((V, I)\) from the graph and sticking them in the formula \( R = \frac{V}{I} \) (See P.B). Easy.

In the end, you'll have to learn this — resistance is futile...

There are quite a lot of important details on this page and you need to learn all of them.

The only way to make sure you really know it is to cover up the page and see how much of it you can scribble down from memory. Sure, it's not that easy — but it's the only way. Enjoy.
Circuit Symbols and Devices

You have to know all these circuit symbols for the Exam.

Circuit Symbols You Should Know:

**CELL**

**BATTERY**

**POWER SUPPLY**

**SWITCH OPEN**

**SWITCH CLOSED**

**FILAMENT LAMP**

**FIXED RESISTOR**

**VARIABLE RESISTOR**

**AMMETER**

**VOLTmeter**

**DIODE**

**FUSE**

**LDR**

**THERMISTOR**

**LED**

**MOTOR**

**HEATER**

**LOUDSPEAKER**

1) **Variable Resistor**

1) A resistor whose resistance can be changed by twiddling a knob or something.
2) The old-fashioned ones are huge coils of wire with a slider on them.
3) They're great for altering the current flowing through a circuit.
   - Turn the resistance up, the current drops. Turn the resistance down, the current goes up.

2) **"Semiconductor Diode" or just "Diode"**

A special device made from semiconductor material such as silicon. It lets current flow freely through it in one direction, but not in the other (i.e. there's a very high resistance in the reverse direction). This turns out to be real useful in various electronic circuits.

3) **Light Emitting Diode or "LED" to you**

1) A diode which gives out light. It only lets current go through in one direction.
2) When it does pass current, it gives out a pretty red or green or yellow light.
3) Stereos usually have lots of jolly little LEDs which light up as the music's playing.

4) **Light Dependent Resistor or "LDR" to you**

1) In bright light, the resistance falls.
2) In darkness, the resistance is highest.
3) This makes it a useful device for various electronic circuits, e.g., automatic night lights; burglar detectors.

5) **Thermistor (Temperature-dependent Resistor)**

1) In hot conditions, the resistance drops.
2) In cool conditions, the resistance goes up.
3) Thermistors make useful temperature detectors, e.g., car engine temperature sensors and electronic thermostats for central heating.

"Diode" — wasn't that a film starring Bruce Willis...

Another page of basic but important details about electrical circuits. You need to know all those circuit symbols as well as the extra details for the five special devices. When you think you know it all try covering the page and scribbling it all down. See how you did, and then try again.

---

Section One — Electricity and Magnetism
Series Circuits

You need to be able to tell the difference between series and parallel circuits just by looking at them. You also need to know the rules about what happens with both types. Read on.

Series Circuits — all or nothing

1) In series circuits, the different components are connected in a line, end to end, between the +ve and -ve of the power supply (except for voltmeters, which are always connected in parallel, but they don't count as part of the circuit).
2) If you remove or disconnect one component, the circuit is broken and they all stop.
3) This is generally not very handy, and in practice, very few things are connected in series.

In Series Circuits:

1) The total resistance is just the sum of all the resistances.
2) The same current flows through all parts of the circuit.
3) The size of the current is determined by the total p.d. of the cells and the total resistance of the circuit: i.e. \( I = \frac{V}{R} \).
4) The total p.d. of the supply is shared between the various components, so the voltages round a series circuit always add up to equal the total voltage of the supply.
5) The bigger the resistance of a component, the bigger its share of the total p.d.

Total p.d., Voltmeters and Ammeters

1) The total p.d. provided by cells in series is the sum of the individual p.d.s.
2) Voltmeters are always connected in parallel around components.
   In a series circuit, you can put voltmeters around each component. The readings from all the components will add up to equal the reading from the voltage source (the cells). Simple.
3) Ammeters can be placed anywhere in a series circuit and will all give the same reading.

Christmas Fairy Lights are Wired in Series

Christmas fairy lights are about the only real-life example of things connected in series, and we all know what a pain they are when the whole lot go out just because one of the bulbs is slightly dodgy.

The only advantage is that the bulbs can be very small because the total 230V is shared out between them, so each bulb only has a small voltage across it.

By contrast, a string of lights as used on a building site are connected in parallel so that each bulb receives the full 230V. If one is removed, the rest stay lit. Which is most convenient.

Make sure you know the difference between these two wiring diagrams.

Series Circuits — phew, it's just one thing after another...

They really do want you to know the difference between series and parallel circuits.

It's not that tricky but you do have to make a real effort to learn all the details. That's what this page is for. Learn all those details, then cover the page and scribble them all down. Then try again...

Section One — Electricity and Magnetism
Parallel Circuits

Parallel circuits are much more sensible than series circuits and so they're much more common in real life.

**Parallel Circuits — Independence and Isolation**

1) In parallel circuits, each component is separately connected to the +ve and -ve of the supply.
2) If you remove or disconnect one of them, it will hardly affect the others at all.
3) This is obviously how most things must be connected, for example in cars and in household electrics.
   You have to be able to switch everything on and off separately.

**In Parallel Circuits:**

1) All components get the full source p.d., so the voltage is the same across all components.
2) The current through each component depends on its resistance. The lower the resistance, the bigger the current that'll flow through it.
3) The total current flowing around the circuit is equal to the total of all the currents in the separate branches.
4) In a parallel circuit, there are junctions where the current either splits or rejoins. The total current going into a junction always equals the total currents leaving — fairly obviously.
5) The total resistance of the circuit is tricky to work out, but it's always less than the branch with the smallest resistance.

Volts all equal to supply voltage: = 6V
Total R is less than the smallest, i.e. less than 2 W
Total Current ($I_t$) = sum of all branches = $I_2 + I_3 + I_4$

**Connection of Voltmeters and Ammeters**

1) Once again the voltmeters are always connected in parallel around components.
2) Ammeters can be placed in each branch to measure the different currents flowing through each branch, as well as one near the supply to measure the total current flowing out of it.

**Everything Electrical in a Car is Connected in Paralle!**

Parallel connection is essential in a car to give these two features:

1) Everything can be turned on and off separately.
2) Everything always gets the full voltage from the battery.

The only slight effect is that when you turn lots of things on, the lights may go dim because the battery can't provide full voltage under heavy load. This is normally a very slight effect. You can spot the same thing at home when you turn a kettle on, if you watch very carefully.

**Electric Circuits — unparalleled dreariness...**

Make sure you can scribble down a parallel circuit and know what the advantages are. Learn the five numbered points and the details for connecting ammeters and voltmeters, and also what two features make parallel connection essential in a car. Then cover the page and scribble it...
Static Electricity

Static electricity is all about charges which are not free to move. This causes them to build up in one place and it often ends with a spark or a shock when they do finally move.

1) Build up of Static is Caused by Friction

1) When two insulating materials are rubbed together, electrons will be scraped off one and dumped on the other.

2) This'll leave a positive static charge on one and a negative static charge on the other.

3) Which way the electrons are transferred depends on the two materials involved.

4) The classic examples are polythene and acetate rods being rubbed with a cloth duster, as shown in the diagrams:

With the polythene rod, electrons move from the duster to the rod.

With the acetate rod, electrons move from the rod to the duster.

2) Only Electrons Move — Never the Positive Charges

Watch out for this in Exams. Both +ve and -ve electrostatic charges are only ever produced by the movement of electrons. The positive charges definitely do not move! A positive static charge is always caused by electrons moving away elsewhere, as shown above. Don't forget!

3) Like Charges Repel, Opposite Charges Attract

This is easy and, I'd have thought, kind of obvious. Two things with opposite electric charges are attracted to each other. Two things with the same electric charge will repel each other. These forces get weaker the further apart the two things are — pretty obviously.

4) Charging by Induction is a bit Tricky

When something which is charged comes near something which isn't, it tends to induce charge, because electrons in the uncharged object move towards or away from the charged object. The result is always the same — the new arrangement of charge always makes the two objects pull together because the repelling charges are now further apart than the attracting charges. It's tricky, but you can understand it — and you can learn it.

5) As Charge Builds Up, So Does the Voltage — Causing Sparks

The greater the charge on an isolated object, the greater the voltage between it and the Earth. If the voltage gets big enough there's a spark which jumps across the gap. High voltage cables can be dangerous for this reason. Big sparks have been known to leap from overhead cables to earth. But not often.

A charged conductor can be discharged safely by connecting it to earth with a metal strap.

Phew — It's enough to make your hair stand on end...

The way to tackle this page is to first learn the five headings till you can scribble them all down. Then learn the details for each one, and keep practising by covering the page and scribbling down each heading with as many details as you can remember for each one. Just keep trying...
Static Electricity — Examples

They like asking you to give quite detailed examples in Exams. Make sure you learn all these details.

Static Electricity Being Helpful:

1) Inkjet Printer:
1) Tiny droplets of ink are forced out of a fine nozzle, making them electrically charged.
2) The droplets are deflected as they pass between two metal plates. A voltage is applied to the plates — one is negative and the other is positive.
3) The droplets are attracted to the plate of the opposite charge and repelled from the plate with the same charge.
4) The size and direction of the voltage across each plate changes so each droplet is deflected to hit a different place on the paper.
5) Loads of tiny dots make up your printout. Clever.

2) Photocopier:
1) The metal plate is electrically charged. An image of what you're copying is projected onto it.
2) Whiter bits of the thing you're copying make light fall on the plate and the charge leaks away.
3) The charged bits attract black powder, which is transferred onto paper.
4) The paper is heated so the powder sticks.
5) Voilà, a photocopy of your piece of paper (or whatever else you've shoved in there).

3) Spray Painting and Dust Removal in Chimneys...

These are other uses but photocopiers and inkjet printers are what they really want you to learn.

Static Electricity Being a Little Joker:

1) Car Shocks
Air rushing past your car can give it a +ve charge. When you get out and touch the door it gives you a real buzz — in the Exam make sure you say "electrons flow from earth, through you, to neutralise the +ve charge on the car." Some cars have conducting rubber strips which hang down behind the car. This gives a safe discharge to earth, but spoils all the fun.

2) Clothing Crackles
When synthetic clothes are dragged over each other (like in a tumble dryer) or over your head, electrons get scraped off, leaving static charges on both parts, and that leads to the inevitable — attraction (they stick together) and little sparks / shocks as the charges rearrange themselves.

Static Electricity Playing at Terrorist:

1) Lightning
Rain droplets fall to Earth with positive charge. This creates a huge voltage and a big spark.

2) Grain Chutes, Paper Rollers and The Fuel Filling Nightmare:
1) As fuel flows out of a filler pipe, or paper drags over rollers, or grain shoots out of pipes, then static can build up.
2) This can easily lead to a spark and in dusty or fumey places — BOOM!
3) The solution: make the nozzles or rollers out of metal so that the charge is conducted away, instead of building up.
4) It's also good to have earthing straps between the fuel tank and the fuel pipe.

Static Electricity — learn the shocking truth...
You really need to learn those two big examples at the top. All the exam boards mention photocopiers and inkjet printers so I bet there'll be a question on them. Crumbs, it's almost relevant to real-life too. Learn the numbered points and keep scribbling them down to check.

Section One — Electricity and Magnetism
## Symbols, Units and Formulas

This is all very basic stuff and you need to learn it all pretty thoroughly. If you don’t, and you then try and do other Physics, it’s like trying to write stories without learning the alphabet first. So as long as this is all just a load of weird symbols and nonsense to you then you won’t find Physics very easy at all. This is the Physics alphabet and without it you’re… in trouble.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Symbol</th>
<th>Standard Units</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Potential Difference</td>
<td>V</td>
<td>Volts, V</td>
<td>V = I×R</td>
</tr>
<tr>
<td>2 Current</td>
<td>I</td>
<td>Amperes, A</td>
<td>I = V / R</td>
</tr>
<tr>
<td>3 Resistance</td>
<td>R</td>
<td>Ohms, Ω</td>
<td>R = V / I</td>
</tr>
<tr>
<td>4 Charge</td>
<td>Q</td>
<td>Coulombs, C</td>
<td>Q = I×t</td>
</tr>
<tr>
<td>5 Power</td>
<td>P</td>
<td>Watts, W</td>
<td>P = V×t or P = I^2 R</td>
</tr>
<tr>
<td>6 Energy</td>
<td>E</td>
<td>Joules, J</td>
<td>E = Q×t or V = E / Q</td>
</tr>
<tr>
<td>7 Time</td>
<td>t</td>
<td>Seconds, s</td>
<td>E = P×t or E = IVt</td>
</tr>
<tr>
<td>8 Force</td>
<td>F</td>
<td>Newtons, N</td>
<td>F = ma</td>
</tr>
<tr>
<td>9 Mass</td>
<td>m</td>
<td>Kilograms, kg</td>
<td>W = mg</td>
</tr>
<tr>
<td>10 Weight (a force)</td>
<td>W</td>
<td>Newtons, N</td>
<td>D = m/V</td>
</tr>
<tr>
<td>11 Density</td>
<td>D</td>
<td>kg per m^3, kg/m^3</td>
<td>M = F×t</td>
</tr>
<tr>
<td>12 Moment</td>
<td>M</td>
<td>Newton-metres, Nm</td>
<td>s = d / t</td>
</tr>
<tr>
<td>13 Velocity or Speed</td>
<td>v or s</td>
<td>metres/sec, m/s</td>
<td>a = Δv / t or a = F / m</td>
</tr>
<tr>
<td>14 Acceleration</td>
<td>a</td>
<td>metres/sec^2, m/s^2</td>
<td>P = F / A</td>
</tr>
<tr>
<td>15 Pressure</td>
<td>P</td>
<td>Pascals, Pa (N/m^2)</td>
<td>P = F / A</td>
</tr>
<tr>
<td>16 Area</td>
<td>A</td>
<td>metres^2, m^2</td>
<td>P_1V_1 = P_2V_2</td>
</tr>
<tr>
<td>17 Volume</td>
<td>V</td>
<td>metres^3, m^3</td>
<td>f = 1 / T (T=time period)</td>
</tr>
<tr>
<td>18 Frequency</td>
<td>f</td>
<td>Hertz, Hz</td>
<td>v = f×λ (wave formula)</td>
</tr>
<tr>
<td>19 Wavelength (a distance)</td>
<td>λ or d</td>
<td>metres, m</td>
<td>Wd = F×d</td>
</tr>
<tr>
<td>20 Work done</td>
<td>Wd</td>
<td>Joules, J</td>
<td>P = Wd / t</td>
</tr>
<tr>
<td>21 Power</td>
<td>P</td>
<td>Watts, W</td>
<td>PE = m×g×h</td>
</tr>
<tr>
<td>22 Potential Energy</td>
<td>PE</td>
<td>Joules, J</td>
<td>KE = ½mv^2</td>
</tr>
<tr>
<td>23 Kinetic Energy</td>
<td>KE</td>
<td>Joules, J</td>
<td></td>
</tr>
</tbody>
</table>

There’s also **efficiency**, which has no units:  

Efficiency = Useful work output  
Total energy input

And also the **transformer equation**:  

Primary Coil Voltage = No. of turns on Primary Coil  
Secondary Voltage = No. of turns on Secondary

---

**Physics — isn’t it just wonderful…**

Your task is simplicity itself. Leave the "Quantity" column exposed and cover up the other three. Then simply fill in the three columns for each quantity: "Symbol", "Units", "Formula". And just keep practising and practising till you can do it all. This really is so important. So do it.

---

Section One — Electricity and Magnetism
Using Formulas

**Always the Same Old Routine**
The thing about using formulas in Physics is that it's always the same old routine. Once you've learnt how to do it for one formula, you can do it for any other. And that makes the whole thing really simple — but there's still a lot of people out there who seem to make a real meal of it. Let's take it nice and slowly...

**Formula Triangles are Pretty Useful for Getting it Right**
All the formulas on the opposite page (except "\( P = V_1(I_2) \)" can be put into formula triangles. It's pretty important to learn how to put any formula into a triangle. There are two easy rules:

1. If the formula is "A = B × C" then A goes on the top and B × C goes on the bottom.
2. If the formula is "A = B/C" then B must go on the top (because that's the only way it'll give "B divided by something") — and so pretty obviously A and C must go on the bottom.

**Three Examples:**

\[ V = I \times R \]
\[ P = I^2 \times R \]
\[ V = E/Q \]

How to use them: Cover up the thing you want to find and write down what's left showing.

**EXAMPLE:** To find Q from the last one, cover up E and you get V left showing, so "Q = E/V".

**Using Formulas — The Three Rules**

1. Find a formula which contains the thing you want to find together with the other things which you've got values for. Convert that formula into a formula triangle.
2. Stick the numbers in and work out the answer.
3. Think very carefully about all the units — and check that the answer is sensible.

**EXAMPLE:** A hairdresser is rated at 700 W and draws a current of 3 A. Find its resistance.

**ANSWER:** The three quantities mentioned are power (700 W), current (3 A) and resistance.

1. The formula with these three in is "\( P = I^2 \times R \)" and the formula triangle version gives us \( R = P / I^2 \)
2. Sticking the numbers in: \( R = 700/9 = 77.78 = 78 \) Ω
3. The power and current are already in their proper units of Watts and Amps, so that's OK.
   The answer for R must be given in its proper units too, namely Ω, which we've done.
   The value of 78 Ω is fine. If it was 1,000,000 W or 0.000034 W you'd worry and check it.

**Watch out For the Units**

Once you've got the hang of formula triangles there's only one thing left to get wrong — units. There's two things about units that you have to really watch out for:

1. Make sure that the numbers you put in to the formula are in standard (SI) units.
2. When you write the answer down, make sure your answer has its proper units.

**IMPORTANT EXAMPLES:** 500 g must be turned into 0.5 kg, 2 minutes into 120 seconds, 700 kJ into 700,000 J, 145 cm into 1.45 m, etc. before putting them into a formula. If you don't put SI units in then the answer won't come out with SI units, which can get tricky unless you know what you're doing.

**Formulas — aren't they just fabulous...**
Physics formulas are amazingly repetitive. You really must get it into your head that they're basically all the same. This page has the simple rules that would allow anyone to work out the answers without really knowing anything about Physics at all. It's easy peasy, surely it is.
The Cost of Domestic Electricity

Electricity is by far the most useful form of energy. Compared to gas or oil or coal etc. it's much easier to turn it into the four main types of useful energy: Heat, light, sound and motion.

Reading Your Electricity Meter and Working out the Bill

Yip, this is in the syllabus. Don't ask me why, because you never actually need to bother in real life.

The reading on your meter shows the total number of units (kWh) used since the meter was fitted. Each bill is worked out from the increase in the meter reading since it was last read for the previous bill.

You need to study this bill until you know what all the different bits are for, and how it all works out. They could give you one very similar in the Exam.

Kilowatt-hours (kWh) are "UNITS" of Energy

1) Your electricity meter counts the number of "UNITS" used.
2) A "UNIT" is otherwise known as a kilowatt-hour, or kWh.
3) A "kWh" might sound like a unit of power, but it's not — it's an amount of energy.

A KILOWATT-HOUR is the amount of electrical energy used by a 1 kW appliance left on for 1 HOUR.

4) Make sure you can turn 1 kWh into 3,600,000 joules like this:

\[ E = P \times t = 1 kW \times 1 \text{ hour} = 1000W \times 3600 \text{ secs} = 3,600,000 \text{ J} \] (=3.6 MJ)

(The formula is "Energy = Power \times time", and the units must be converted to SI first. See P8 and P9)

The Two Easy Formulae for Calculating The Cost of Electricity

These must surely be the two most trivial and obvious formulas you'll ever see:

No. of UNITS (kWh) used = POWER (in kW) \times TIME (in hours)

\[
\text{COST} = \text{No. of UNITS} \times \text{PRICE per UNIT}
\]

EXAMPLE: Find the cost of leaving a 60 W light bulb on for a) 30 minutes  b) one year.

ANSWER: a) No. of Units = kW \times hours = 0.06kW \times \frac{1}{2} \text{hr} = 0.03 \text{ units}.
Cost = Units \times price per unit(6.3p) = 0.03 \times 6.3p = 0.189p for 30 mins.

b) No. of Units = kW \times hours = 0.06kW \times (24 \times 365) \text{hr} = 525.6 \text{ units}.

Cost = Units \times price per unit(6.3p) = 525.6 \times 6.3p = £33.11 for one year.

N.B. Always turn the power into kW (not Watts) and the time into hours (not minutes)

Kilowa Towers — the Best Lit Hotel in Hawaii...

This page has three sections and you need to learn the stuff in all of them. Start by memorising the headings, then learn the details under each heading. Then cover the page and scribble down what you know. Check back and see what you missed, and then try again. And keep trying.