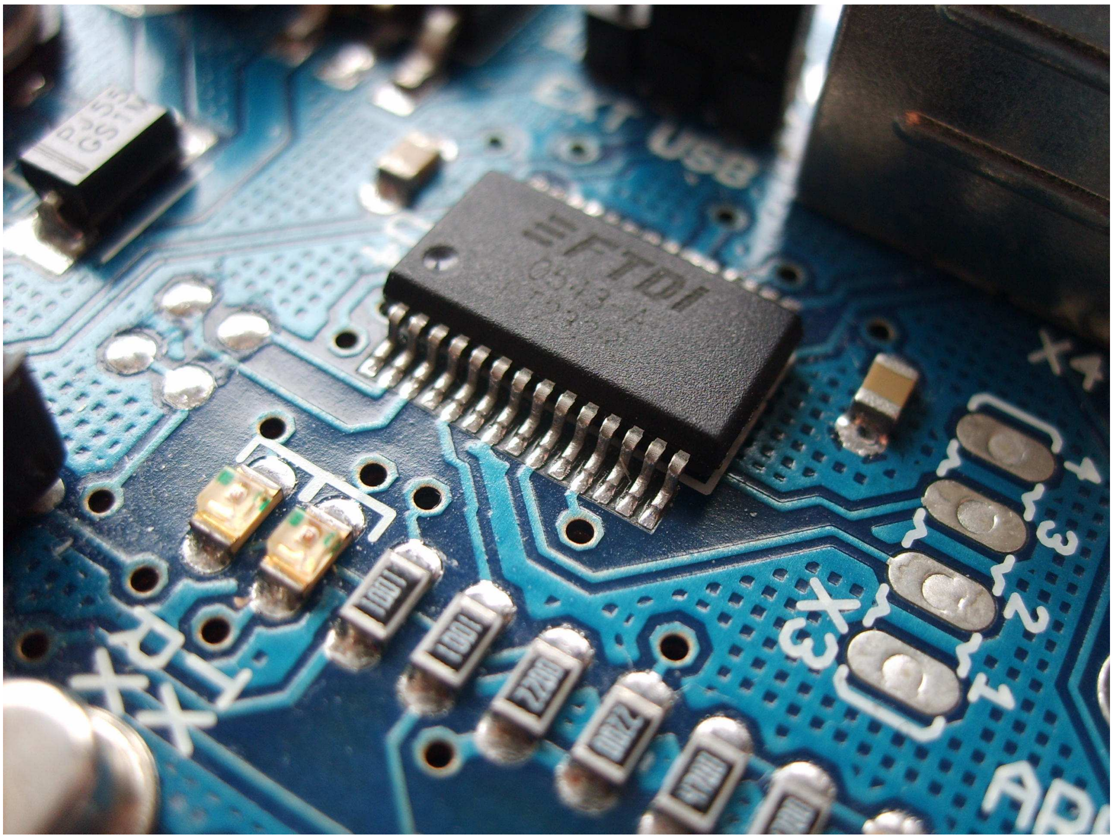
ENGINEERING SCIENCE

# Electronic Components




Name ____________________

Class ____________________

Teacher ____________________

FAMAM EXTENDITE FACTIS

Ellon Academy
Technical Faculty

# Learning Intentions

- To know what an analogue component is
- To know how to properly draw a circuit diagram using the proper symbols
- To know about the basic concepts of current, voltage and resistance
- To investigate simple series circuits
- To investigate parallel circuits
- To learn about symbols in circuit diagrams
- To learn about LDR and thermistors
- To learn about L.E.D.'s and protective resistors

# Success Criteria

- I can describe a range of analogue components and say what their function and purpose is within a circuit
- I can produce circuit diagrams of analogue electronic circuits that
- I can measure current and resistance in series circuits using voltmeters and ammeters
- I am able to produce circuit diagrams for both series and parallel electronic circuits
- I am able to simulate and construct electronic control systems
- I can use mathematical formulae to calculate appropriate component values, such as resistor sizing
- I can test and evaluate an electronic solution against a specification

YENKA is a free program you can download at home to build electronic circuits and help you with your studies

http://www.yenka.com/en/Free_student_home_licences/

To access video clips that will help on this course go to www.youtube.com/MacBeathsTech

# Electric Circuits

An electric circuit is a closed loop made up of electrical components such as batteries, bulbs and switches.

Electric current is the name given to the flow of negatively charged particles called electrons.

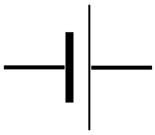
Conventional current is the direction in which an electric current is considered to flow in a circuit. By convention, the direction is that in which positive-charge carriers would flow – from the positive terminal of a cell to its negative terminal. It is opposite in direction to the flow of electrons. In circuit diagrams, the arrow shown on symbols for components such as diodes and transistors point in the direction of conventional current flow.

Current (I) is measured in amperes, usually referred to as amps (A). Current is the rate of flow of the electrons through the circuit.

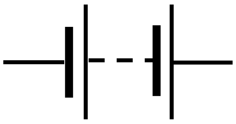
Voltage (V) is used to drive/push the electrons through components in the circuit. Voltage is measured in volts (v).

Resistance(R) is the measure of how much voltage is required to let current flow in a circuit. Resistance is measured in ohm s (Ω).

# Electrical and Electronic Graphical Symbols



Cell



Battery

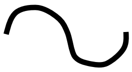
Terminal

−

Negative Polarity

+

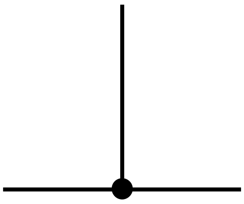
Positive Polarity



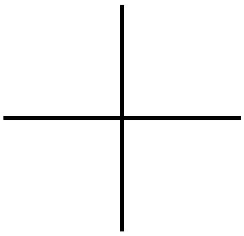
Alternating Current

A.C. Supply

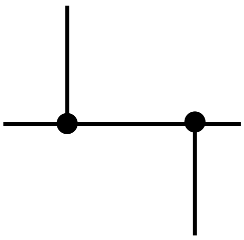

D.C. Supply



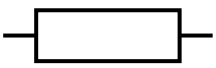
Junction of Conductors



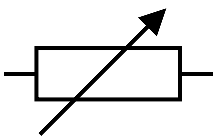
Crossing of Conductors with no Electrical Connection



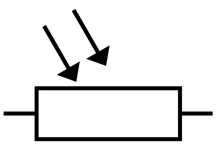
Double Junction of Conductors



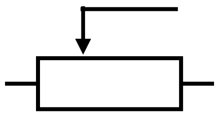
Resistor



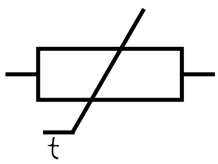
Variable Resistor



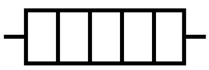
Light Dependant Resistor



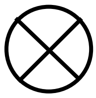
Potentiometer



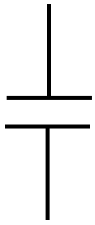

Thermistor



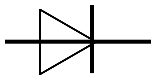
Heating Element



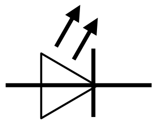
Lamp



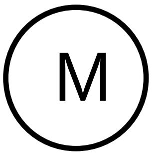
Capacitor



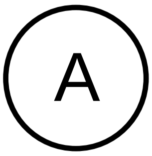
Semi-Conductor Diode



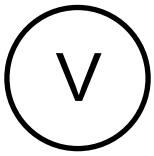
Light Emitting Diode



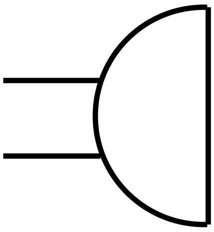

Motor



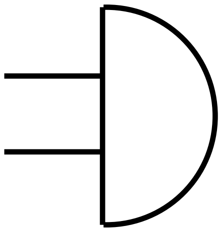

Ammeter



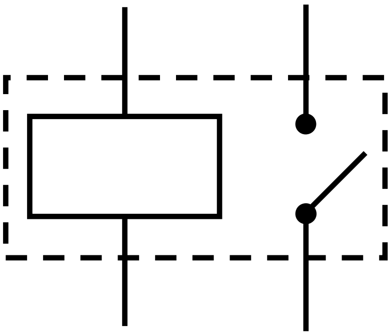

Voltmeter



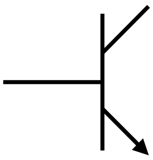
Buzzer



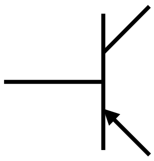
Bell



Relay



NPN Transistor



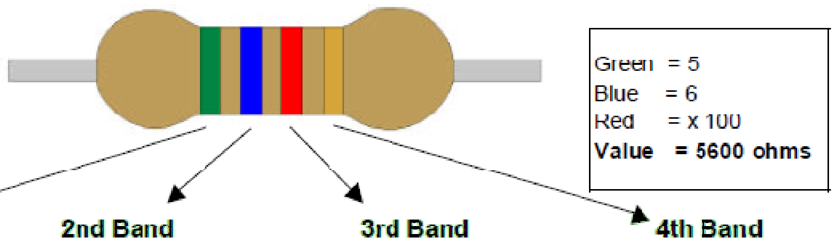
PNP Transistor

http://www.bbc.co.uk/schools/gcsebitesize/design/systemscontrol/electronicsrev5.shtml

# Resistor Colour Codes

Resistors are used for regulating current and they 'resist' the current flow and the extent to which they do this is measured in ohms (Ω). In essence they act as a dam to current. Resistors are found in almost every electronic circuit.
Resistors are marked with what is known as a resistor colour code. Each band of colour helps identify the value (in ohms) and the tolerance (in per cent).

The colour code chart for resistors is shown below.




| | 1st Band | 2nd Band | 3rd Band Multiplier | 4th Band Tolerance |
|---|---|---|---|---|
| BLACK | 0 | 0 | x 1 | |
| BROWN | 1 | 1 | x 10 | ± 1% |
| RED | 2 | 2 | x 100 | ± 2% |
| ORANGE | 3 | 3 | x 1,000 | |
| YELLOW | 4 | 4 | x 10,000 | |
| GREEN | 5 | 5 | x 100,000 | |
| BLUE | 6 | 6 | x 1,000,000 | |
| VIOLET | 7 | 7 | | |
| GREY | 8 | 8 | | |
| WHITE | 9 | 9 | | |
| SILVER | | | x 0.01 | ± 10% |
| GOLD | | | x 0.1 | ± 5% |

http://www.youtube.com/watch?v=CtQYryuwtfg

Task 1

Collect the resistors from your teacher.

For each resistor write down the colour of each band and then calculate its value.

| Resistor | Band 1 | Band 2 | Band 3 | Tolerance Band | Resistor Value |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |

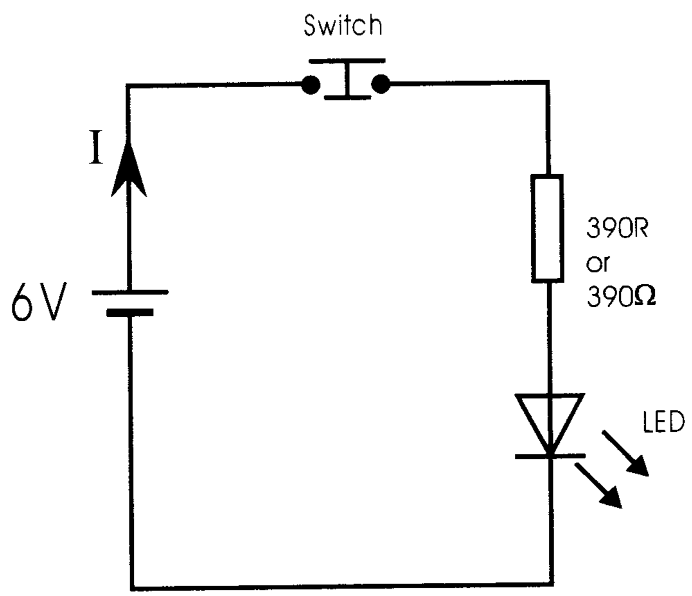
Task 2

Write down the colours for the following resistors and then collect them to show to your teacher.

| Resistor Value | Resistor Colours | | | Checked |
|---|---|---|---|---|
| 3K3 | | | | |
| 270 | | | | |
| 1M | | | | |
| 10K | | | | |
| 47 | | | | |
| 120 | | | | |

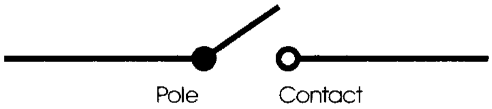
# Series Circuits

The diagram below shows a series circuit, which is the simplest to deal with as the same current flows through all of the components. The voltage however is divided up between the components.

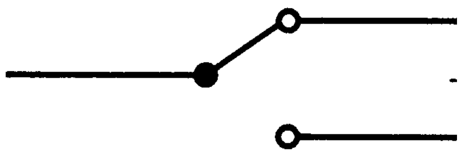



# Switches

Most of the switches you have seen so far are known as 'Single pole single throw'. The diagrams below show switches that allow us to have more control over components.

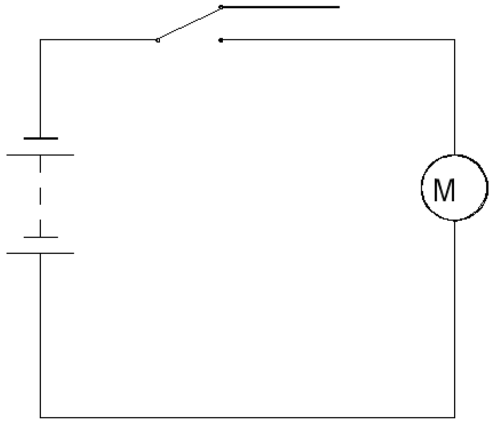



Single-pole single-throw switch (SPST)

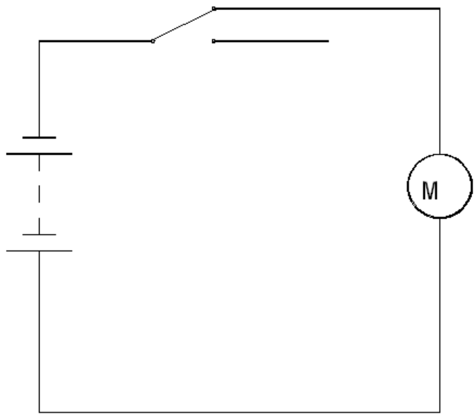


Single-pole double-throw switch(SPDT)

Micro switches which are Single pole double throw can be wired up to produce a switch that is normally open (which means no current will flow until the switch is pressed and the circuit is a closed loop) or normally closed (which means the circuit is a closed loop and current is flowing to all components until the switch is pressed).



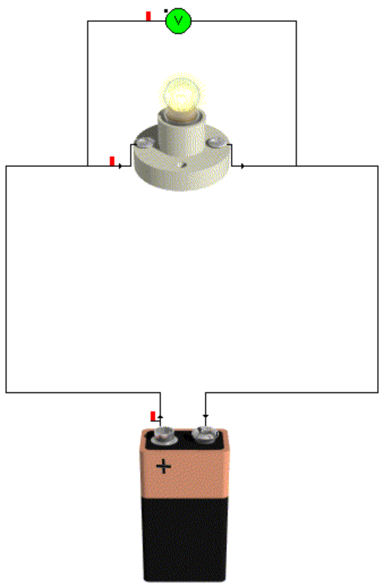

Normally open




Normally closed

Task 3

Series Circuits: Build the circuit shown below.

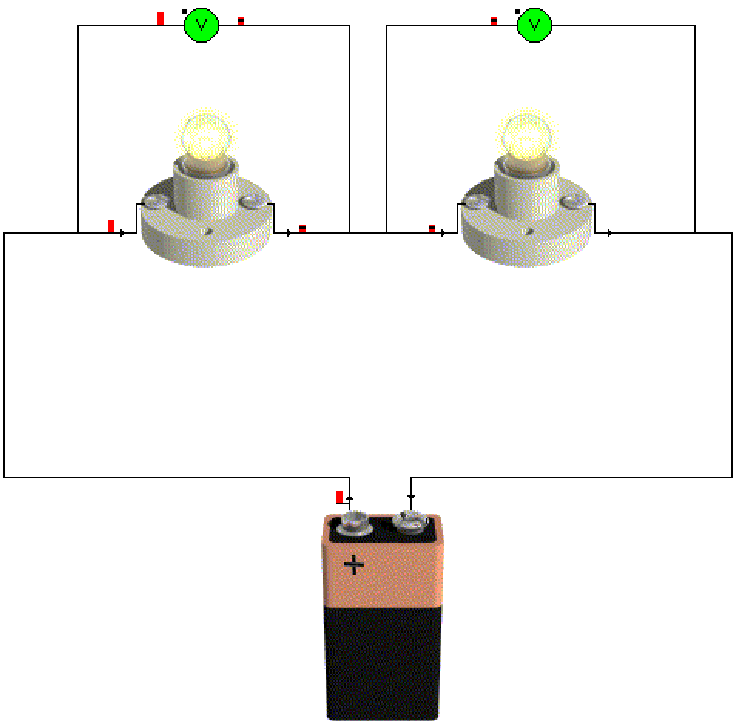



Draw the circuit diagram for the circuit opposite using the correct circuit diagrams.

The reading on the voltmeter is ……………V.

Task 4

Build the circuit shown below

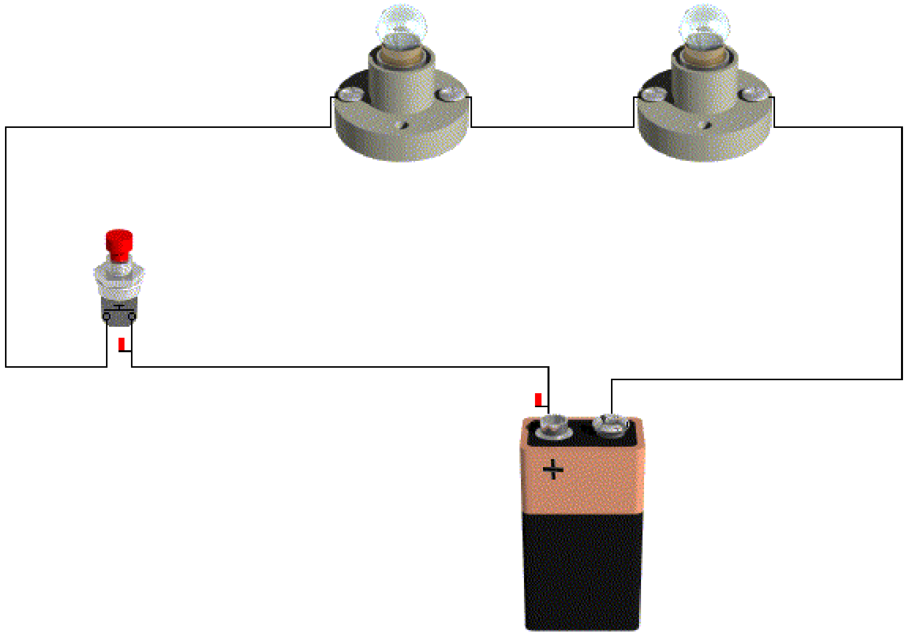



Draw the circuit diagram for the circuit opposite using the correct circuit diagrams.

The readings on the voltmeters are ……………V.

Task 5

Build the circuit shown below



The push switch breaks the circuit and allows you to switch the bulbs on and off; this is a single pole single throw switch.

If the push switch is not being pressed the bulbs will go off. What type of switch should you use if you want the bulbs to stay on until the switch is pressed again?

Draw the circuit diagram for the circuit using the correct symbols

Task 6

You are now going to create an electronic toy that uses a Series circuit to work

You will need:

- 2 pieces of pine – 15mm x 25mm x 90mm
- 1 piece of hardboard - 150mm x 100mm
- Wire – 200mm
- Copper – 400mm
- 6v buzzer
- Battery terminal
- Soldering Iron
- Solder
- Hot glue gun

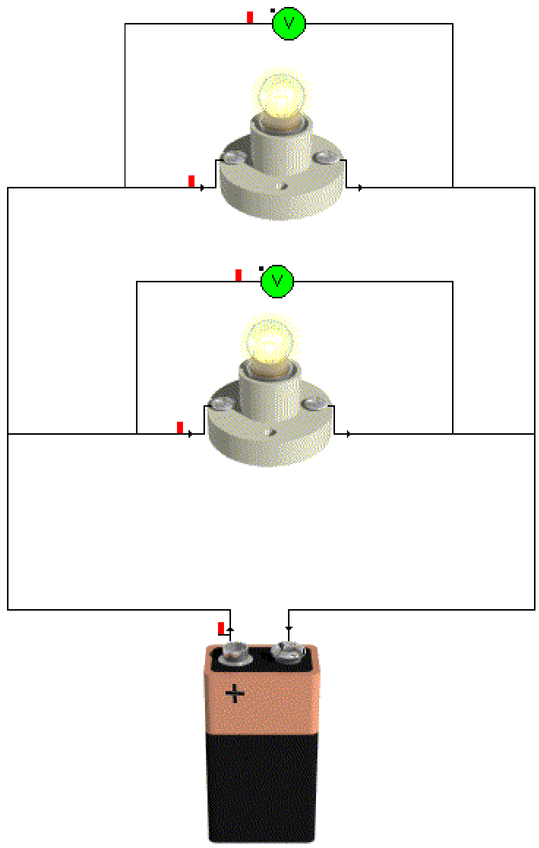
a) Draw the circuit that you will use

b) Place photo of your working model here.

# Parallel Circuits

Task 7

Build the circuit shown below

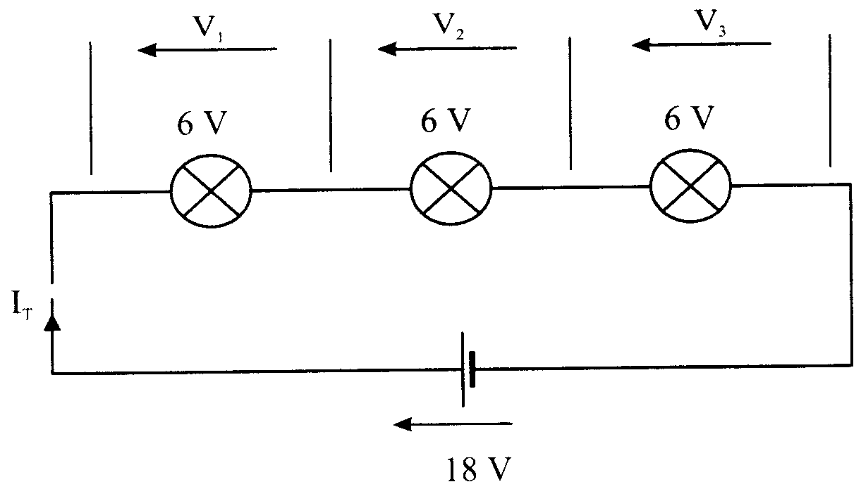



The readings on the voltmeters are..............V.

This is a parallel circuit. Current can flow through each of the bulbs without first having to flow through any others. If any of the bulbs fail the others will still work as current can still flow through the rest of the circuit.

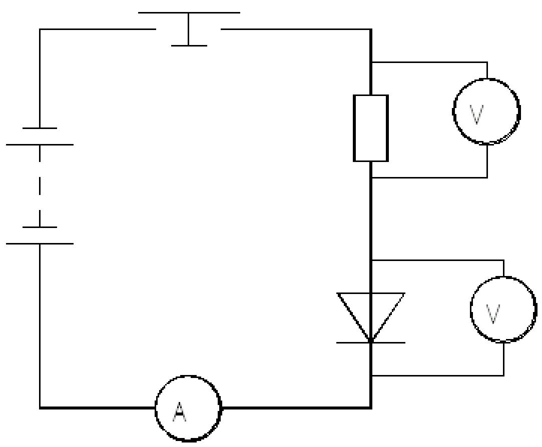
# Kirchoff's 2nd Law

$V_s = V_1 + V_2 + V_3$




# Measuring Voltage and Current

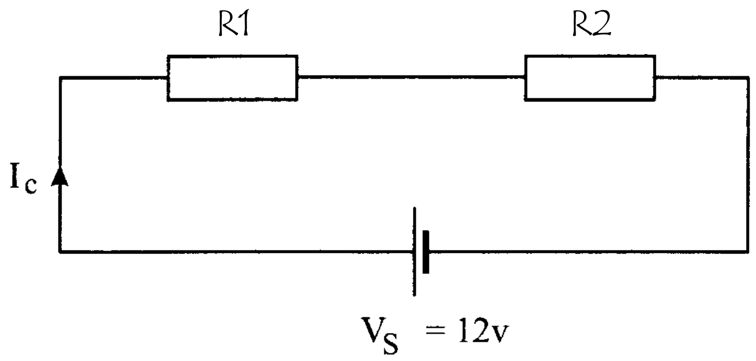
To measure the voltage used up by a component, the voltage drop, we connect the voltmeter in parallel with the component, as shown below. As the current in a series circuit is the same all the way through the circuit we only need to take a reading from one place in the circuit, to do this we must connect it up in series with the other components, as shown below.



# Resistors Connected In Series

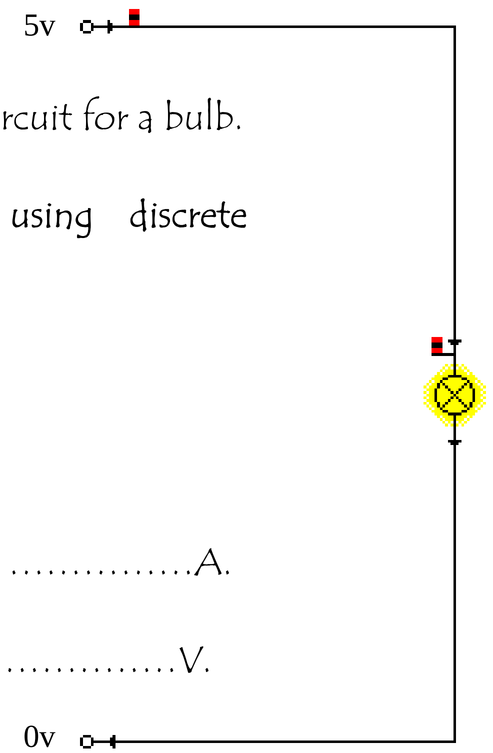
As resistors come in standard sizes, they are often connected in series to obtain a specific size that is required.

$$R_{total} = R_1 + R_2$$




Task 8

Circuit 1 - Series circuit




The following circuit shows a simple circuit for a bulb.

(a) Build and test the circuit using discrete components and a breadboard.

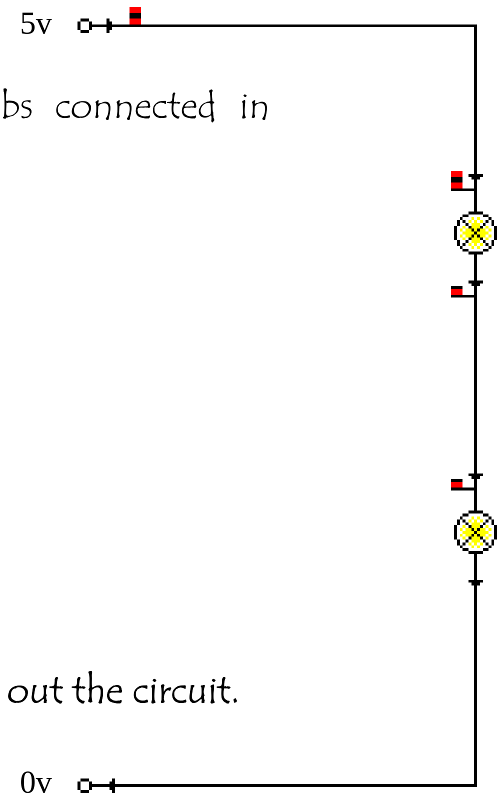
(b) Complete the statements below.

The current going through the bulb is ……………A.

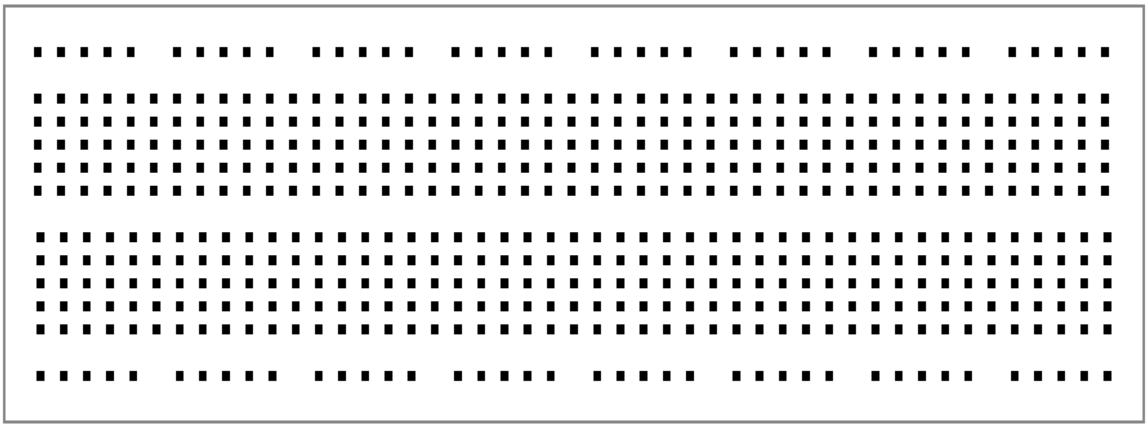
The voltage drop across the bulb is ………………V.

## Circuit 2 - Series circuit

The following circuit shows 2 bulbs connected in series.




(a) Using breadboard template plan out the circuit.



(b) Build and test the circuit using discrete components and a breadboard.

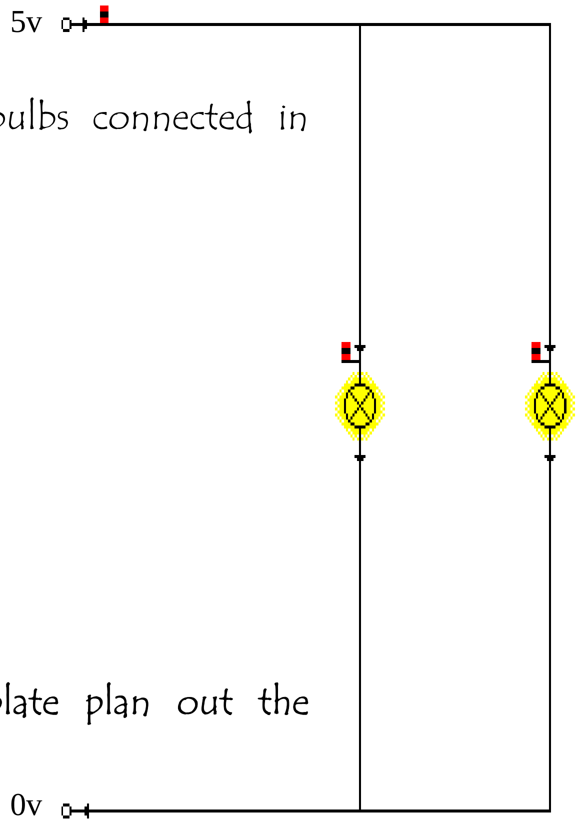
(c) Complete the statements below.

The current going through the bulb is ...............A.

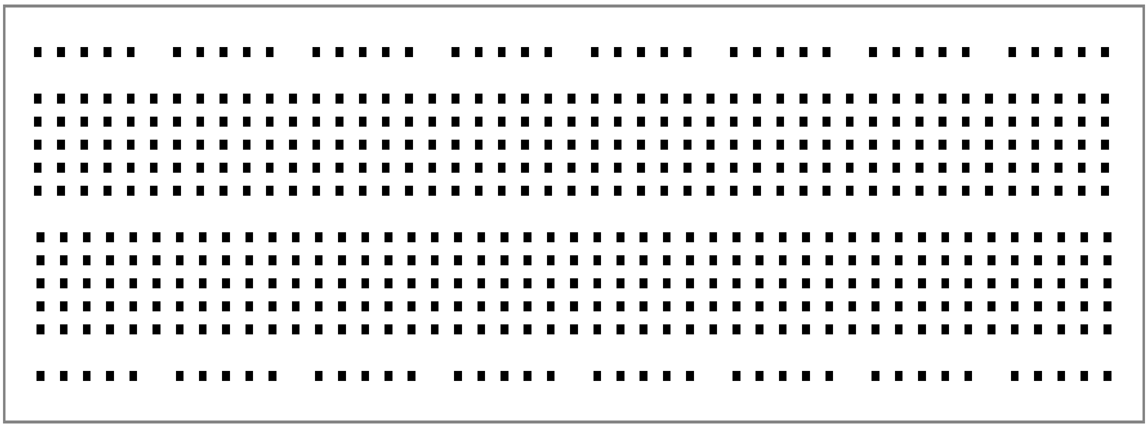
The voltage drop across the bulb is ..................V.

## Circuit 3 – Parallel circuit

The following circuit shows 2 bulbs connected in parallel.




(a) Using the breadboard template plan out the circuit.



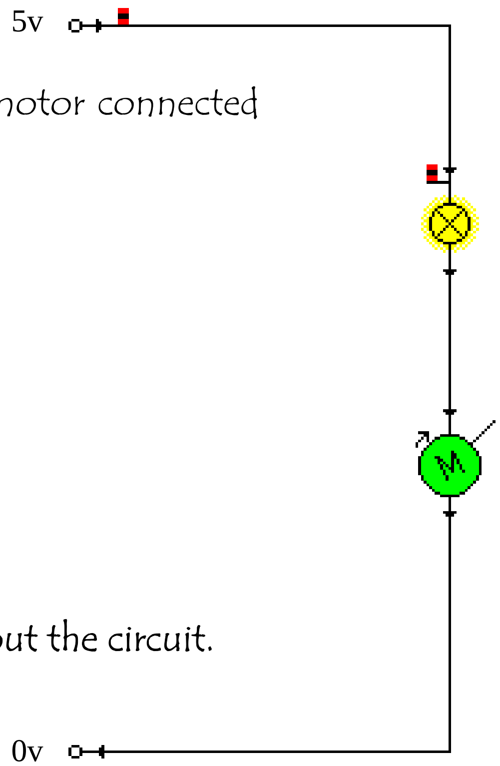
(b) Build and test the circuit using discrete components and a breadboard.

(c) Complete the statements below.

The current going through each bulb is ……………A.

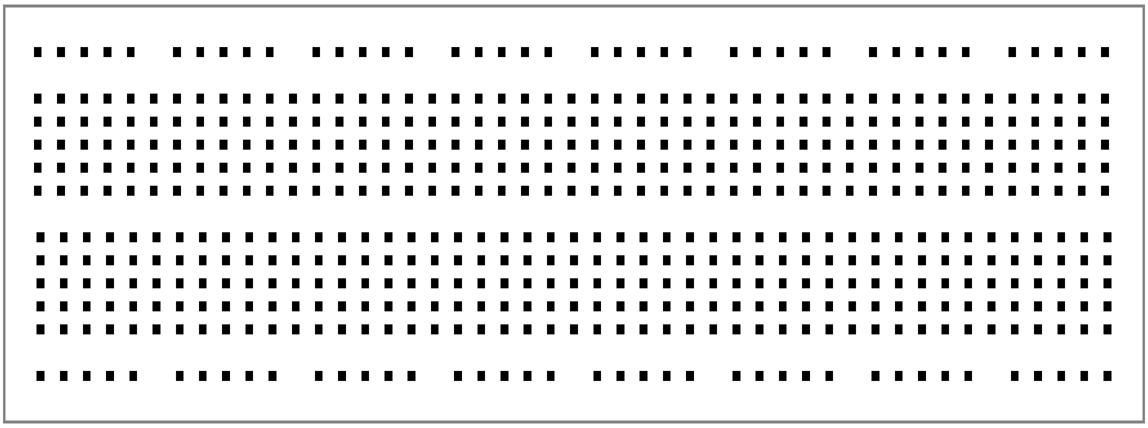
The voltage drop across each bulb is ………………V.

Circuit 4 – Series circuit




The following circuit shows a bulb and motor connected in series.

(a) Using the breadboard template plan out the circuit.



(b) Build and test the circuit using discrete components and a breadboard.

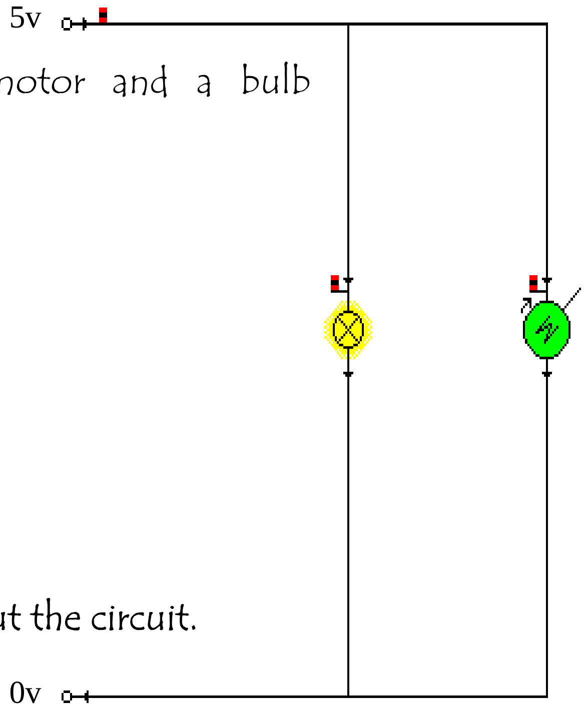
(c) Complete the statements below.

The current going through the bulb is ……………A.

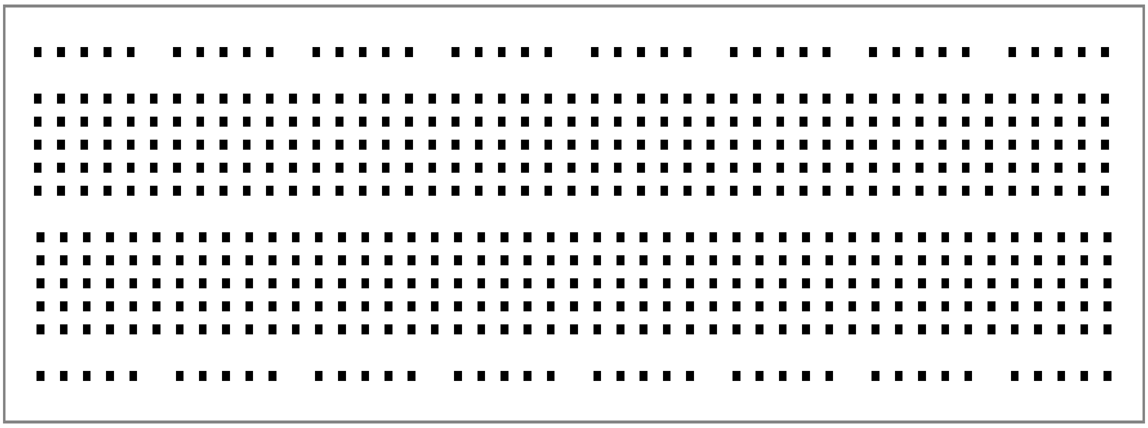
The voltage drop across the motor is ………………V.

## Circuit 5 – Parallel circuit

The following circuit shows a motor and a bulb connected in parallel.




(a) Using breadboard paper plan out the circuit.



(b) Build and test the circuit using discrete components and a breadboard.

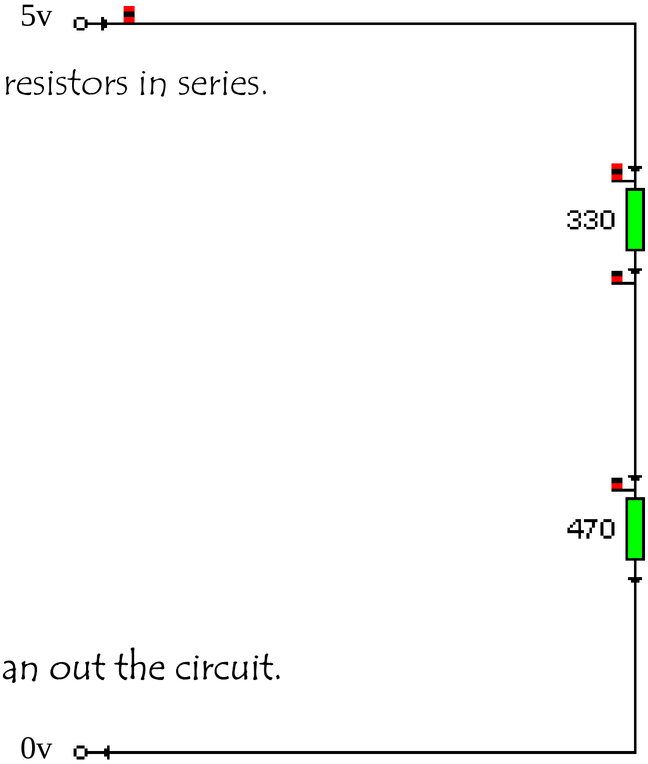
(c) Complete the statements below.

The current going through the motor is ……………A.

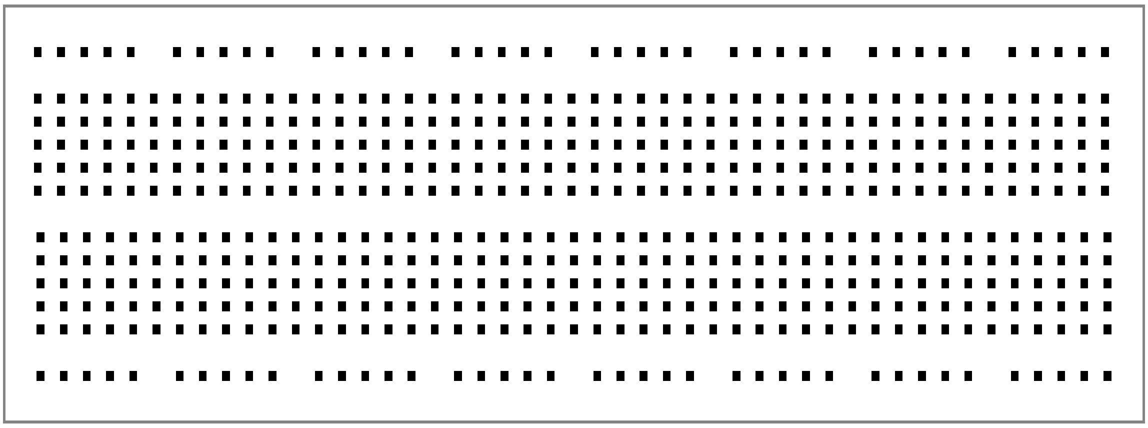
The voltage drop across the bulb is ………………V.

## Circuit 6 - Series circuit

The following circuit shows 2 resistors in series.




(a) Using breadboard paper plan out the circuit.



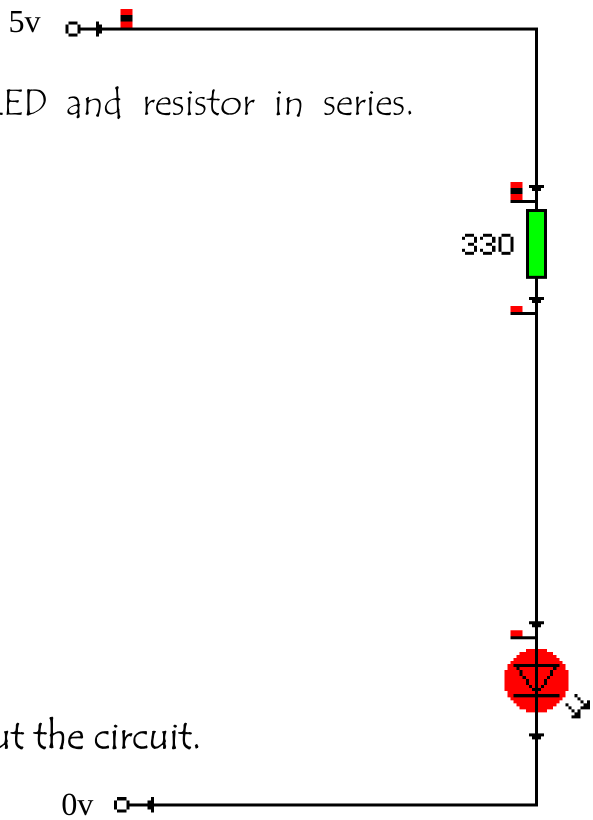
(b) Build and test the circuit using discrete components and a breadboard.

(c) Complete the statements below.

The current going through the 330Ω is ……………A.

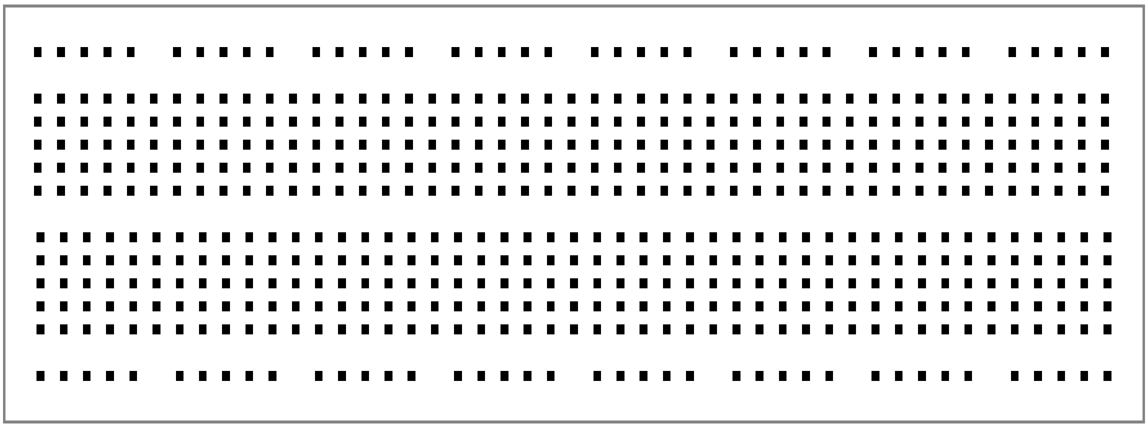
The voltage drop across the 330Ω is ………………V.

## Circuit 7 – Series circuit




The following circuit shows an LED and resistor in series.

(a) Using breadboard paper plan out the circuit.



(b) Build and test the circuit using discrete components and a breadboard.

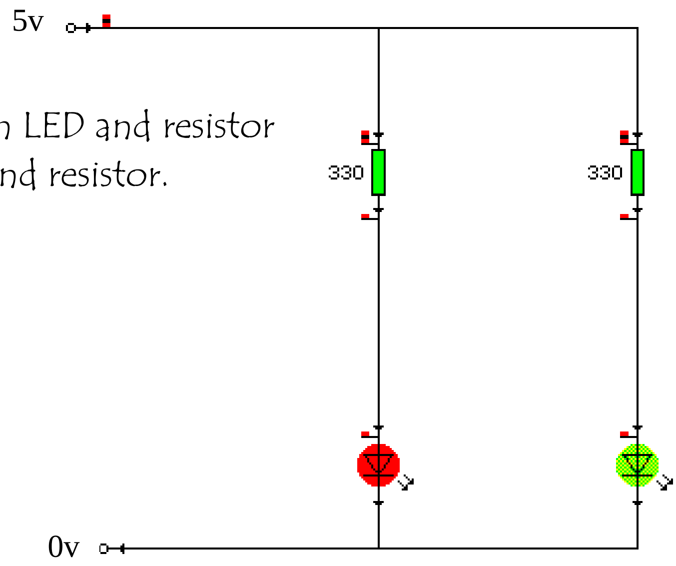
(c) Complete the statements below.

The current going through the LED is ……………A.

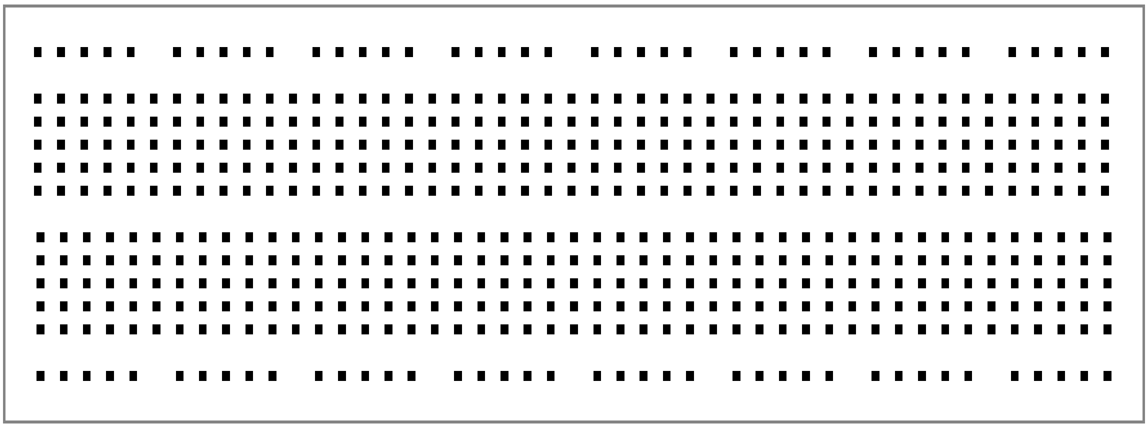
The voltage drop across the LED is ………………V.

## Circuit 8 – Parallel circuit

The following circuit shows an LED and resistor in parallel with another LED and resistor.




(a) Using breadboard paper plan out the circuit.



(b) Build and test the circuit using discrete components and a breadboard.

(c) Complete the statements below.

The current going through the LEDs is ...............A.

The voltage drop across the LEDs is ..................V.

Task 9

You are now going to create an electronic toy that uses a parallel circuit to work

You will need:

- Template Design
- Copper tracking
- Soldering Iron
- Solder
- 2 x coloured LED
- 1 x flashing LED
- 2 x 180 Ω Resistor
- Card for front design

a) Draw the circuit that you will use

b) Place photo of your working circuit here.

# Ohm's Law

Ohm's law states that the current in a series circuit is proportional to the voltage drop across a resistor.

$$V = IR$$

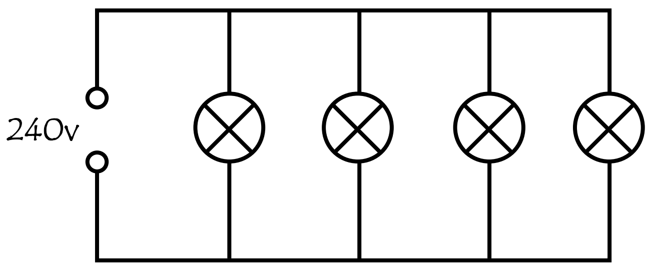
Voltage = Current x Resistance

http://www.youtube.com/watch?v=HWn_TKVpOmQ

http://www.bbc.co.uk/schools/gcsebitesize/design/electronics/calculationsrev1.shtml

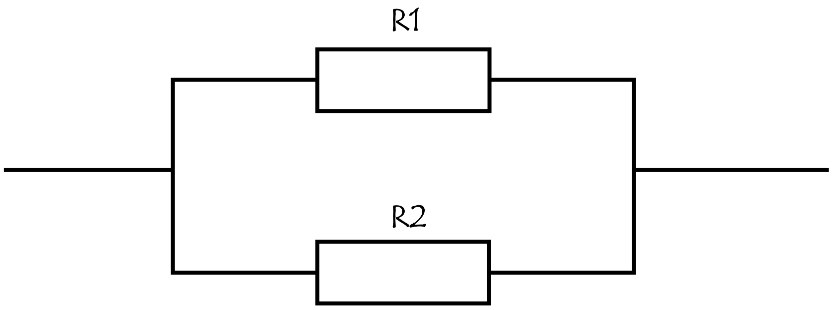
# Parallel Circuits

Parallel circuits are circuits where there is more than one path for electricity to flow along or that have more than one 'branch'. Each branch receives the supply voltage, which means that you can run a number of devices from one supply. A good example is a set of Christmas tree lights where all the bulbs require a 240v supply.



# Resistors in Parallel

As resistors come in standard sizes, they are often connected in parallel to obtain a specific size that is unavailable.




To calculate the total resistance in a parallel circuit you can use either of the following rules

$$\frac{1}{Rt} = \frac{1}{R1} + \frac{1}{R2} \ldots\ldots$$

or

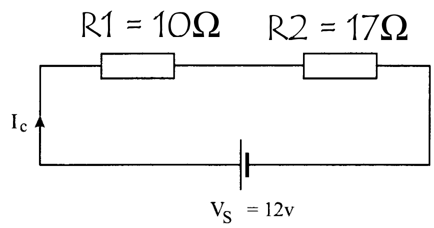
$$Rt = \frac{R1 \times R2}{R1 + R2}$$

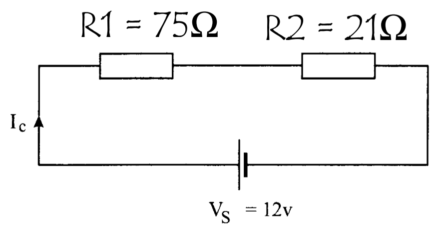
The second equation can only be used to calculate the total resistance of two resistors in parallel.

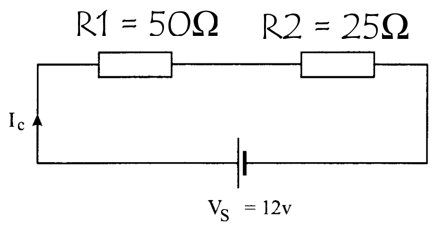
http://www.youtube.com/watch?v=uTIweqLB_fw

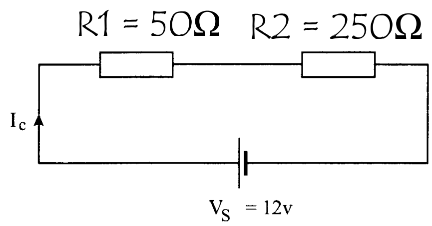
## Task 10

Calculate the total current and resistance of each circuit.



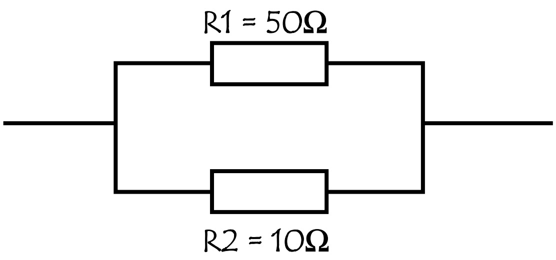



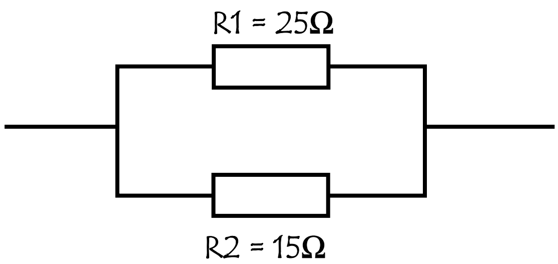



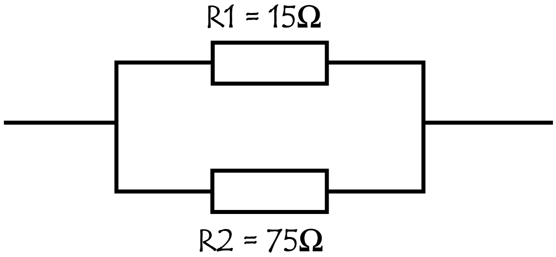



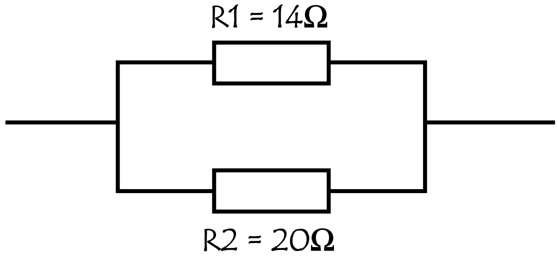

## Task 11

Calculate the total resistance of each circuit.



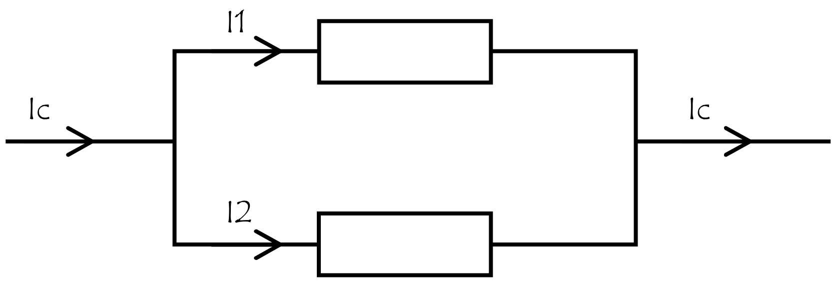



# Current in parallel circuits

We know that each branch of a parallel circuit receives the total supply voltage but when the current reaches a junction it splits up and some current goes along one branch and the rest goes along the other branch, as shown in the diagram below.




# Power in Electric Circuits

Electrical power (P) is measured in watts (W). Electrical power can be converted into other forms of power using electrical circuits. A good example is an electric fire, which has a heating element- the power used in overcoming the electrical resistance can be converted into heat.

The power in an electric circuit depends both on the amount of current (I) flowing and the voltage (V) applied. To calculate the power in a circuit you can use the following rule.

$$P = IV$$

Task 12

Draw the circuit diagram and then answer the questions in your jotter.

1. Two resistors (15kΩ, 25kΩ) are connected in parallel and then connected to a 6v supply voltage. Calculate;
a) The total resistance,
b) The circuit current.

2. Three resistors (2kΩ, 5kΩ, and 10kΩ) are connected in parallel and then connected to a 10v supply voltage. Calculate;
a) The total resistance,
b) The circuit current,
c) Current through the 2kΩ resistor.

3. A burglar alarm has 2 buzzers connected in parallel, which have a resistance of 200Ω and 300Ω and are connected to an 8v supply voltage. Calculate;
a) The circuit resistance,
b) The circuit current,
c) The current through the 200Ω buzzer.

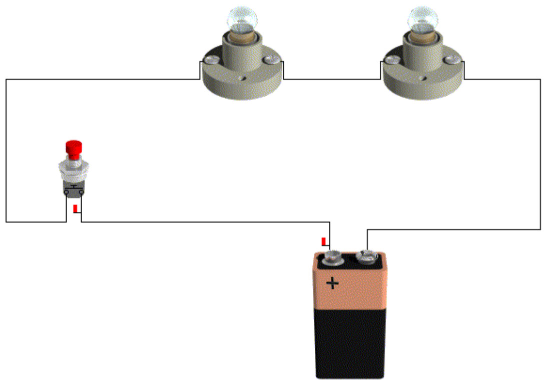
4. A student needs a 50Ω resistance to complete her electronics project. Unfortunately she only has two 100Ω available. Draw a solution to her problem and explain your answer by providing proof (calculation) that it is correct.

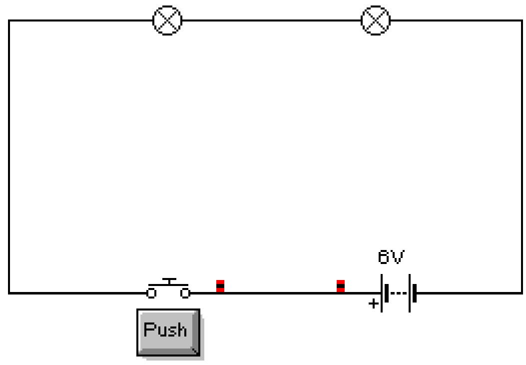
5. A circuit with a voltage supply of 6v has a 30Ω and a 20Ω resistor connected in parallel and then they are connected in series to a 10Ω resistor. Calculate;
a) The total resistance of the circuit,
b) The circuit current,
c) The voltage dropped over the 10Ω resistor,
d) The current through the 30Ω resistor.

Task 13
Switches, variable resistors and motors

Push Switch

The circuit below shows a simple series circuit which uses a push switch, one known as a "Single Pole Single Throw" (SPST). When the Switch is held down the bulbs will come on and when the button is released the bulbs will go off.



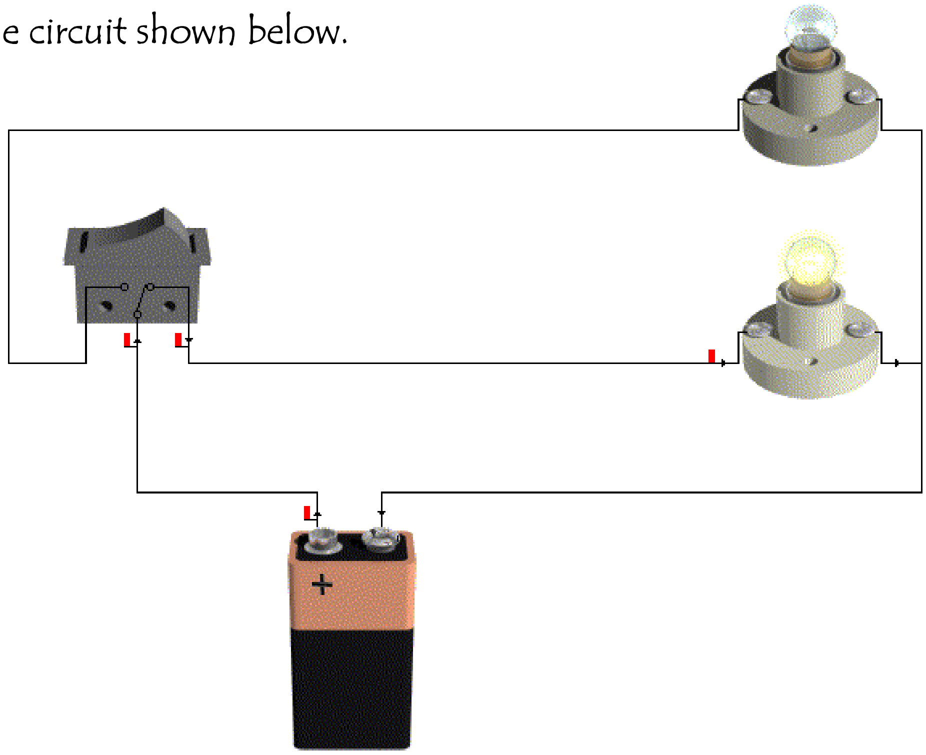



Replace the push switch with a toggle switch (SPST) and build the circuit.

Draw the circuit diagram for the circuit you have just built, using the correct circuit symbols.

The circuit below shows another type of **rocker switch, a "Single Pole Double Throw (SPDT)**. This one switch allows you to turn two bulbs but not at the same time.

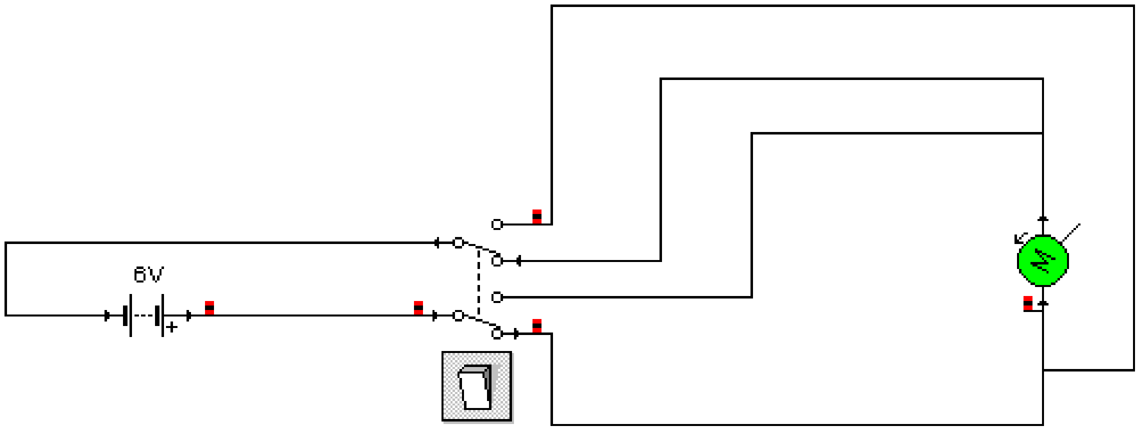
Build the circuit shown below.




Draw the circuit diagram for the circuit you have just built, using the correct circuit symbols.

The circuit below uses a Double Pole Double Throw (DPDT) switch to control the direction of a motor.

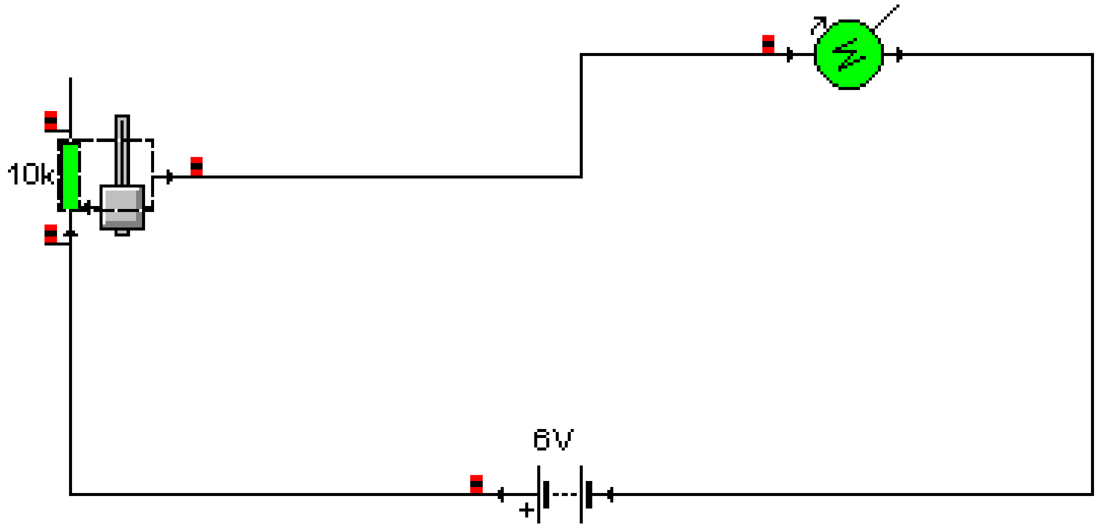
Using Crocodile Technology, build and test the circuit.



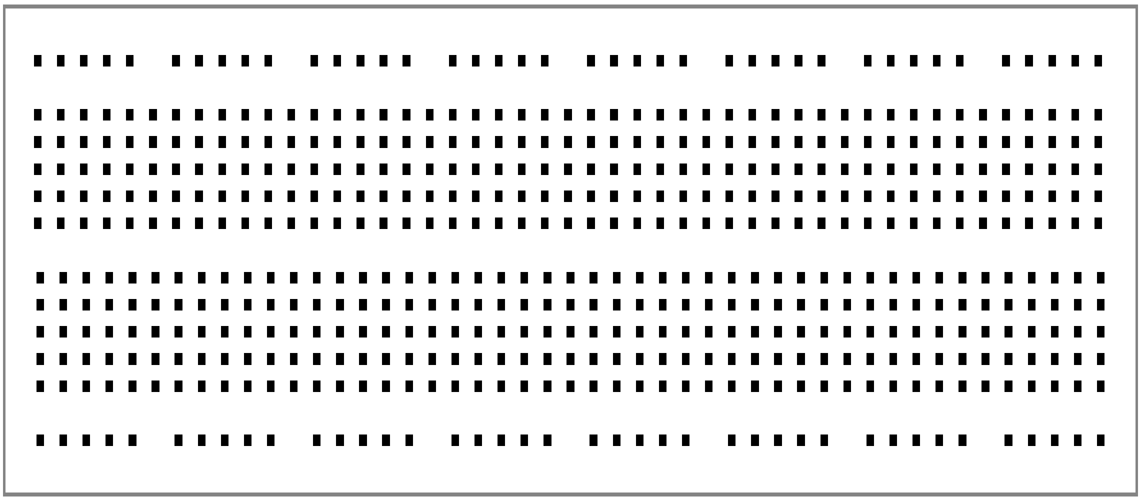

Explain what is happening in the circuit.

Give two examples of where this could be used in a real life situation.

The circuit below shows a potentiometer being used to control the speed of a motor.



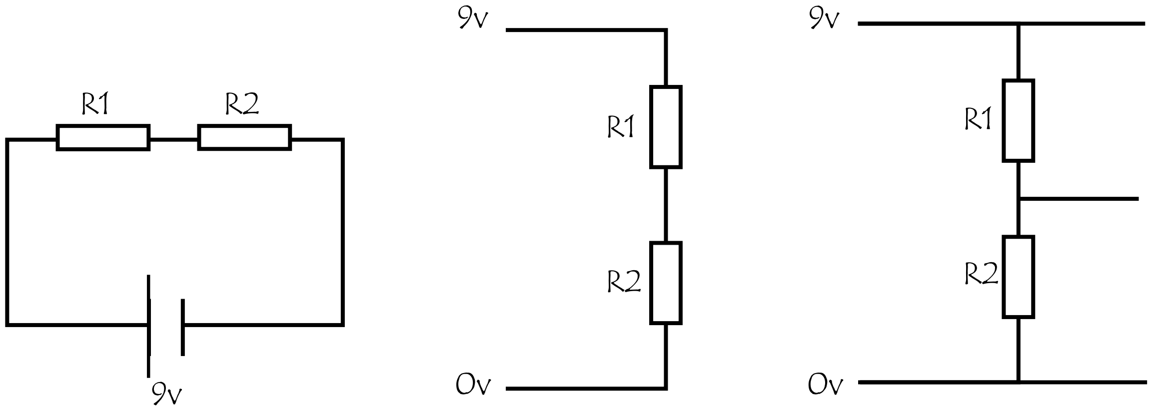

Plan out the circuit on the breadboard diagram below and then build and test it.



What does the potentiometer do?

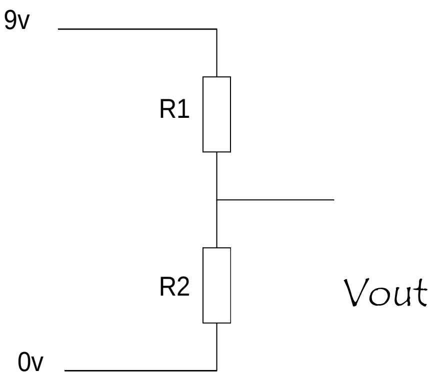
# Input Transducers

Input transducers are devices that convert a change in physical conditions (for example a thermistor, LDR, or variable resistor) into a change in resistance and/or voltage. This is then processed by a voltage divider circuit.
Below are some examples of how a voltage divider can be drawn.




# Voltage Divider

If an input transducer changes its resistance as the physical conditions change, then the resistance change has to be converted into a voltage change so that the signal can be processed. This is normally done using a voltage divider circuit. A typical voltage divider circuit is shown below.



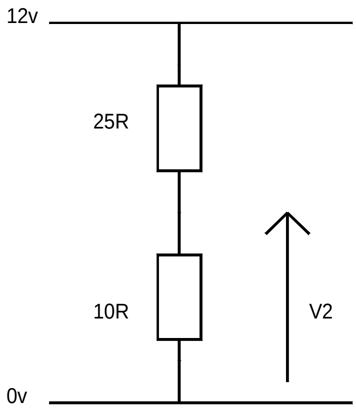

$$Vout = \frac{R2}{R1 + R2} \times Vs$$

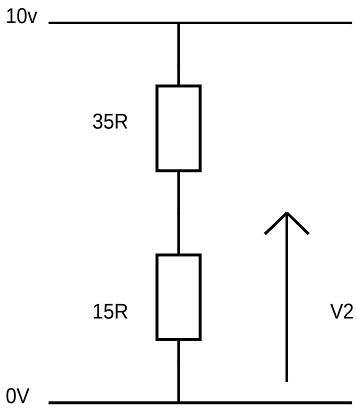
http://www.youtube.com/watch?v=1noHcoDsK-c

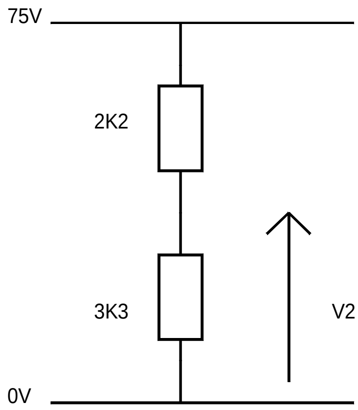
The circuit above consists basically of two resistors connected in series. If the value of R1 is changed the voltage across it will change, as will the voltage of R2. In other words, the resistors divide the voltage up between them….this is why it is known as a voltage divider.

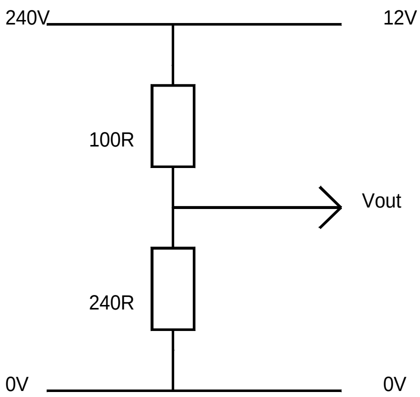
<u>Task 14</u>

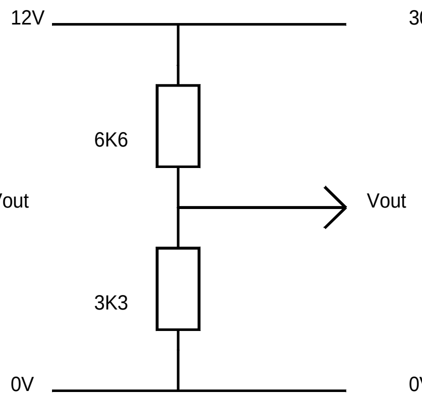
Calculate the missing value for each of the following circuits.

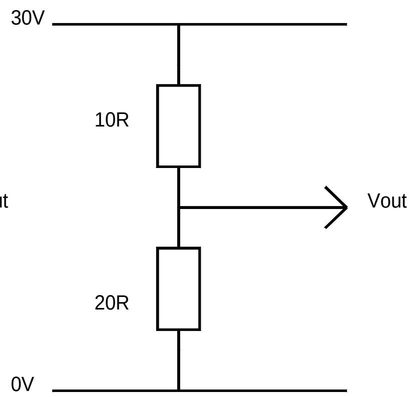


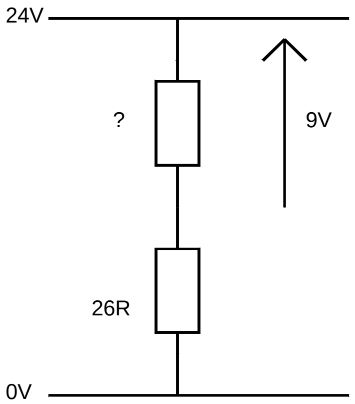
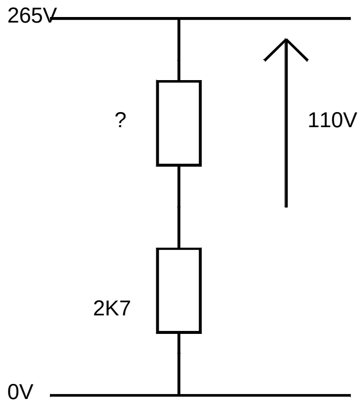
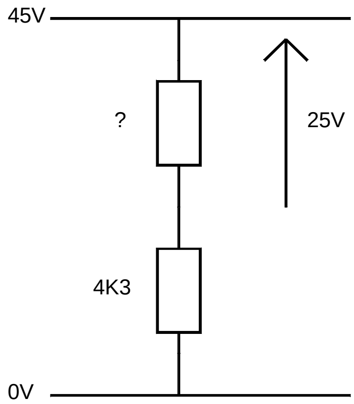
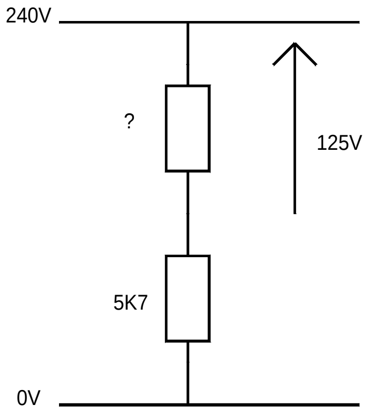
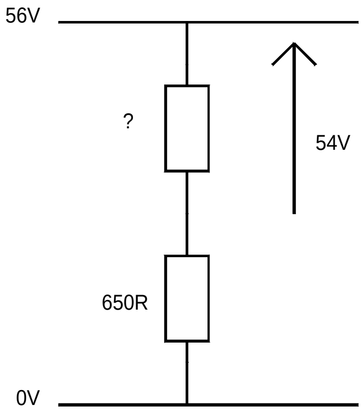
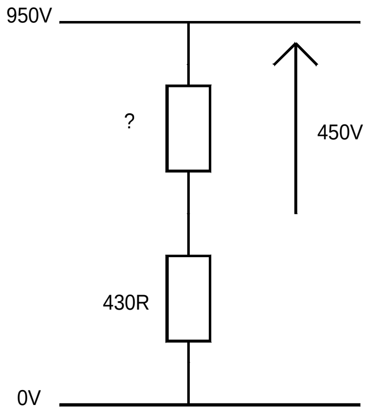



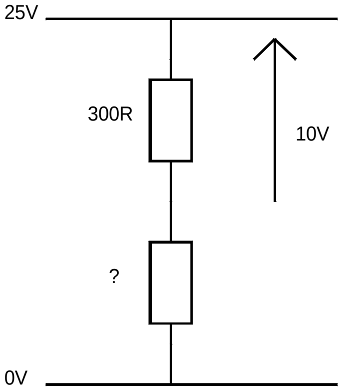



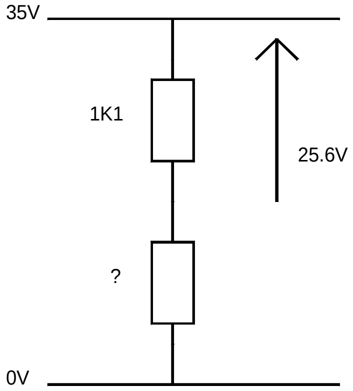



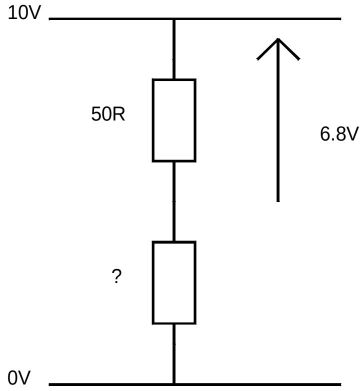



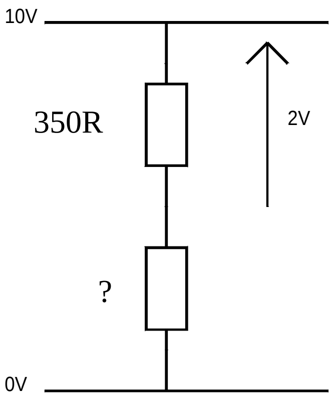

http://www.bbc.co.uk/schools/gcsebitesize/design/electronics/calculationsrev2.shtml

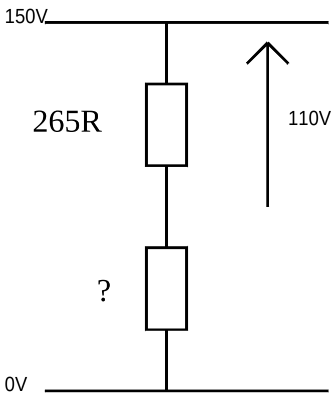

24V
?
9V
26R
0V

265V
?
110V
2K7
0V

45V
?
25V
4K3
0V

240V
?
125V
5K7
0V

56V
?
54V
650R
0V

950V
?
450V
430R
0V

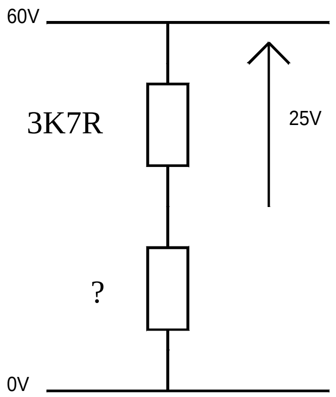

25V
300R
10V
?
0V


35V
1K1
25.6V
?
0V


10V
50R
6.8V
?
0V

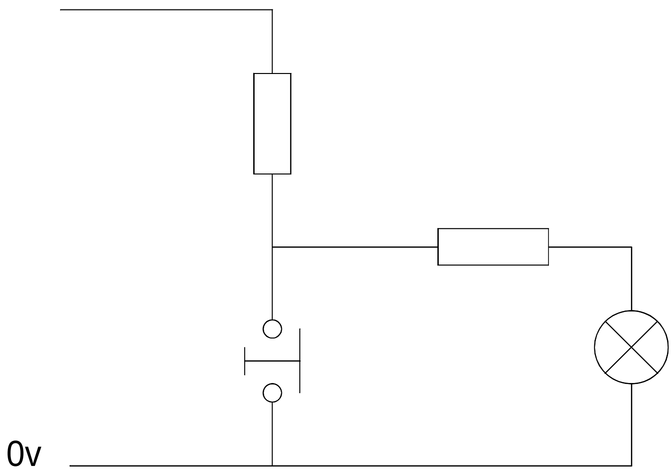

10V
350R
2V
?
0V


150V
265R
110V
?
0V

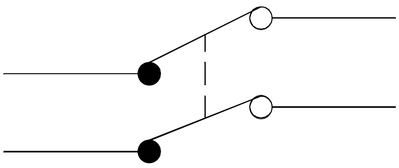

60V
3K7R
25V
?
0V

# Digital Switches

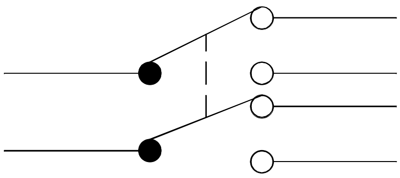
Simple switches can be used in voltage divider circuits to give a digital signal (that is definitely on or off) to another part of a circuit. See the diagram below.




Different types of switch can be wired up to suit their application. A switch with its contacts wired apart when it is not operating is called Normally Open. A switch with its contacts wired closed when it is not operating is called Normally Closed.



Double pole single throw (DPST)



Double pole double throw (DPDT)

# Analogue Input Transducers

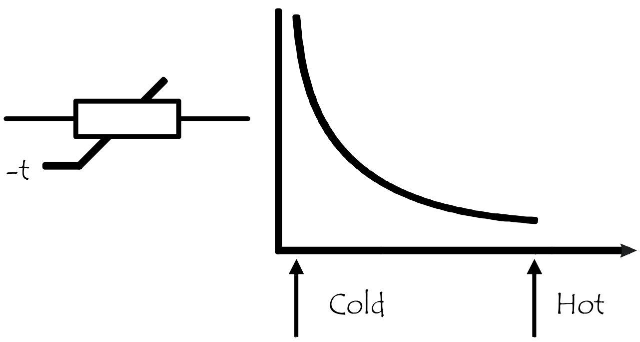
The two most common analogue input transducers are the thermistor and the light dependent resistor (LDR).

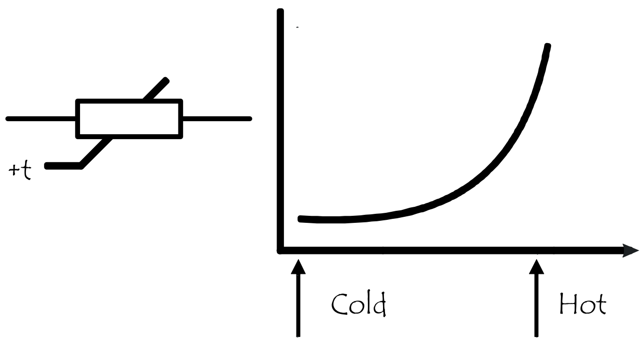
Thermistor – a thermistor is a device whose resistance varies with temperature. It is a temperature dependent resistor. There are 2 main types,

Negative temperature coefficient (-t or NTC) - where resistance decreases as temperature increases. These are the most commonly used.

Positive temperature coefficient (+t or PTC) – where resistance increases as temperature increases.

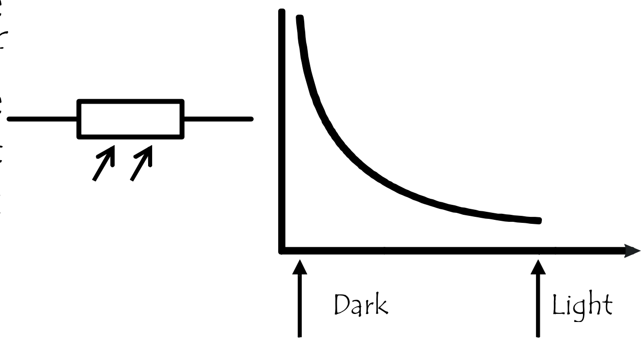
The circuit symbols for and typical characteristics of the two types of resistors are shown below,




Light Dependent Resistor

The LDR (sometimes called a photo-resistor) is a component whose resistance depends on the amount of light falling on it. Its resistance changes with light level in bright light its resistance is low (usually around 1K). In darkness its resistance is high (usually around 1M).

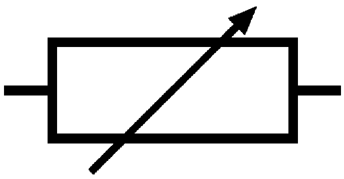



Strain Gauges

Strain gauges are really load sensors. They consist of a length of resistance wire and when stretched their resistance changes. Strain gauges are attached to structural members, like beams and as they are loaded a reading on a voltmeter can be obtained.

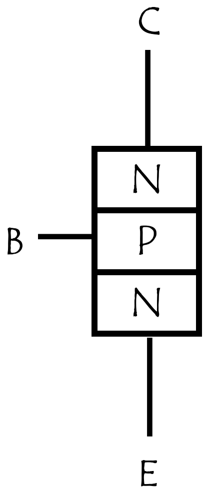
Variable resistor (potentiometer)

A potentiometer/variable resistor can be used in a circuit as a voltage or current control device, for example a control. They are often used in voltage divider circuits to adjust the sensitivity of the input.

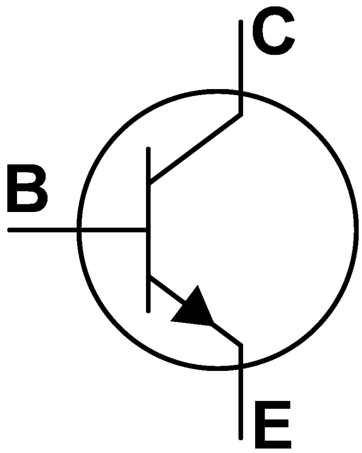


Transistors (bipolar)

The transistor is a semiconductor device. This means it is sometimes a good conductor and sometimes a poor conductor of electricity.
There are 2 types of bipolar transistor available: pnp or npn.
We will only deal with the npn type.




C is the collector
B is the base
E is the emitter




Transistors are switches; they convert an analogue signal into a digital signal.
To allow voltage and current to flow from the collector to the emitter a voltage of 0.7v or more must be applied across the base of the transistor.

http://www.youtube.com/watch?v=sMk345vBlkU

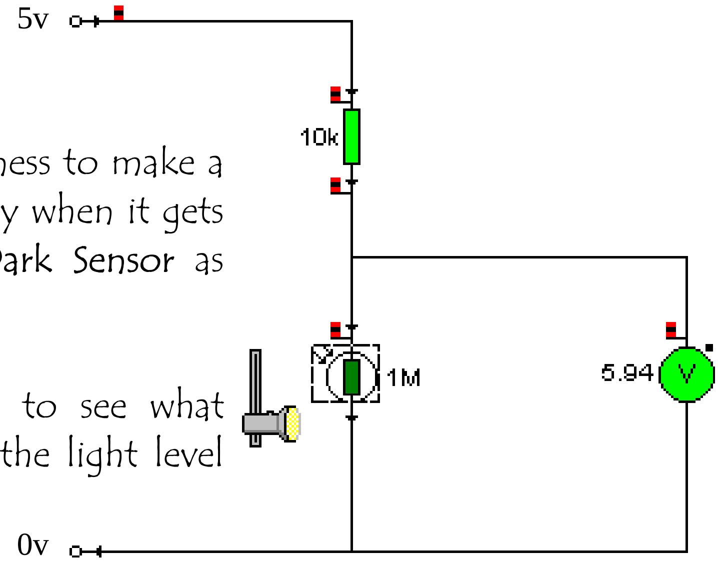
Task 15

## Light Dependant resistors, voltage dividers and transistors

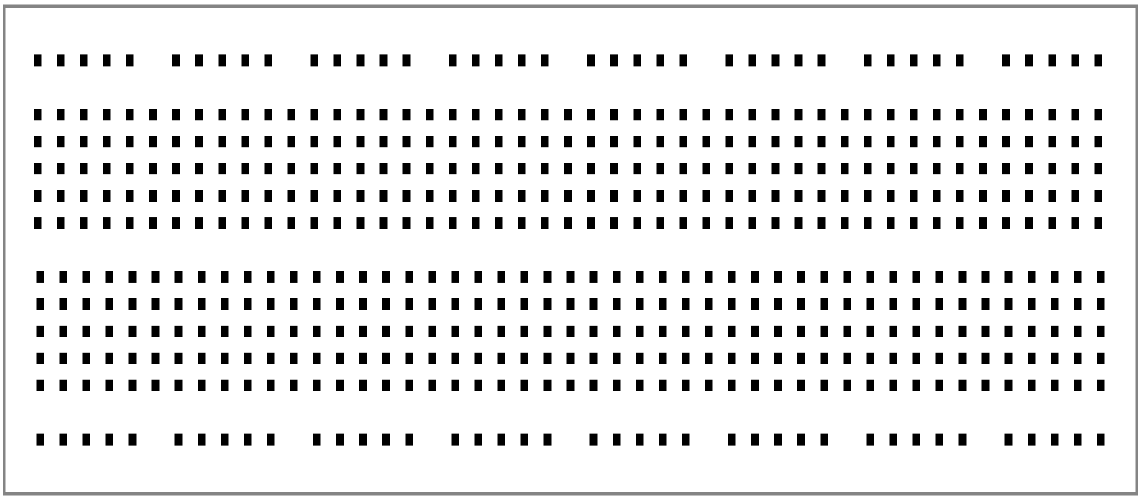
### Dark Sensor

If we wanted to sense darkness to make a light come on automatically when it gets dark, we would need a Dark Sensor as shown.

Build and test the circuit to see what happens to the voltage as the light level changes.




Use the breadboard below to plan your circuit before you build it.

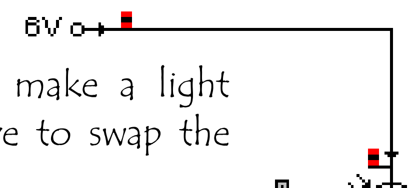


Complete the sentence below.

When light shines on the LDR the voltmeter reads..............v.

When the LDR is covered the voltmeter reads..................v.

### Light Sensor

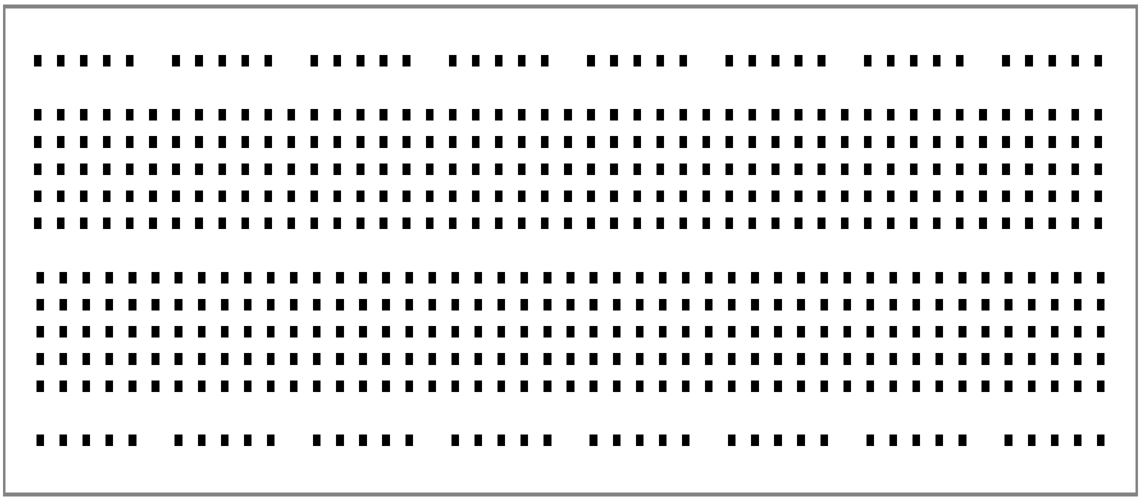



So if we wanted to make a light sensor we would have to swap the resistor and LDR over

5v

0v

Use the breadboard below to plan your circuit before you build it.

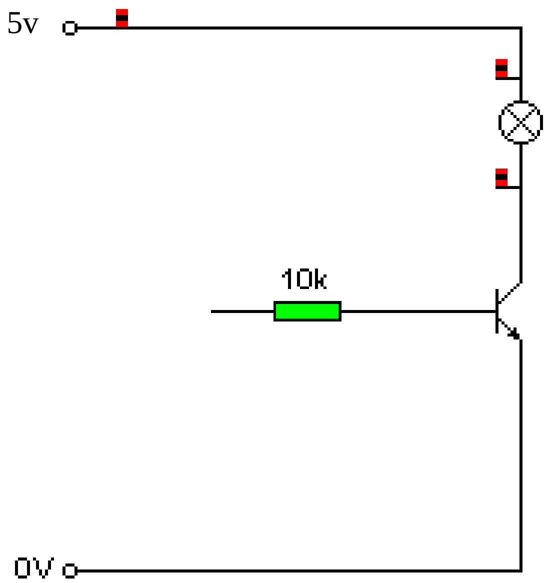


Complete the sentence below.

When light shines on the LDR the voltmeter reads…………..v.

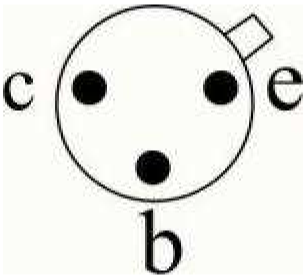
When the LDR is covered the voltmeter reads………………..v.

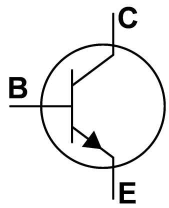
A transistor can have two basic jobs it can be used as an electronic switch or it can be used as a current amplifier. This part of a system is know as the process sub system.

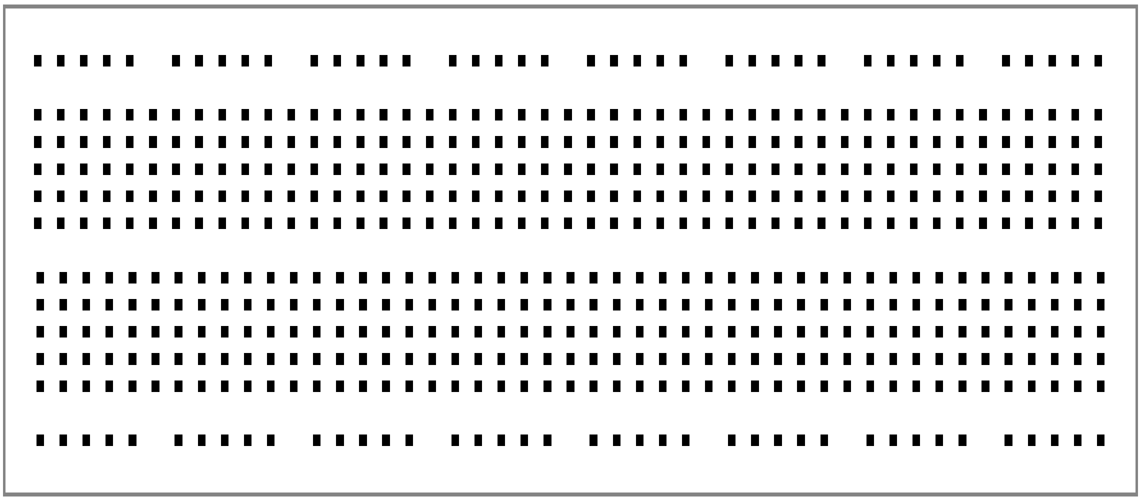



Build and test the circuit.

Use the breadboard below to plan your circuit before you build it.



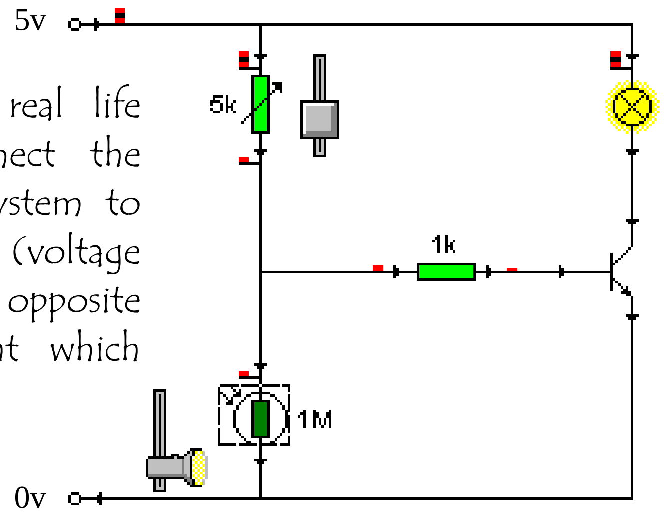
Complete the sentences below.

If A is connect to 0v the bulb……………………………………………

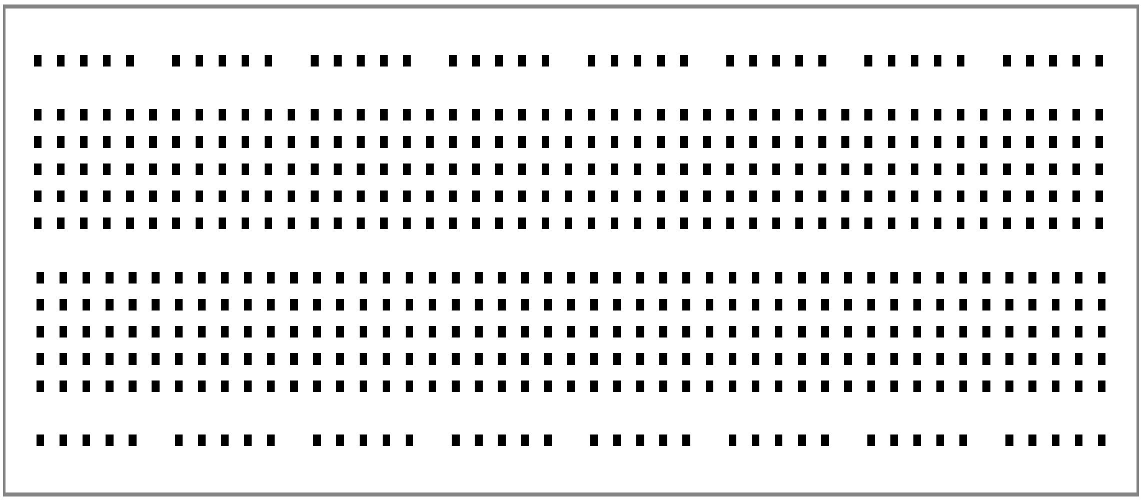
If A is connected to 6v the bulb…………………………………………..

To use a resistor in a real life situation we must connect the transistor (process) sub system to and input sub system (voltage divider circuit). The circuit opposite shows an automatic light which turns on when it gets dark.

Build and test the circuit.




Use the breadboard below to plan your circuit before you build it.



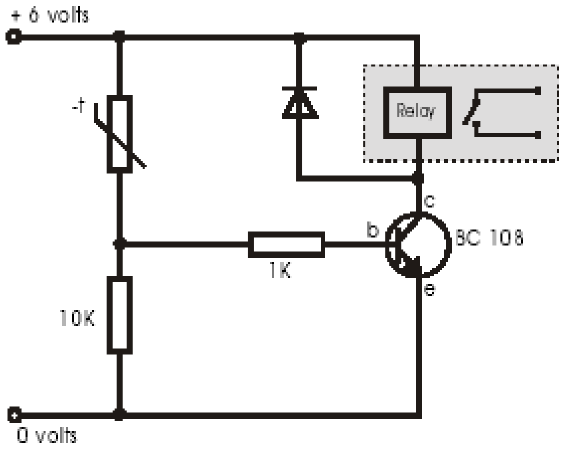
Complete the sentences below.

When light is hitting the LDR the bulb.....................................

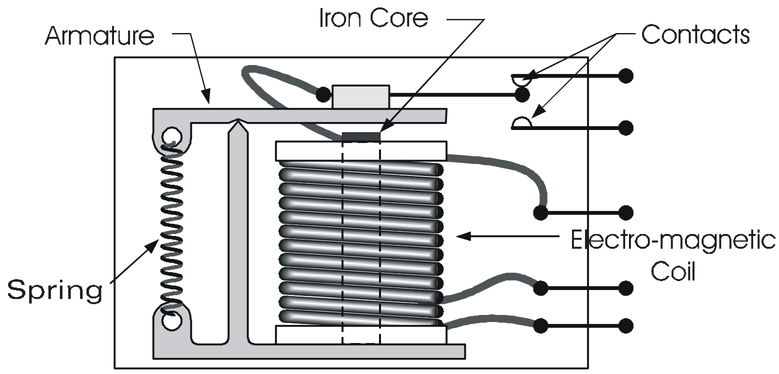
When there is no light hitting the LDR the bulb..........................

# Relays

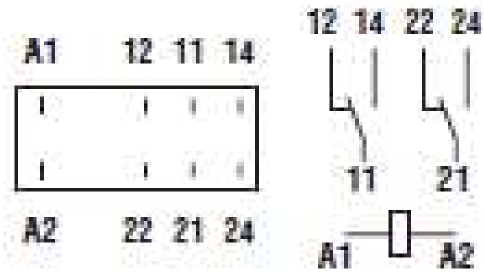
Although relays are often considered to be output devices, they are really output switches from electric or electronic circuits. These output switches are used as inputs for other circuits. In practice you can hear relays clicking on and off when a car's indicators are used.




A relay has a coil that is energised and de-energised as the relay switches on and off. During this process the coil can generate a large reverse voltage (called back EMF). This reverse voltage can cause considerable damage to components, especially transistors. Sensitive components can be protected by the inclusion of a diode that provides a path for the current, caused by the reverse voltage, to escape.



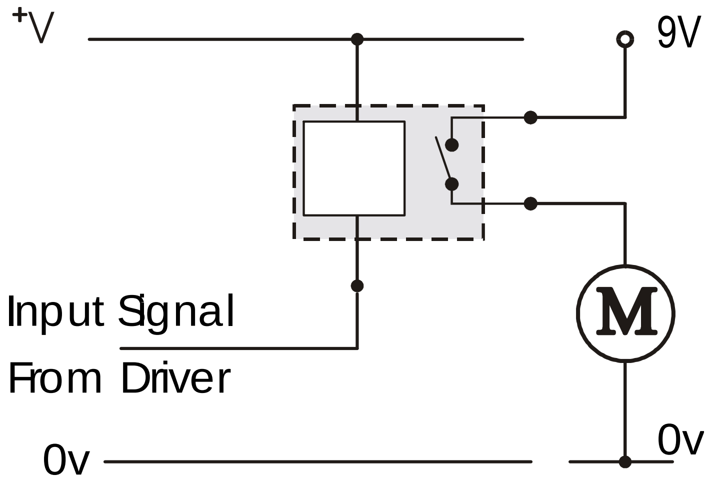

RELAY



The relay is a very useful device and is particularly useful for energising devices that require substantial amounts of current. It is perhaps the most commonly used switch for driving devices that demand large currents

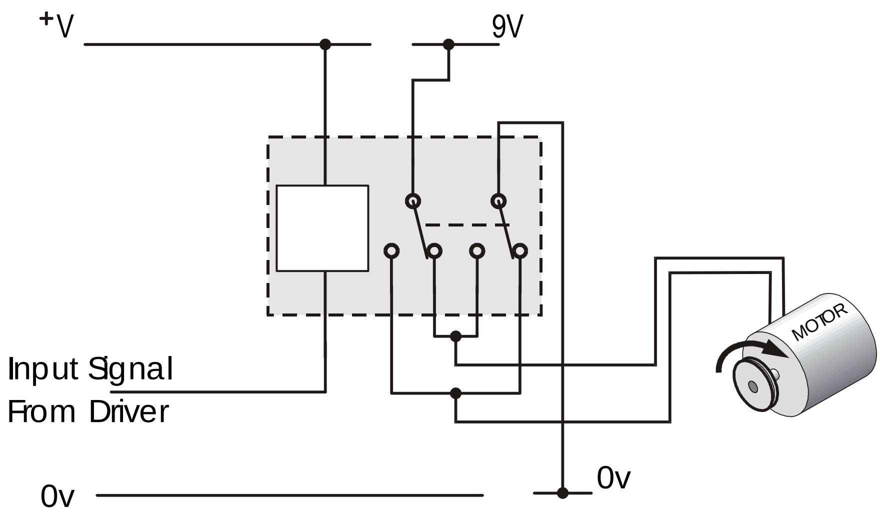
## Single Pole Single Throw (SPST)

The SPST is used for any simple control system e.g. controlling a lamp, turning a heating element on etc.




## Double Pole Double Throw

A DPDT relay is ideal for controlling a motor. As can be seen below the motor can run backwards or forwards.



## 555 Timers

An integrated circuit is simply an electronic package that contains a number of components on a silicon chip. The 555 Timer IC is versatile and can do many operations. 555 Timers can be used as a monostable device. This means that it is stable in only one state (normally off), that is, it jumps back to its initial state after a set time.

## Capacitors

Capacitors are electronic components that store electricity for short periods of time within electronic circuits or networks. They are made from 2 metal plates or films separated by an insulator. Capacitors are especially useful in timer circuits with 555 Timer chips. There are two basic types of capacitors normally used in timer circuits; electrolytic and polyester.

## Stepper Motor

Stepper motors are very accurate motors that are commonly used in computer drives, printers, X-Y plotters and clocks.

Unlike d.c. motors which spin round freely when power is applied, stepper motors require that their power supply is continuously 'pulsed' in four different patterns. For each pulse, the stepper motor moves around one 'step', typically 7.5 degrees (giving 48 steps per revolution).

Stepper motors do have some limitations. First the power consumption is greatest when the stepper motor is stopped (as all coils are still energised). The speed of revolution is also limited to around 100 steps per second, which provides a rotational speed of 2 rev per sec or 120 rev per min.

The stepper motor contains magnets that are fixed to the central armature. Four electronic coils are located around the casing. When a current is passed through these coils they generate a magnetic field, which attracts/repels the permanent magnets on coils are then energised in a different pattern to create a different magnetic filed and the armature spins another step.

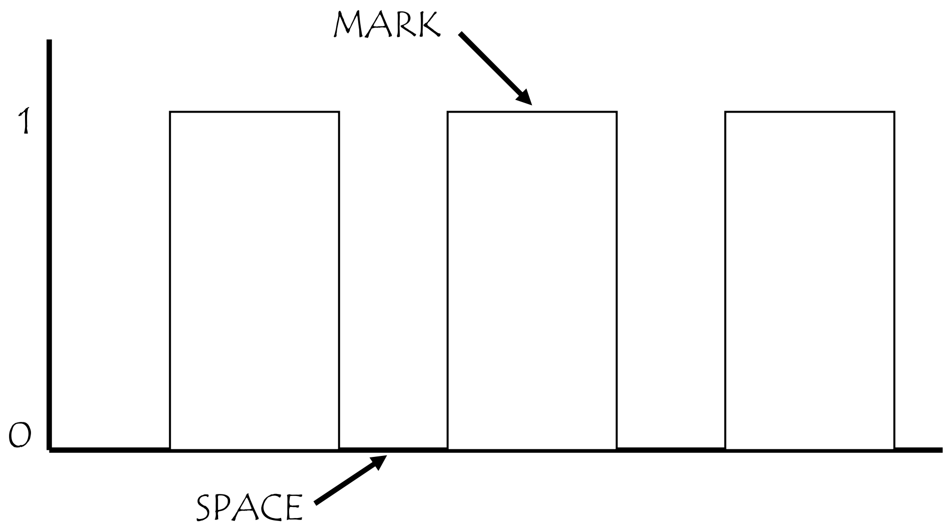
To make the armature rotate continuously, the four coils inside the stepper motor must be switched on and off in a certain step order. The ULN2803A driver chip on the output driver module provides the method of interfacing these four coils.

Pulse Width Modulation

Pulse-width modulation control works by switching the power supplied to the motor on and off very rapidly. The DC voltage is converted to a square-wave signal, alternating between fully on (nearly 12V) and zero, giving the motor a series of power "kicks".

If the switching frequency is high enough, the motor runs at a steady speed due to its fly-wheel momentum.

By adjusting the duty cycle of the signal (modulating the width of the pulse, hence the 'PWM') i.e., the time fraction it is "on", the average power can be varied, and hence the motor speed.

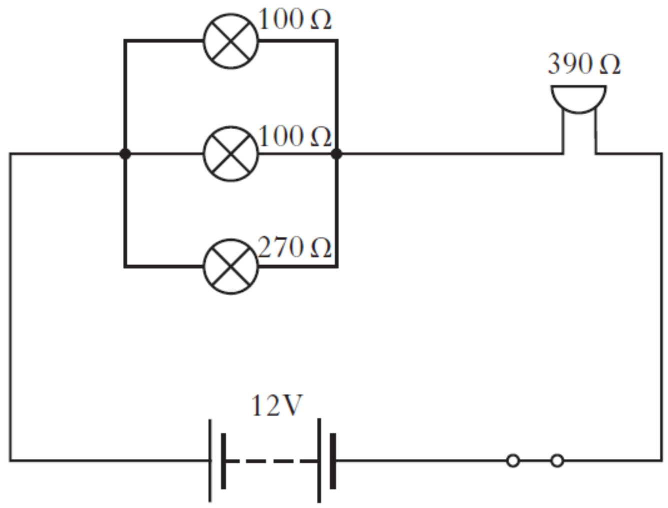



Frequency

Frequency is the regular rate at which a physical event repeats itself, eg. A flashing LED.

Task 16

A circuit used to warn when a vehicle is reversing is shown




a) Calculate:

(i) The equivalent resistance of the three lamps;

(ii) The total circuit resistance

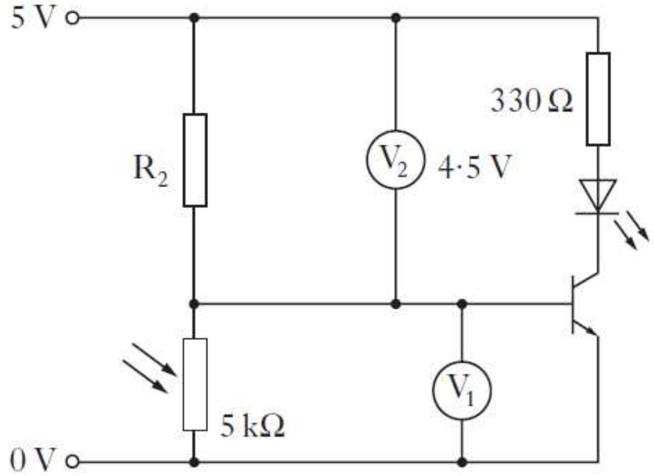
(iii) The total circuit current

(iv) The power used by the circuit.

b) Indicate with a cross (X), where an ammeter would be placed to measure the current through the 270 Ω lamp.

Task 17

Here shows an electronic circuit for a garden night light.




a) State with reference to the Data Booklet, the light level that will produce a resistance of 5 k**Ω** in the LDR.

For the conditions shown in the diagram

b) Determine the voltage shown on V1;

c) Calculate the resistance R2;

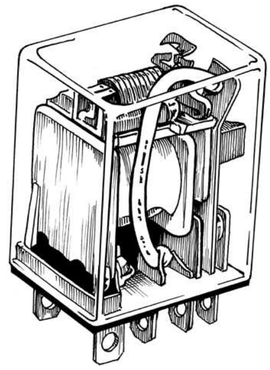
d) State if the LED is on or off, and explain why this is the case.

e) Describe the effect that an increasing light level will have on the resistance of the LDR and the voltage shown on V1.

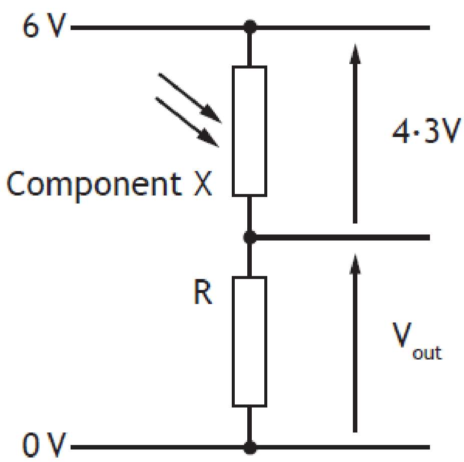
*As the light level increases . . .*

Task 18

1. Relays, like the one shown in the diagram to the right, are often used in electronic control circuits. Describe the general purpose of a relay.

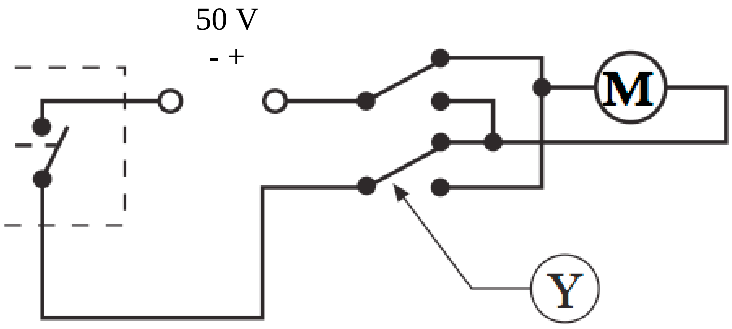


2. A weather monitoring station is used to collect data. Light levels are measured using the sensing sub-system shown in the diagram.




State the full name of Component X and say what it does.

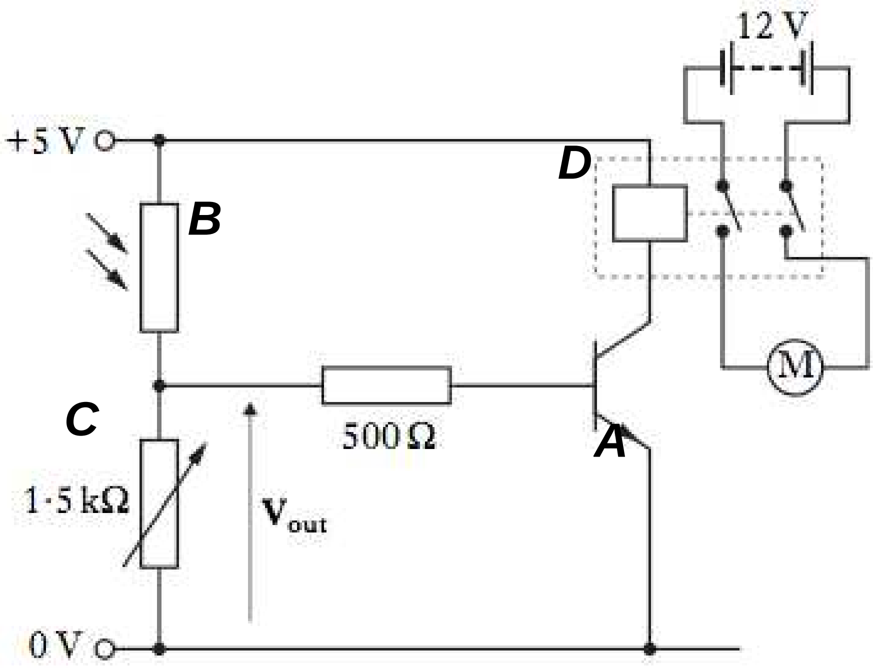
3. The output stage of a control circuit is shown below. The DPD switch Y is being used to control the motor.




Describe what happens to the motor as Y switches positions.

Task 19

1. Part of a prototype electronic circuit that operates an automatic window blind is shown below.




a) State the name of the following components

A ______________________ B ______________________

C ______________________ D ______________________

b) Describe the function of the following components

A –

D –

Components *B* and *C* are connected in series to form a voltage divider.

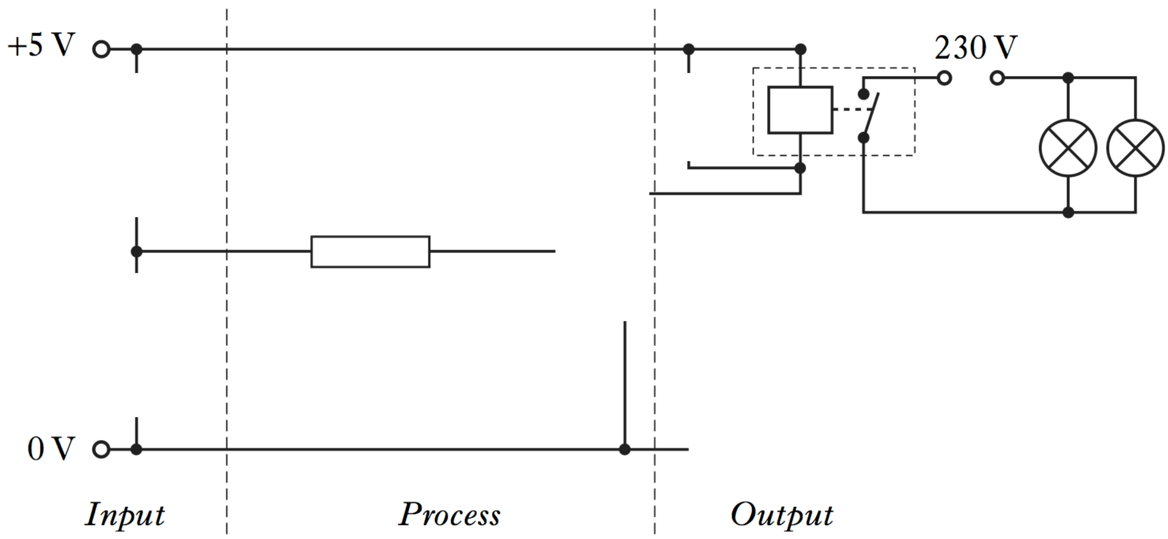
c) State the function of the voltage divider in this circuit.

Task 20

A sports field requires floodlights that will come on automatically when it starts to get dark. An incomplete circuit is shown below.

a) Complete the circuit by drawing the following components in the appropriate places:

- an LDR and variable resistor in series to form a light sensor
- a transistor
- a diode to protect the transistor from back voltage produced by the relay




b) Describe how the circuit works