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GRADE 9

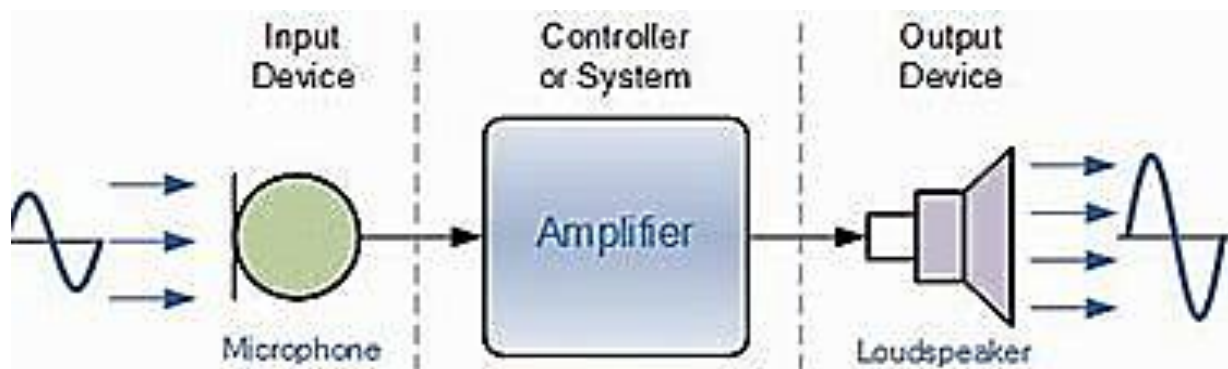
TECHNOLOGY ACTIVITIES - 2022

TERM 3

MEMORANDUM

ELECTRICAL SYSTEMS & CONTROL

Non Polar Capacitor



WEEK 1: BASELINE ASSESSMENT

“Components” are the parts that we connect in an electric circuit.

The simplest circuit needs the following components to work correctly:

- a **power source** such as a **cell**,
- a **conductor**, and
- a **load that provides resistance**, such as a **lamp**.

ACTIVITY 1

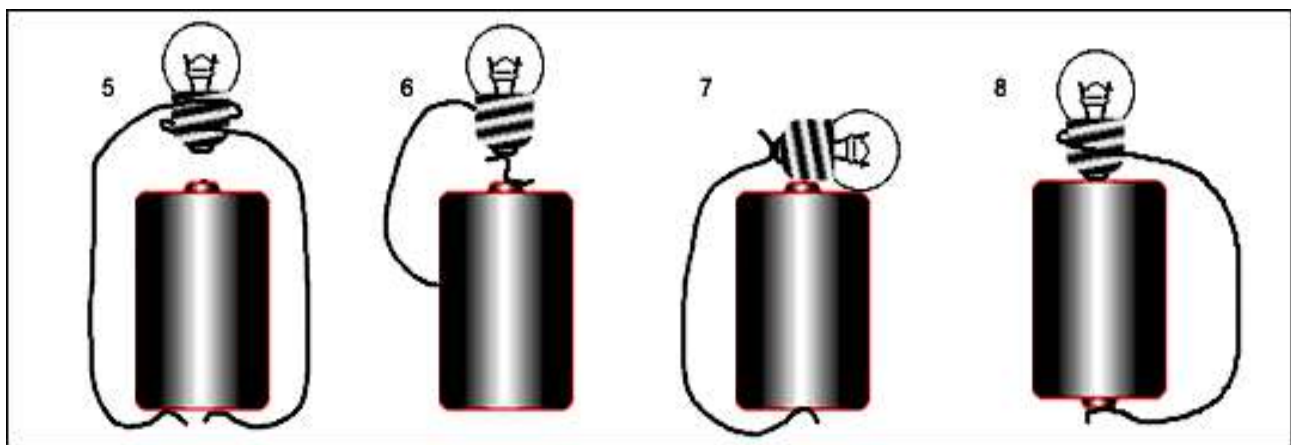
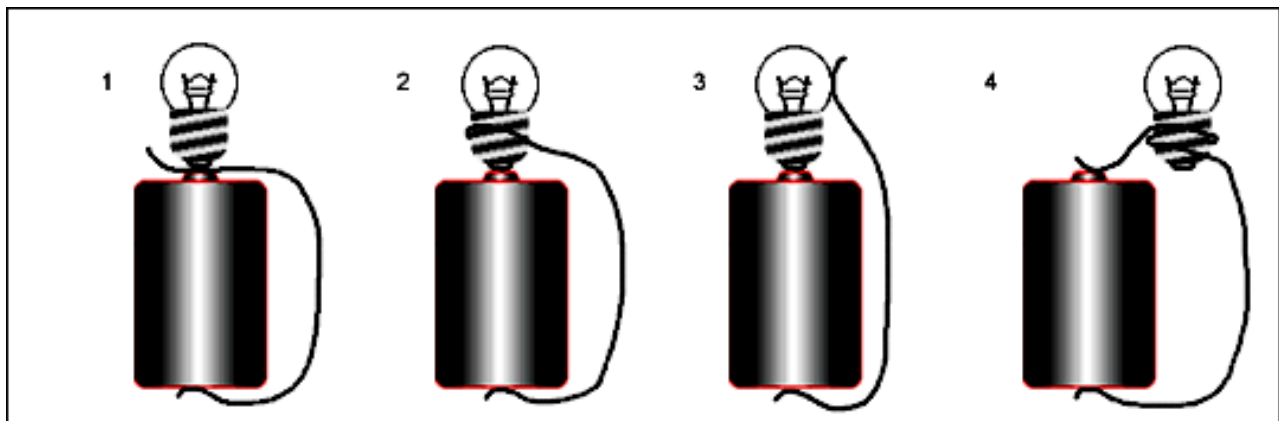
1.1 Complete the table below by using the different resources to find the information required:

- Draw the symbol for each of the electronic components (5)
- State the function / use of each electronic component (5)
- Indicate whether the component is an input/output or control device. (5)

NAME	SYMBOL	USE/ function	INPUT/OUTPUT /CONTROL
Cell 1.1.1		Source of energy.	Input
Bulb/Globe 1.1.2		Lights up. / Glows	Output
Push switch 1.1.3		Temporarily close a circuit.	Control
Bell / Buzzer 1.1.4		Used as an alarm. It gives off sound.	Output
LED 1.1.5		Converts electrical current into coloured light.	Output

1.2 When electricity flows through a circuit it can be used to light up a globe.
Predict which of these globes will light.

(8)

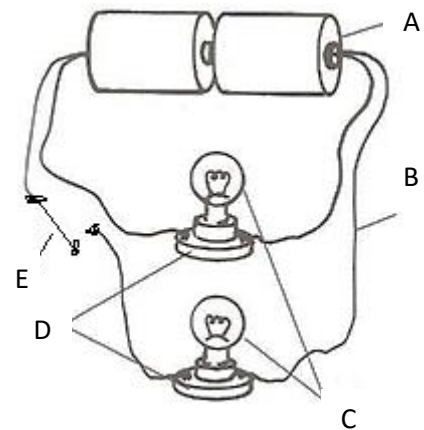


	ON	OFF
Globe 1		OFF
Globe 2	ON	
Globe 3		OFF
Globe 4		OFF
Globe 5		OFF
Globe 6		OFF
Globe 7	ON	
Globe 8	ON	

1.3.1 Label the components in the electrical circuit below.

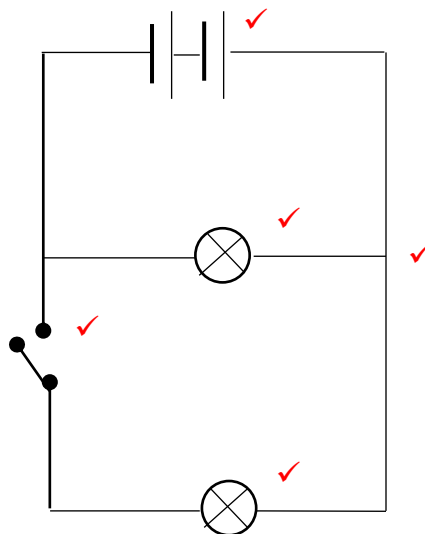
(5)

- A. Cell ✓
- B. Connecting wires ✓
- C. Bulbs ✓
- D. Bulb holders ✓
- E. Switch ✓



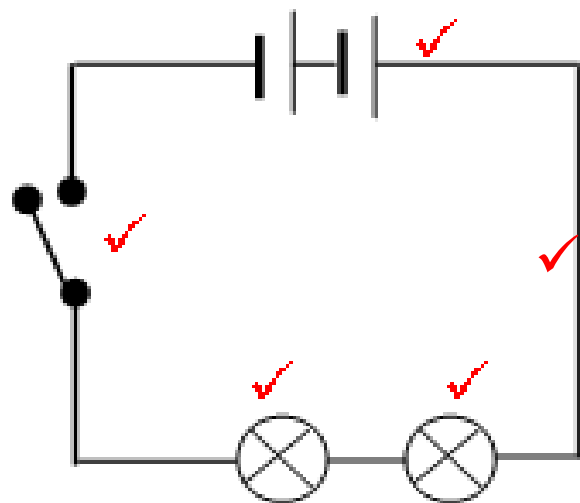
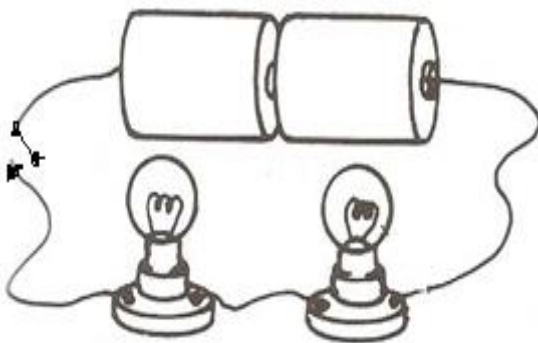
1.3.2 Draw the circuit diagram for the electrical circuit above.

(5)



1.4 Draw the circuit diagram for the electrical circuit below.

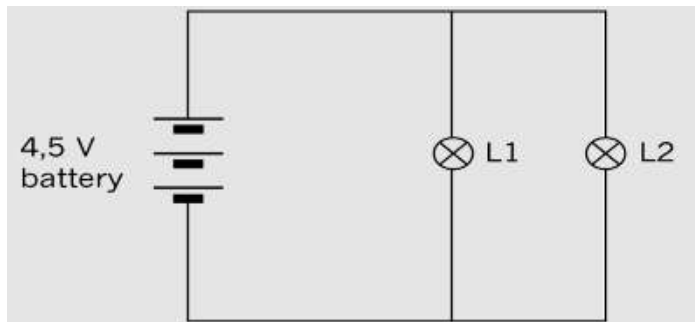
(5)



1.5 Study the circuit diagram below and answer the questions.

(7)

The diagram shows two bulbs in an electric circuit.



1.5.1 How many cells are there in this circuit?

3

1.5.2 Will the two bulbs glow at the same brightness?

YES

1.5.3 If bulb L1 is removed, will bulb L2 glow?

YES

1.5.4 Give a reason for your answer in question 1.5.3

Bulb are connected in parallel, when L1 is removed, the current will still flow to bulb L2.

1.5.5 Indicate the positive and negative terminals of the battery on the diagram.

1.5.6 In what direction is the current moving in the conventional circuit?

From the positive terminal of the battery to the negative terminal

1.5.7 What energy conversion is taking place in the bulb?

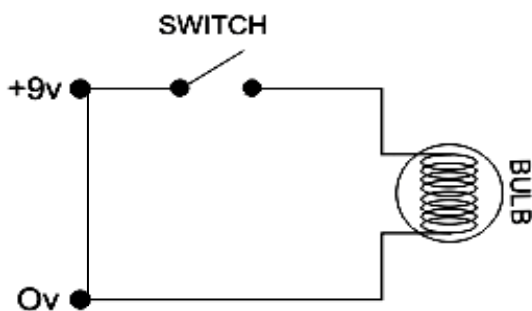
Electrical potential energy to light and heat energy

TOTAL = 45

ELECTRICAL SYMBOLS AND DRAWING CIRCUITS

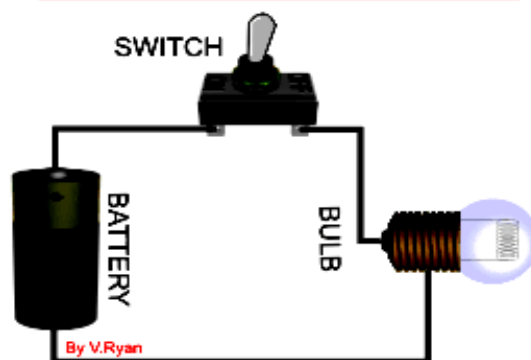
You must be able to draw an electrical circuit diagram from a pictorial diagram.

CIRCUIT DIAGRAM



Circuit diagram

PICTORIAL CIRCUIT DIAGRAM



Pictorial diagram

WEEK 1: REVISE SERIE & PARALLEL

CELLS IN SERIES

Key words

- **series** – a circuit where the current passes through the components one after another
- **parallel** – a circuit that has more than one path for the current

We say that the cells are **connected in series** if :

- the positive pole of one cell is connected to the negative pole of another cell there is only one path for the current.
- Two or more cells can be connected **in series** to **increase the voltage in the circuit**. Figure 2 below shows two cells connected in series in a circuit. The positive terminal of cell A is connected to the lamp.
- The negative terminal of cell A is connected to the positive terminal of cell B, and the negative terminal of cell B is connected to the other terminal of the lamp.

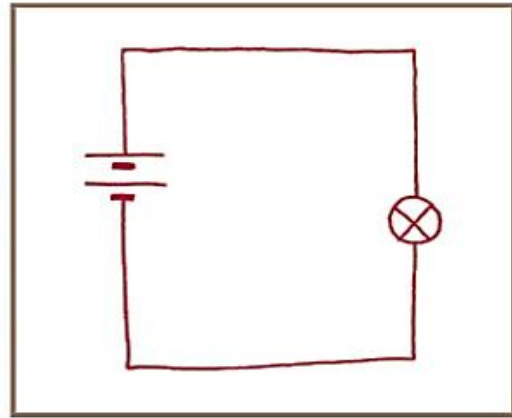
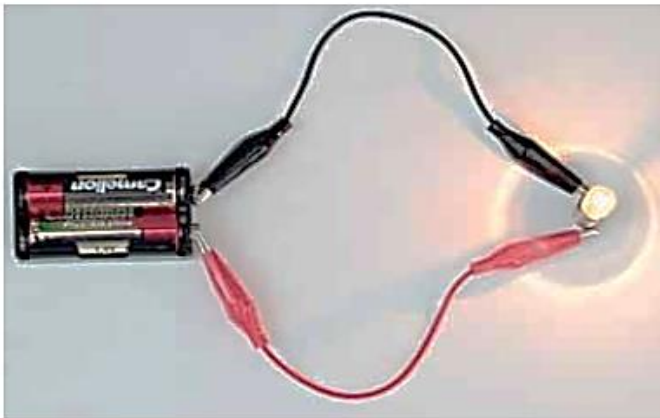


Figure 2: Two cells in series connected to a lamp

- **In series** means the cells are connected end-to-end, and the current flows through each cell in turn.

Figure 3 below shows three cells connected in series in a circuit. Draw a circuit diagram of the circuit in the space to the right of Figure 3.

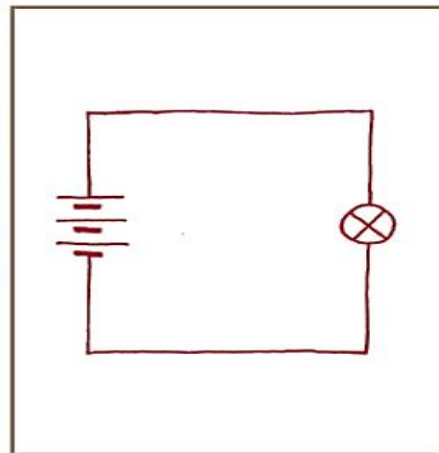
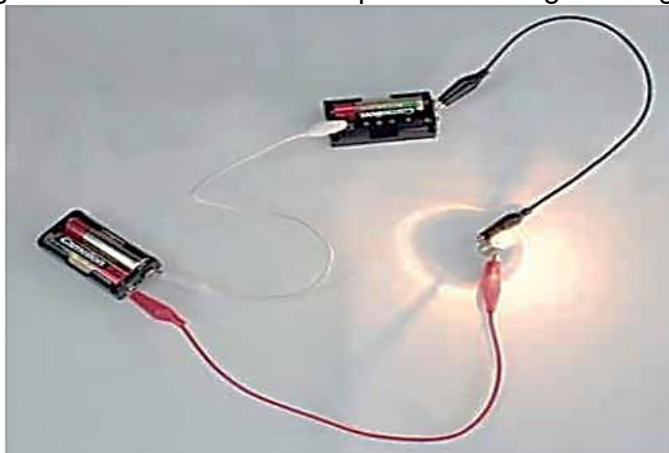


Figure 3: Three cells in series connected to a lamp

When cells are **connected in series**, their **TOTAL VOLTAGE** is **the sum of the voltages of the three cells**: $1,5\text{ V} + 1,5\text{ V} + 1,5\text{ V} = \underline{4,5\text{ V}}$

CELLS IN PARALLEL

The cells are in parallel if :

- the positive pole of each cell is connected to the positive pole of the next cell there are as many paths for the current as there are cells.
- There are **two or more different paths** for the current to travel along.
- The **positive terminals of both cells are connected to each other and to the lamp**. The **negative terminals of both cells are connected to each other and to the other terminal of the lamp**.

→ Draw a circuit diagram of the circuit in Figure 4 in the space to the right of it.

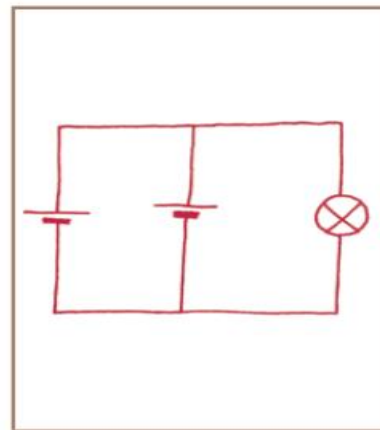
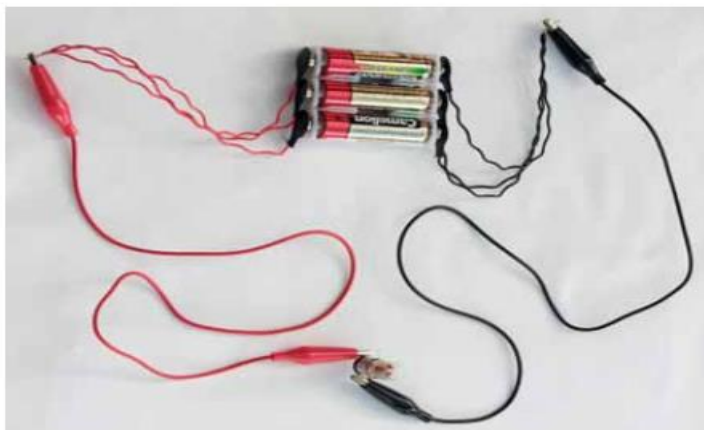
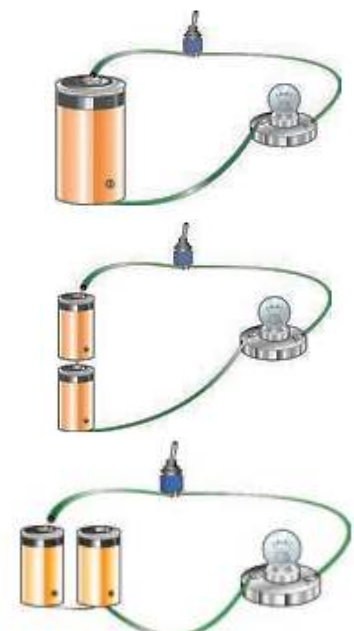


Figure 4: Three cells in parallel connected to a lamp

When cells are connected in parallel, the **TOTAL VOLTAGE OF THE CELLS** is the same as that of a single cell (1,5 volts).

The pictures alongside show cells connected in series and parallel:

1. a circuit with a lamp, a switch and one cell
2. a circuit with a lamp, a switch and two cells in series
3. a circuit with a lamp, a switch and two cells in parallel



EFFECTS ON THE BRIGHTNESS OF THE LAMPS:

➔ The lamp in the circuit with **ONE CELL** in series is about as bright as the lamp with **TWO CELLS CONNECTED IN PARALLEL**.

➔ The lamp in the circuit with **TWO CELLS** in **SERIES** is much brighter.

LAMPS / BULBS IN SERIES

- Two or more lamps can be connected in series.
- The diagrams below show circuit diagrams of two and three lamps connected in series with the battery.

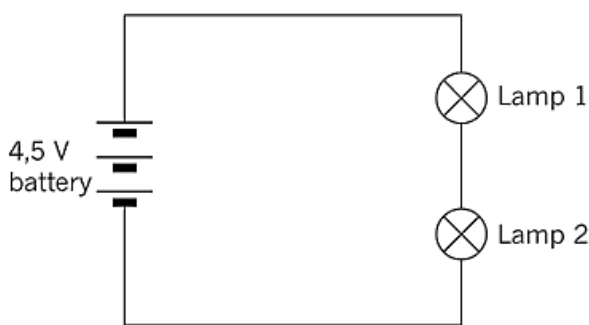


Figure 5: Two lamps in series

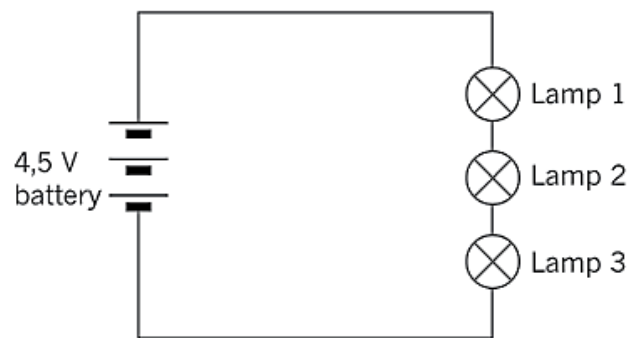


Figure 6: Three lamps in series

- The positive terminal of the battery(+B) is connected to lamp 1, the other side of lamp 1 is connected to lamp 2, the other side of lamp 2 is connected to the negative terminal (B-) of the battery, and so forth.
- ➔ How does increasing the number of lamps in series change the current and voltage in the circuit?

The overall voltage drop of the lamps remains the same, but the current decreases.

- If all the **lamps have the SAME RESISTANCE**, the **voltage** across each lamp **will be equal to 1,5 V**.
- When the **voltage drops of all the lamps are added**, the **total battery voltage of 4,5 V is obtained**.
- The current is the same through each lamp.

LAMPS / BULBS IN PARALLEL

- Two or more lamps can be connected to the battery in parallel, as shown in the circuit diagrams below.

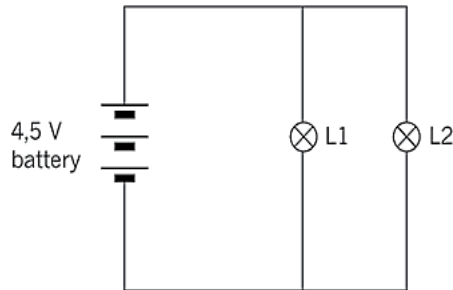


Figure 7: Circuit diagram of two lamps in parallel

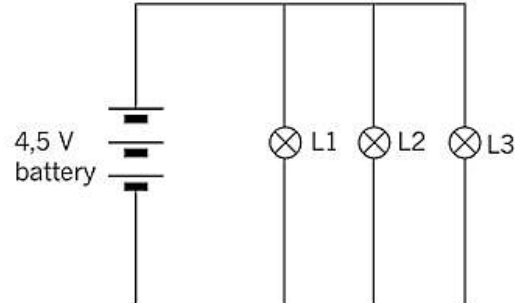


Figure 8: Circuit diagram of three lamps in parallel

- The positive terminal of the battery is directly connected to one side of each lamp and the negative terminal to the other side of each lamp.

- The applied **VOLTAGE** is the same across each lamp.
- The current is divided across each lamp, and the total current is the sum of the current through each lamp: $I_t = I_1 + I_2 + I_3$

Ohm's law quantitatively: as voltage increases, current increases if resistance is constant.

SWITCHES IN SERIES

In the circuit below, there are two switches in series.

This gives us four different switch combinations:

- Switch A and B both open,
- Switch A open and B closed,
- Switch A closed and B open, and
- both switches closed.

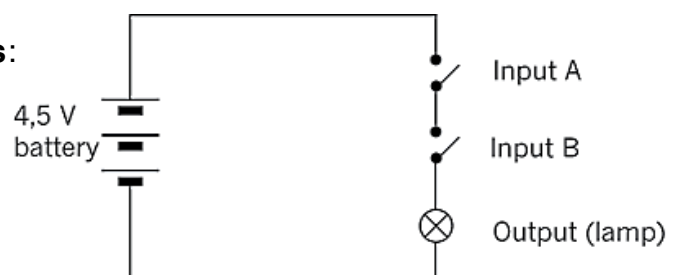


Figure 9: Circuit with two switches in series.

→ Complete the truth table to show all the different combinations possible in the circuit in Figure 9.

→ Indicate a "0" for an off position, and "1" for an on or closed position.

Input A	Input B	Output
0	0	0
0	1	0
1	0	0
1	1	1

CONCLUSION FOR SWITCHES IN SERIES

- The current cannot flow through the circuit if either switch A or switch B is open.
- BOTH SWITCHES must be CLOSED for the LAMP TO GLOW (an output).
- Therefore, SWITCHES CONNECTED IN SERIES give us an AND function

SWITCHES IN PARALLEL

In the circuit below, there are two switches in parallel. This also gives us four different switch combinations.

- Switch A and B both open,
- Switch A open and B closed,
- Switch A closed and B open, and
- both switches closed.

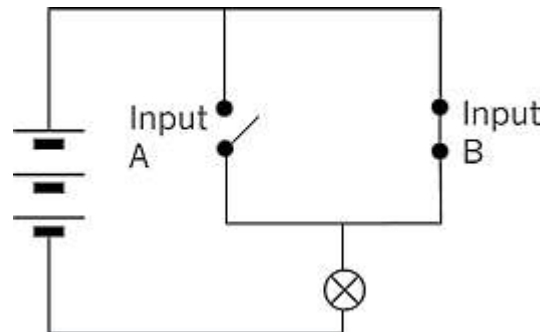


Figure 10: Circuit with two switches in parallel

- Complete the truth table to show all the different combinations possible in the circuit in Figure 10.
- Indicate a “0” for an off position, and “1” for an on or closed position.

Input A	Input B	Output
0	0	0
0	1	1
1	0	1
1	1	1

CONCLUSION FOR SWITCHES IN PARALLEL

- The current can go through a closed switch, even if the other switch is open.
- When SWITCH A OR SWITCH B IS CLOSED, the OUTPUT WILL BE 1 (the lamp will be on).
- We call SWITCHES IN PARALLEL an OR function.

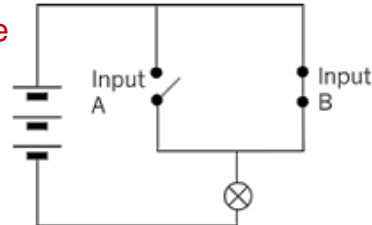
ACTIVITY 2

Use prior knowledge and complete the following questions:

2.1 Study the diagrams of the electric circuits below and answer the questions.

2.1.1 Would the lamp light up in the circuit below? Explain your answer.

Yes, because the lamp light is part of a complete circuit that includes the battery (there is a continuous conducting loop including the lamp light and the battery).

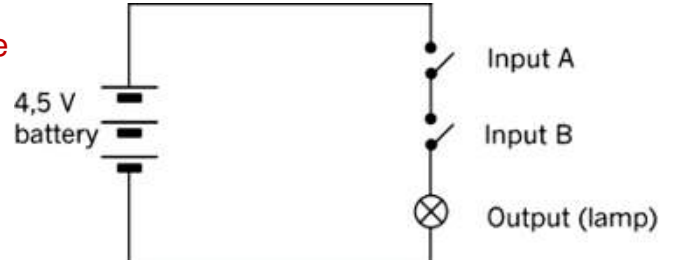


2.1.2 Complete the truth table for the circuit by providing Output conditions.

Input A	Input B	Output
0	0	0
0	1	1
1	0	1
1	1	1

2.2.1 Will the lamp light up in the circuit below? Give a reason for your answer.

No, the lamp light is not part of a complete circuit that includes the battery (the lamp and bulb are in a loop that is open).



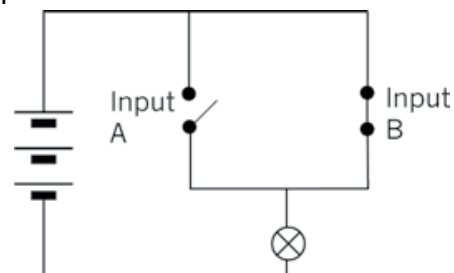
2.2.2 Complete the truth table for the circuit.

Input A	Input B	Output
0	0	0
1	0	0
0	1	0
1	1	1

2.3 Study the control circuit below and answer the questions below.

2.3.1 Name the logic control gate.

OR logic gate



2.4 A kettle must be switched on at the wall plug first and then at the kettle itself.

2.4.1 Fill in the truth table to show all the possible combinations.

Wall plug switch	Kettle switch	Output
0	0	0
0	1	0
1	0	0
1	1	1

2.4.2 Is this an AND function or an OR function? Explain your answer.

It is an AND function. Both switches have to be closed for the kettle to work. If one is off, the kettle will not work.

2.5 Identify the symbols for the following logic gates and fill in the output in the truth table next to each symbol.

2.5.1 OR logic gate.



Truth table

Input		Output
A	B	Z
0	0	0
0	1	1
1	0	1
1	1	1

2.5.2 AND logic gate.



Truth table

Input		Output
A	B	Z
0	0	0
0	1	0
1	0	0
1	1	1

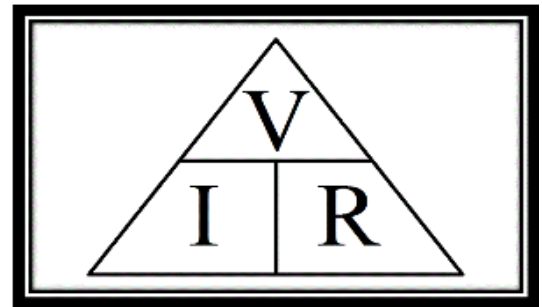
WEEK 2: OHM'S LAW

CALCULATE CURRENT WITH OHM'S LAW

- We have learnt **Ohm's Law**: For a **given resistance**, the **current in the circuit is directly proportional to the voltage across the circuit**.
- Therefore, **if you double the voltage, the current will also double**.

THE EQUATION FOR OHM'S LAW IS:

- I** is the **current in amps (A)**
- V** is the **voltage across the circuit in volts (V)**
- R** is the **resistance of the circuit in ohms (Ω)**.



REVISE AND PRACTISE: OHM'S LAW TO CALCULATE CURRENT

You will need: calculator

Work on your own.

- 2.6 In the table alongside, use Ohm's Law to calculate the value of the current.

Circuit	Voltage (V)	Resistance (Ω)	Current (I)
1	10	2	5
2	12	12	1
3	6	50	0.12
4	1,5	100	0.015

HOW TO MEASURE THE CURRENT IN A CIRCUIT

- Ammeters** are used to measure current.
- The **unit** in which electric current is measured is the **ampere (A)**.
- The **current** flowing in the circuit (or in the part of the circuit being measured) **must pass through the ammeter**.

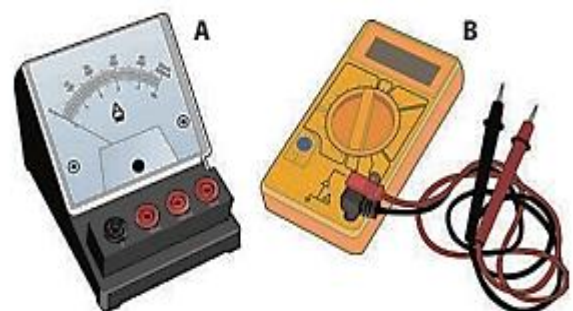


Figure 9.18 An analog ammeter (A) and a digital multimeter (B)

- The **ammeter is connected in series** in the circuit.
- Ammeters **must not alter the flow of current** in circuits, so their resistance is very low.
- The **current must flow in the correct direction** through an ammeter:
 - Connect the **RED positive wire** towards the positive pole of the cell.
 - Connect the **BLACK negative wire** towards the negative pole of the cell.

2.7 Draw the circuit diagram, using the correct symbols for the pictorial diagram below.



Figure 9.19 The ammeter is connected in series in a circuit.

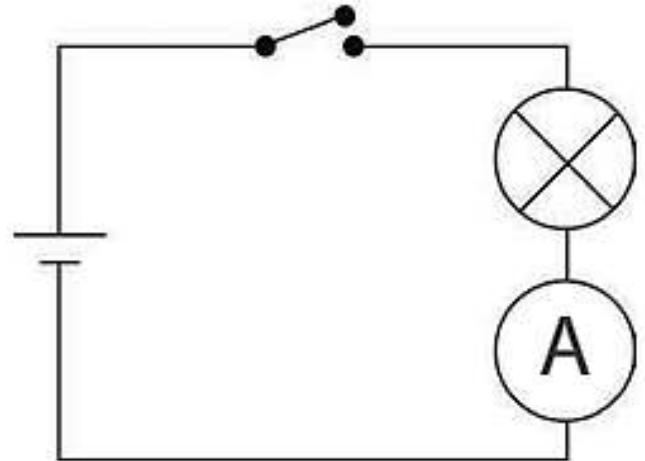
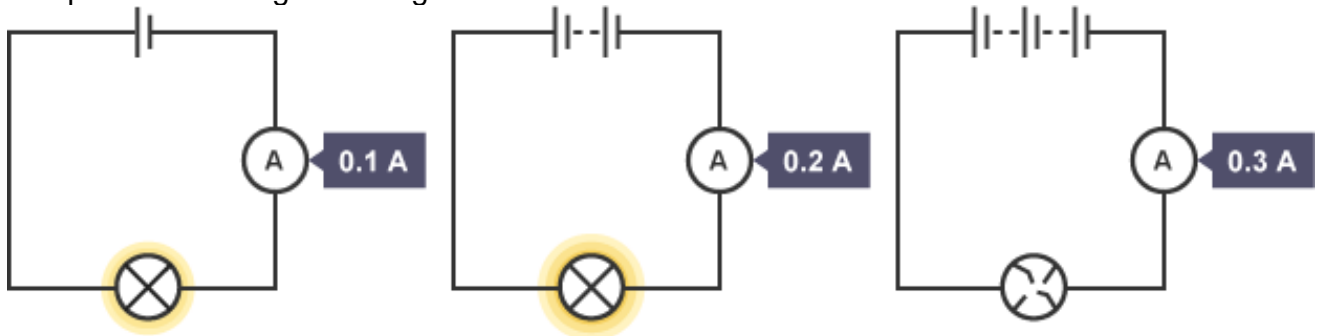


Figure 9.20 A circuit diagram showing an ammeter connected in series.

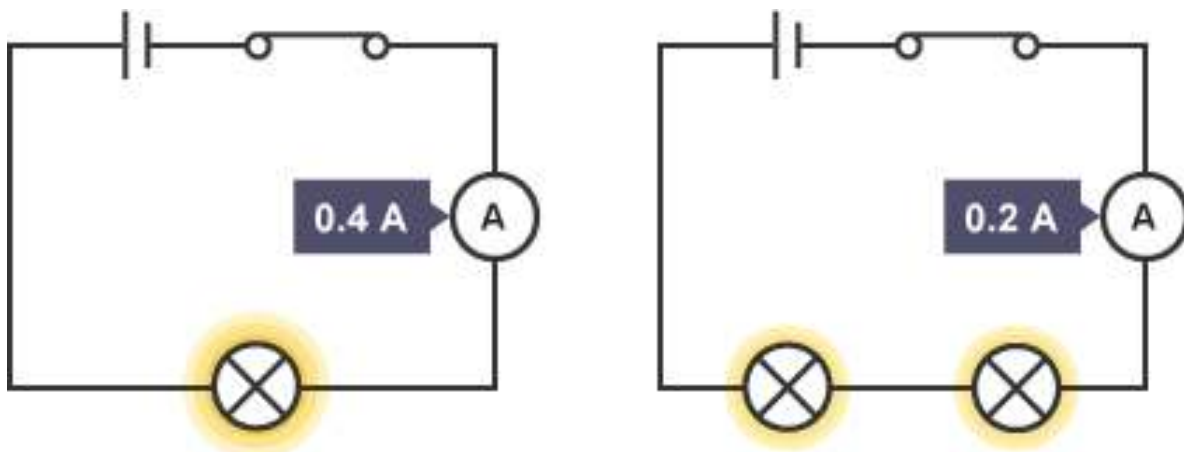
CHANGING THE VOLTAGE

If you increase the voltage across a component, there will be more current in the component. Too high a voltage and the bulb will blow.



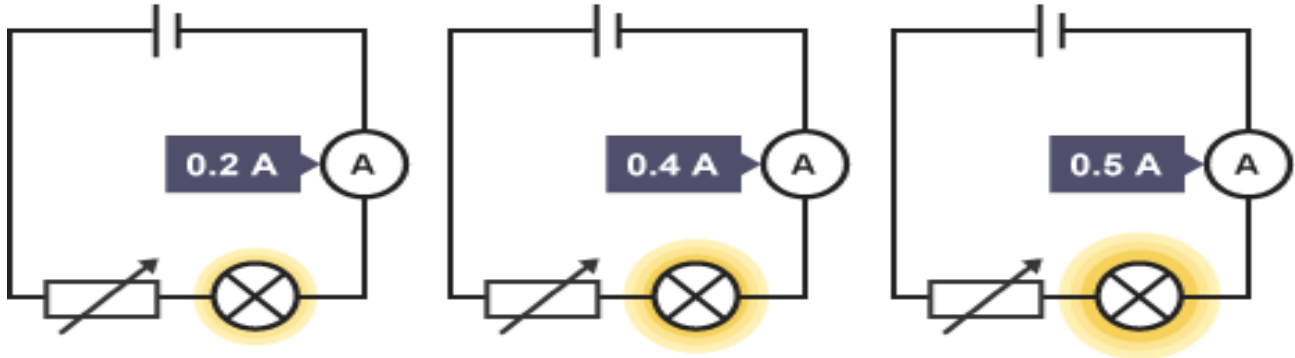
CHANGING THE RESISTANCE

If you increase the number of lamps in a series circuit, there will be less current. The lamps resist the current, so if you put more lamps into the circuit, there is more resistance.



Number 1 has a cell and closed switch on the top, an ammeter reading 0.4A at the right and a brightly lit bulb at the bottom. Number 2 also has a cell and closed switch at the top, an ammeter reading 0.2A at the right and two dimly lit bulbs at the bottom.

YOU COULD DO THE SAME WITH A VARIABLE RESISTOR.



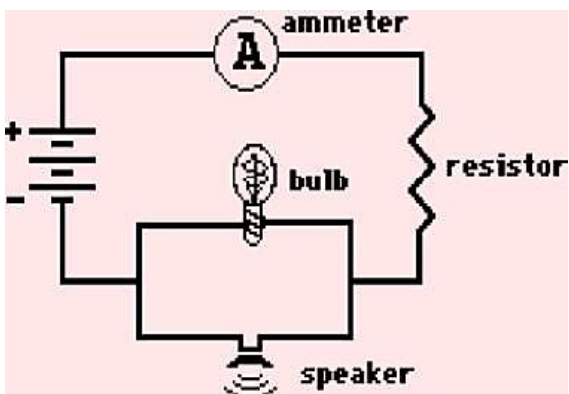
Circuit 1 has a cell at the top, an ammeter reading 0.2A on the right and a lamp giving off a little light at the bottom right and a variable resistor bottom left.

Circuit 2 has a cell at the top, an ammeter reading 0.4A on the right and a lamp giving off a medium amount of light at the bottom right and a variable resistor at bottom left.

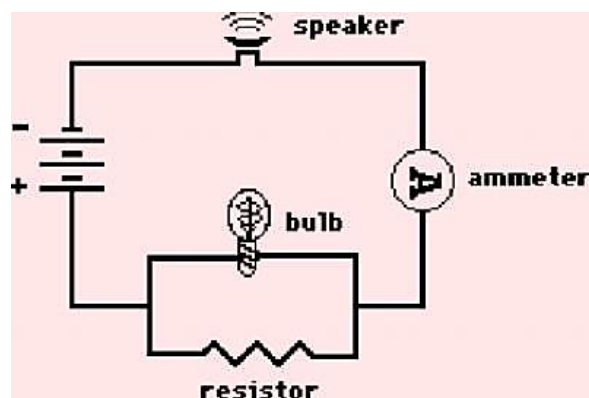
Circuit 3 has a cell at the top, an ammeter reading 0.5A on the right and a lamp giving off a lot of light at the bottom right and a variable resistor at bottom left.

2.8 ACTION RESEARCH: OHM'S LAW PRACTICALLY

2.8.1 Two electric circuits are diagrammed below. For each circuit, indicate which two devices are connected in series and which two devices are connected in parallel.



Series : **ammeter ; resistor**
Parallel : **bulb ; speaker**



Series : **speaker ; ammeter**
Parallel : **bulb ; resistor**

2.8.2 Use Ohm's Law to calculate the missing values in the table.

Section of the circuit	Voltage measured (V)	Resistance of the section of the circuit (Ω)	Current calculated (A)
1	9	300	0.03
2	3	1000	0.003
3	4.5	1000	0.0045
4	45	500	0.09

2.9 PRACTICAL DEMONSTRATION: THE EFFECT OF TWO AND MORE CELLS IN SERIE IN A CIRCUIT

You will need

Ammeter that measures up to 0,5 A (500 MA)

Voltmeter that measures up to 5 V,

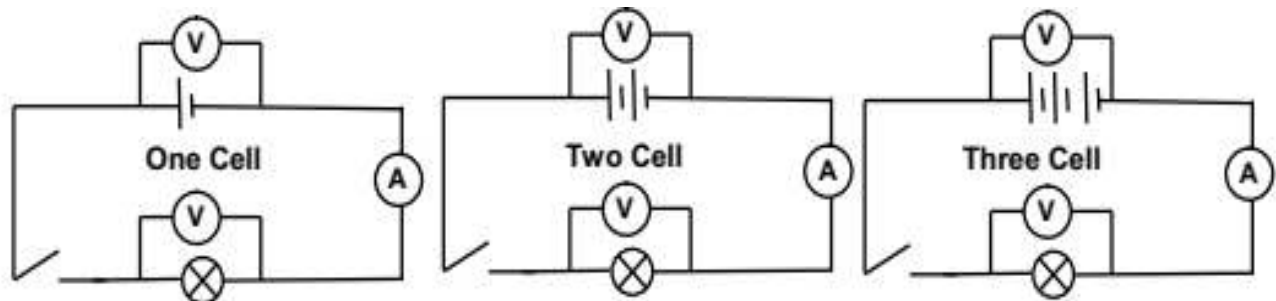
Bulbs (20 ohm (Ω) resistors)

Cells

METHOD

Set up the different circuits using lamps as 20 ohm (Ω) resistors and measure the current and voltage for each one:

- a. Connect one cell, a globe, a switch and an ammeter in series as indicated in the circuit diagram.



- b. Connect a voltmeter over the globe, as well as over the cell, as shown.
- c. Switch the circuit on and take the readings on the voltmeter and ammeter.
- d. Observe the brightness of the globe. Repeat by using two, and then three cells in series.

2.9.1 Complete the table below with the readings of the voltmeter and ammeter.

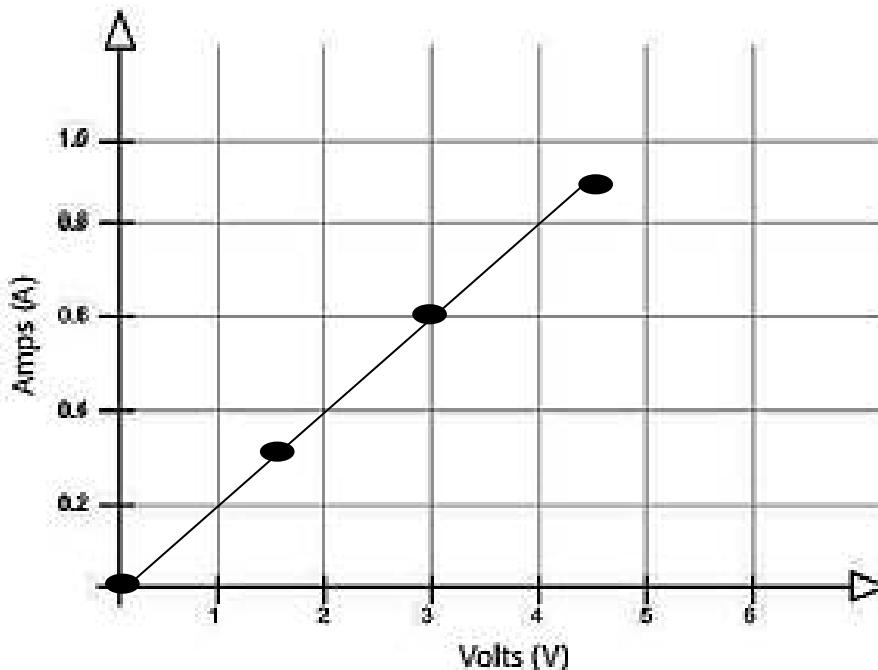
Cells in series	Voltmeter reading over cells	Voltmeter reading over globe	Ammeter reading	Brightness of the globe
1	1,5V	1,5V	0,3A	Brightly
2	3,0V	3,0V	0,6A	More Brightly
3	4,5V	4,5V	0,9A	Very Bright

2.9.2 Which ammeter reading is the largest?

The one where 3 cells are connected in series

2.9.3 Plot the readings of the voltmeter reading over the globe / bulb and the ammeter reading on the graph below.

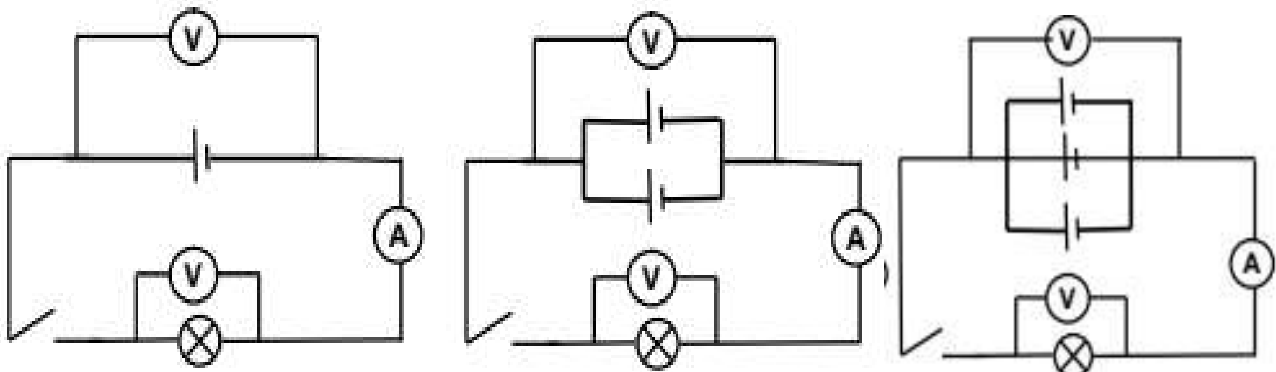
Plot voltage of the on the horizontal axis and current on the vertical axis.



2.9.4 What important conclusion can we reach from this experiment?

Observation: The brightness of the light bulb increases as the number of cells in series increases. Connecting more cells in series will yield a higher current strength and also a higher potential difference.

2.10 PRACTICAL DEMONSTRATION: THE EFFECT OF TWO AND MORE CELLS IN PARALLEL IN A CIRCUIT



METHOD

- Connect one cell, a globe, a switch, and an ammeter in series.
- Connect a voltmeter over the globe, as well as one over the cell.
- Switch the circuit on and take the readings on the voltmeters and the ammeter. Watch the brightness of the globe as well. Repeat by using two and then three cells in parallel.

2.10.1 Complete the table below with your findings

Cells	Voltmeter reading over cells	Voltmeter reading over globe	Ammeter reading	Brightness of the globe
One cell	1,5V	1,5V	0,3 A	Globe has the same brightness in all three circuits
Two cells in parallel	1,5V	1,5V	0,3 A	
Three cells in parallel	1,5V	1,5V	0,3 A	

2.10.2 How did an increase in the number of cells in parallel influence the voltmeter reading, connected over the cells?

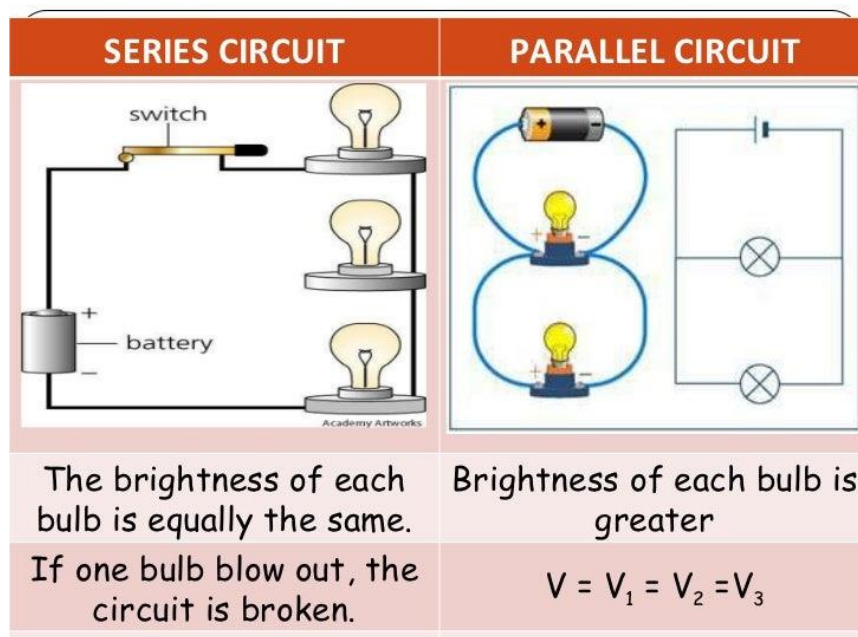
Readings remain the same

2.10.3 How did an increase in the number of cells in parallel influence the ammeter reading at any point in the main current?

The ammeter readings remained the same.

2.10.4 What important conclusion can we reach from this experiment?

Observation : The brightness of the bulb stayed the same in all three cases. Connecting more cells in parallel will not increase current strength or the potential difference in the circuit.



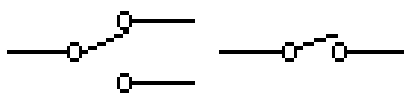
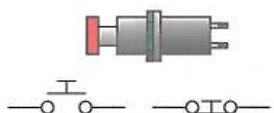
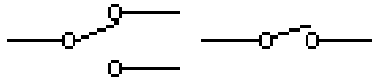
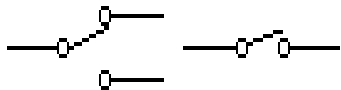
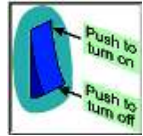
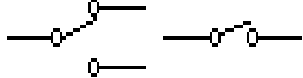
WEEK 3: CONTROL DEVICES

A. SWITCHES

B. DIODES and

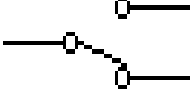
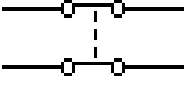
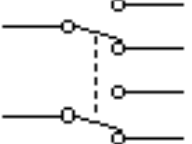
C. TRANSISTORS

A. DIFFERENT TYPES OF SWITCHES

TYPE	SYMBOL	APPEARANCE
a. PUSH SWITCH (Push for on push again for off)		
b. SLIDE SWITCH (are pushed or pulled)		
c. ROCKER SWITCH (are usually pressed)		
d. MICRO-SWITCH		

ARRANGEMENT OF MANUAL SWITCHES

- The **POLES** are the **number of circuits** that the switch makes or breaks.
- The **THROWS** are the **number of positions to which each pole is switched**.

SPST	Single pole single throw (Single pole ON/OFF)	
SPDT	Single pole double throw (Single pole changeover)	
DPST	Double pole single throw (Double pole ON/OFF)	
DPDT	Double pole double throw (Double pole changeover)	

Switches **give us control over the circuits** we build by:

- allowing a **current to flow through it**.
- preventing a current from flowing** through them
- by **changing its path**, so that **current can be diverted** (rather like points on a railway track.)



Figure 11.3 A push switch and a toggle switch

ACTIVITY 3

I. Single-Pole, Single-Throw Switch (SPST)

- A simple on/off switch is called a single-pole, single-throw switch.

- Single-pole, single-throw switches (SPST) control **one input circuit and make one contact with the output circuit**.

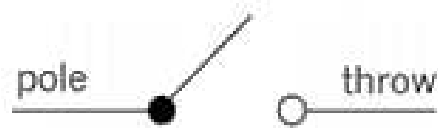


Figure 3: The symbol for an SPST switch

- An example of an SPST is a **light switch**. Below is a typical lighting circuit.
- When the **switch is closed**, the **current will flow from the positive terminal (+) of the battery through the switch, through the lamp and back to the negative (-) terminal of the battery**

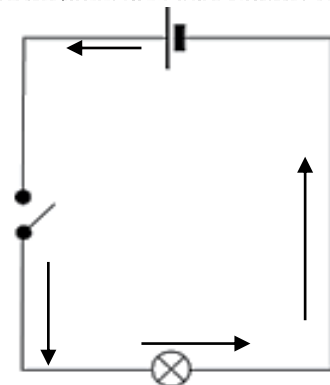


Figure 4: A typical light circuit with an energy source, switch and lamp

II. Single-Pole, Double-Throw Switches (SPDT)

- Single-pole, double-throw switches **control one circuit**, but they **make two contacts** so that they can **control two devices**.
- They **turn on device 1** in one position and **device 2** in the other position. There is **no "off" position for this switch**.
- An example of an SPDT is a switch that **turns on a red lamp in one position and a green lamp** in the other position.

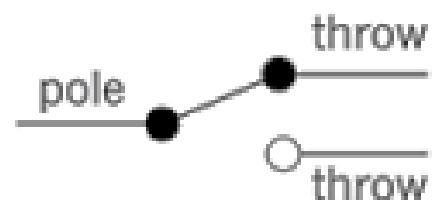


Figure 5: The symbol for an SPDT switch

3.1 The circuit diagram below shows a two-way lighting circuit.

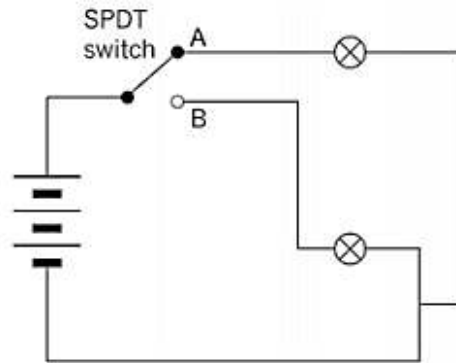


Figure 6: A circuit with a battery, two lamps and an SPDT switch controlling two outputs

3.1.1 Explain in your own words how this circuit works.

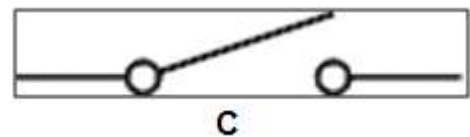
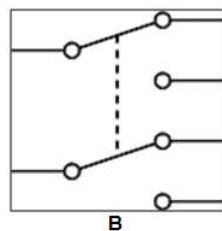
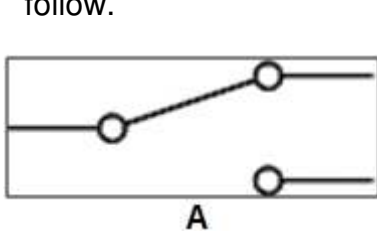
The explanation must mention that at any given time one of the lamps is on and the other is off.

3.1.1 Think about how you can use an SPDT switch. You can make up an example, as long as it makes sense.

A few examples could be:

- green and red lights to show whether a door is open or closed,
- a heat-sensitive switch to show if a plate on a stove is hot or cold,
- lights to show if the water level in a tank is low or high (switch connected to a floating lever device),
- to show if a train is arriving at a level crossing or not, and
- a TV that shows a green light when it's on, a red light when it's off but it is supplied with electrical energy, and no light when it's not being supplied with electrical energy (for instance if the plug is pulled out, or the wall switch is off, or there's a power failure)

3.2 Study the symbols of the different switches below and answer the questions that follow.



3.2.1 Identify the type of switch by providing the acronym as well as the full name in the table below:

Switch	Acronym	Full Name
A	SPDT	SPDT = Single Pole Double Throw.
B	DPDT	DPDT = Double Pole Double Throw.
C	SPST	SPST = Single Pole Single Throw.

3.2.2 How many routes of current flow is possible for switch A? **2**

3.2.3 Which of these three switches can also be wired up as a reversing switch on a motor?

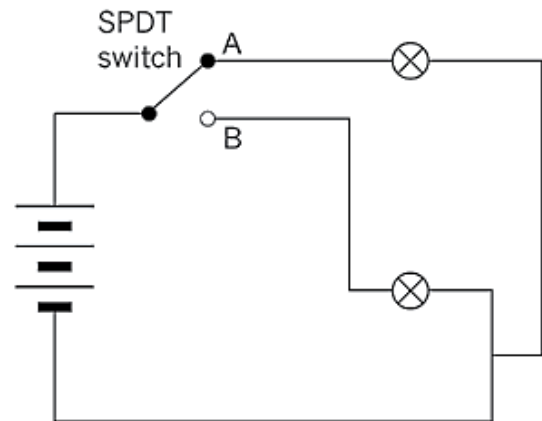
Switch B (DPDT)

3.2.4 Which switch allows current to flow only when it is in the closed (on) position?

Switch C (SPST)

3.3 Study the circuit diagram on the right.

An **SPDT switch** controls two possible outputs. They **cannot both be ON, nor can they both be OFF**.



3.3.1 Is this an example of OR logic or AND logic?

OR logic gate

3.3.2 Explain your answer.

One throw is always on (1) while the other is off. (0).

In other words, only the 1-0 and 0-1 inputs are possible with an SPDT switch. It's impossible to give a 0-0 or a 1-1 input.

As long as the circuit is supplied with electrical energy, it's impossible to get a 0 output.

3.4 Look at the circuit diagram below. It shows how one light can be controlled by two different switches. Answer the questions based on the circuit.

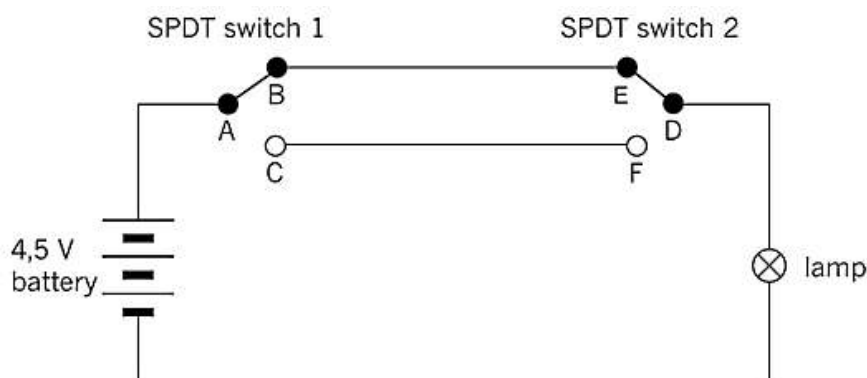


Figure 7: A circuit with two SPDT switches is often used to control a lamp with one switch at each end of a long passage. It is also used to control a lamp with one switch at the bottom of a staircase, and the other switch at the top of the staircase.

3.4.1 Will the lamp turn on if A connects to C and D connects to F? **Yes**

3.4.2 Will the lamp turn on if A connects to C and D connects to E? **No**

- 3.4.3 Will the lamp turn on if AB and ED are closed? **Yes**
- 3.4.4 Will the lamp turn on if DF and AB are closed? **No**
- 3.4.5 Explain why the type of circuit in Figure 7 is useful for controlling the lamp/bulb in a long passage.

If you want to walk down a long passage at night, you want to switch the lamp on when you enter the passage on the one side and switch it off when you exit the passage on the other side. If you could not switch off the lamp on the other side, the lamp would remain on, and you would be wasting electrical energy

III. Double-Pole, Double-Throw switches (DPDT)

- There are **two input circuits**, and **for each input circuit**, there are **two possible output circuits**.
- In the symbol on the right, the dotted line shows that the **switches operate together**.
- Consider an **automatic car gate powered by an electric motor**.
- To **open the gate**, the **motor should turn in one direction**.
- To **close the gate**, the **motor should turn in the opposite direction**.

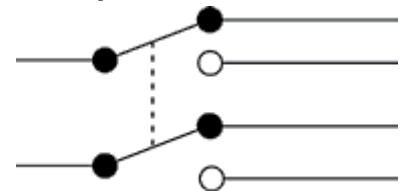


Figure 8

How can the direction in which the motor turns be changed?

- ➔ The way to do this is to change the direction of the current through the electric motor.
- ➔ Double-pole, double-throw switches can be used to reverse the direction of current through a circuit, so they are useful in applications such as automatic car gates.



Figure 11.4 SPDT and DPDT switches



- The circuit diagram below shows how a DPDT switch can change the direction of current through an electric motor.

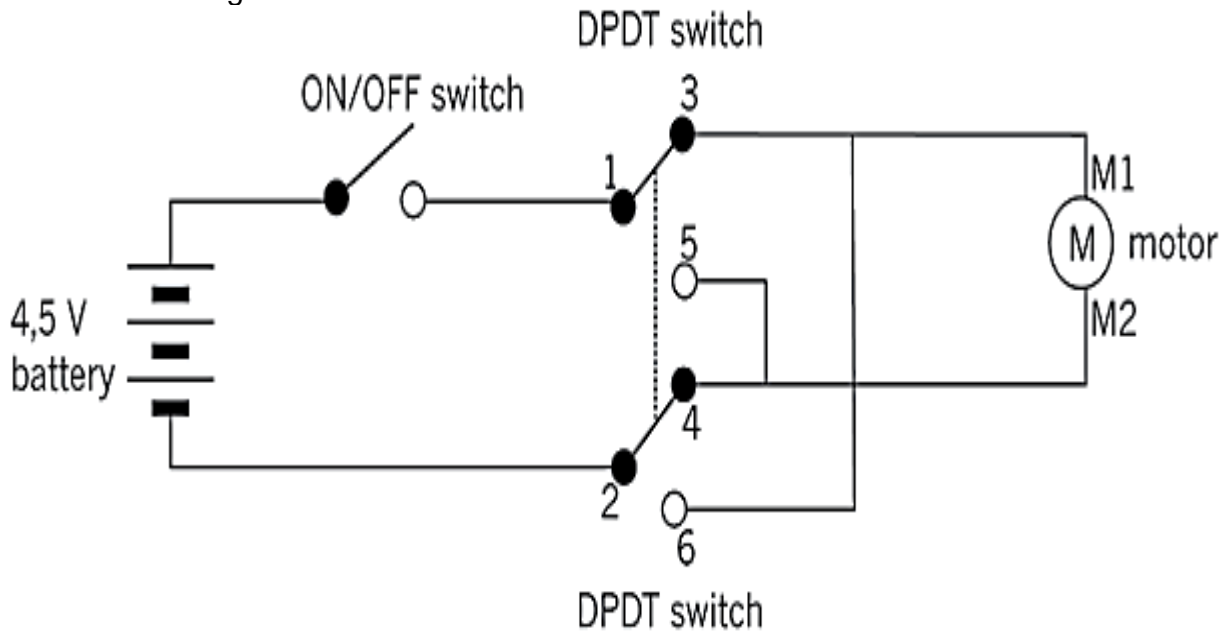


Figure 9: A circuit where a DPDT switch controls the direction in which an electric motor turn

- The **motor shaft will rotate in one direction** when the **current passes through it** from **terminal M1 to M2**, but
- the motor **shaft will rotate in the opposite direction** when the current passes through it from terminal **M2 to M1**.
- When the **ON/OFF switch is switched ON**, with the DPDT switch in the position indicated in the diagram above, the **current will flow from the positive of the battery, through the ON/OFF switch to 1, to 3, through the motor from M1, to M2, to 4, to 2 and back to the negative of the battery.**
- When the **DPDT switch is moved to the other position** than in Figure 9, the current will flow through the circuit in the following order:
 - from the **positive terminal of the battery**,
 - through the **ON/OFF switch to 1**,
 - through the **top part of the DPDT switch from 1 to 5**,
 - through **the motor from M2 to M1**,
 - to **6**,
 - through the **bottom part of the DPDT switch from 6 to 2**, and
 - to the **negative terminal of the battery**.

3.5 Explain the difference between a SPDT and a DPDT switch.

- An SPDT switch does not allow you to reverse the direction of current through a part of a circuit.
- A DPDT will always let current through to the same part of a circuit, but it will change the direction of the current in this part of the circuit depending on which position the switch is in.

3.6 Answer the questions about the following two electric circuits.

Circuit A has three cells of 1.5 volts each and are connected in series.

Circuit B has three cells of 1.5 volts each and are connected in parallel.

3.6.1 What voltage will be provided by the parallel connection? **1.5 V**

3.6.2 What voltage will be provided by the series connection? **4.5 V**

3.7 Choose the correct DESCRIPTION in COLUMN B and match it with the TERM in COLUMN A. Write the correct letter of the alphabet in the answer column.

COLUMN A: TERM	ANSWER	COLUMN B: DESCRIPTION
3.7.1 Variable	C	A. Used to measure the current and is always connected in series.
3.7.2 Constant	F	B. The amount of electricity.
3.7.3 Resist	G	C. A quantity that can have a different value.
3.7.4 Ammeter	A	D. Used to measure the potential and is always connected in parallel.
3.7.5 Voltmeter	D	E. Allows something to pass through.
3.7.6 Current	H	F. A quantity that always has the same value.
3.7.7 Potential	B	G. Try to prevent.
3.7.8 Conduct	E	H. The flow of electricity.

3.8 Complete the table with relevant information of electricity / electronics.

Quantity	Abbreviation of quantity	Unit of measurement	Abbreviation of unit
Potential difference	V	3.8.1 Volt	V
Current	3.8.2 I	ampere	3.8.3 A
3.8.4 Resistance	R	ohm	3.8.5 Ω

3.9 Answer the following questions on Ohm's Law.

3.9.1 State Ohm's Law.

Ohm's law says that in an electric circuit, the current passing through a resistor between two points is related to the voltage difference between the two points and inversely related to the electrical conductance between the two points.

3.10 Use Ohm's Law to calculate the following answers:

- 3.10.1 Calculate the resistance across the filament in a lamp with a current of 0,5 A when it is connected to a supply of 220V.

$$\begin{aligned} V &= 220V \\ I &= 0.5A \\ R &= x \end{aligned}$$

$$R = \frac{V}{I}$$

$$R = \frac{220V}{0.5A}$$

$$R = 440\Omega$$

- 3.10.2 A lamp operates from a 220V supply. The resistance is 550Ω. Calculate the strength of the current when it is lit.

$$\begin{aligned} V &= 220V \\ I &= x \\ R &= 550\Omega \end{aligned}$$

$$I = \frac{V}{R}$$

$$I = \frac{220V}{550\Omega}$$

$$I = 0.4A$$

- 3.10.3 An electronic circuit needs a potential difference of 3,6V across a resistor when a current of 30mA is in it. Will the voltage be 3,6V if the resistor had a resistance of 96Ω?

$$\begin{aligned} V &= x \\ I &= 30mA \quad (30mA \div 1000 = 0.03A) \\ R &= 96\Omega \end{aligned}$$

$$\begin{aligned} V &= I \times R \\ V &= 0.03A \times 96\Omega \\ V &= 2.88V \end{aligned}$$

Answer: No, the voltage would be 2.88V and not 3.6V.

B. DIODES



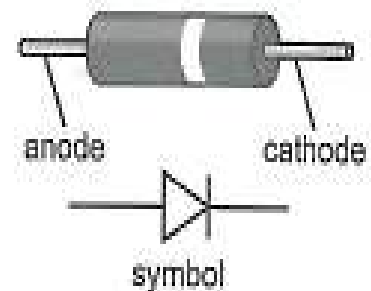
- Diodes are **electronic devices** that are **used to control the flow of current in electrical circuits**.
- A diode allows the **current to flow in one direction only**.
- Diodes are **control devices**.
- A diode is a component with **two terminals that can be connected in a circuit**
- **A silicone diode is mostly used.**
- It is a **semiconductor** consisting of 'p-type' and 'n-type, junctions.
- All diodes are **polar**, so they must be inserted the correct way in a circuit, with the negative pole of the diode to the negative pole of the battery.

Key words

- **diodes** – electronic devices that are used to control the flow of current in electrical circuits
- **Light-emitting diodes or LEDs** – types of diodes that emit light

DIODES consist of:

- ➔ The **cathode (positive)** side and
- ➔ The **anode (negative)** side.
- ➔ If the **anode** is connected to a **higher voltage** than the cathode, the **current will flow from the anode to the cathode**. This is called "**forward bias**".
- ➔ If the diode is put in the circuit back to front, so that the **voltage at the cathode is higher than the voltage at the anode**, the diode will not conduct electricity. This is called "**reverse bias**".



USES OF DIODES:

- Diodes are used to **protect electronic devices from damage against reverse polarity** in a circuit.
E.g., it acts as a barrier to prevent the flow of current to a device (radio) from a power source (battery) if polarity is reversed (positive and negative terminals are connected the other way round)
- **As lights:** Some diodes emit light. They are called light-emitting diodes or **LEDs**. They are often used to indicate that a circuit is on or on standby. More powerful LEDs are used in torches and as small spotlights.

LEDs (Light Emitting Diodes)

- LEDs have **two legs**.
The **shorter leg is the negative leg**.
- The casing of the LED's negative end is flat, and the positive end is rounded.
- It glows when electricity passes through it.
- The LED will only allow current to pass in one direction.
- The **cathode is normally indicated by a flat side** on the casing and the **anode is normally indicated by a slightly longer leg**. The current required to power an LED is usually around 20 mA.
- The **arrow symbol for an LED** tells you in which direction the current flows.
- LEDs produce light of specific colours**, based on the materials they are made from. For example, they can produce red, amber, yellow, green, blue, violet, and white. The most common colour is red.
- To protect an LED from too much current, a resistor has to be added to the circuit, as in the diagram below

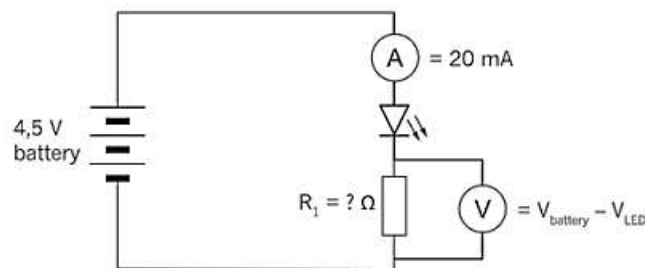
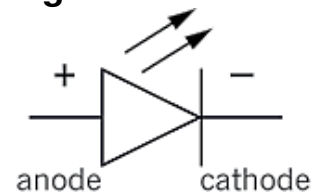
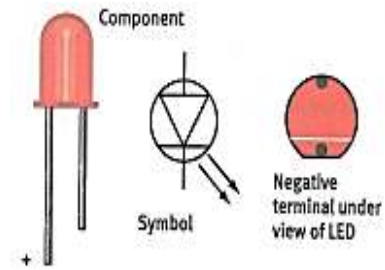


Figure 14: LED circuit with a current-limiting resistor.

USES OF LEDs:

- LEDs are often **used to show if a circuit is working**.
Think about the small red light glowing on the front of a TV set that can sometimes change from red to amber.
- LEDs are used as **indicators in many devices**, including **calculator screens and digital clocks**.
- Nowadays, LEDs are **used in many cases where normal light bulbs were used**. For example, **household lighting** is being replaced by LEDs.
- LEDs are **replacing light bulbs because they are more efficient and use much less electric energy**. They also last for a long time.

3.11. Describe the function of a diode in your own words.

A diode allows the current to flow in one direction, but not in the opposite direction.

3.12 Why is it advisable to use a fixed resistor with an LED?

An LED's function is destroyed by heavy currents. A fixed resistor will help to protect the LED against the current.

3.13 List at least four places where LEDs are used. Don't use the examples already given.

A few examples: a cell phone light, LED computer and TV screens (only on more modern screens), to show if an appliance (for example a printer or air conditioner) is active or on standby; to show if a multi-plug adapter is switched on at the wall socket modern torches modern traffic lights (robots); "daytime running lights" on some new cars

3.14 Study the illustration of the LED below. Explain how you can make sure that a diode is connected correctly in a circuit.?

- The longer of the two wires coming out of the LED should be connected to the positive terminal of the electricity source, and the other wire to the negative terminal.
- You can also use a multimeter or ammeter to check in which direction a diode conduct.



3.15 Draw the circuit symbols for a diode and for an LED here:



3.16 What is meant by the barrier potential of an LED?

The barrier potential is the minimum voltage with which an LED will light up.

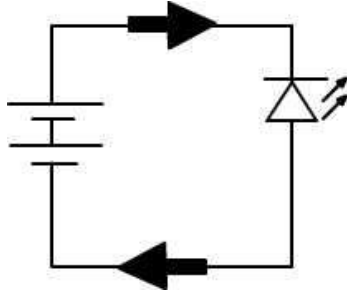
3.17 Name four advantages of the use of LEDs.

- It only needs a small current to function.
- It will function at a low voltage, as long as the voltage is more than the barrier potential.
- It is very robust; they do not break when dropped.
- It lasts a very long time

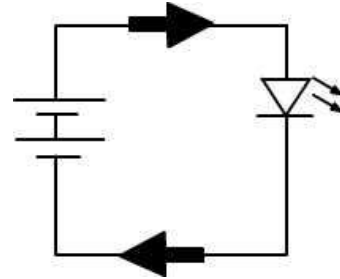
3.18 Study the two circuits below.

Identify the circuit which is forward-biased and the circuit which is reverse-biased.

a) **Reverse-biased**



b) **Forward-biased**



C. TRANSISTORS

- A transistor is a **semiconductor device that consists of three conducting pins / terminals.**
- **Each pin / terminal has its own connection point with a specific name: collector, base, and emitter.**

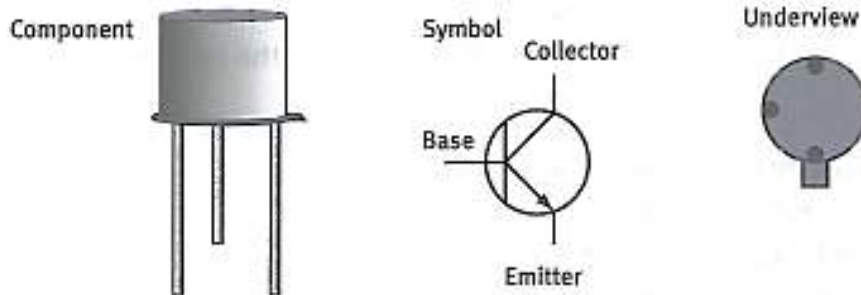
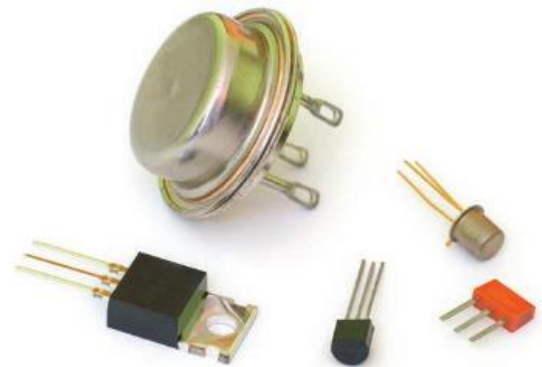


Figure 16: The symbol for a NPN transistor

- **The three legs have to be connected in a specific way:**
 - ➔ The **base** receives the signal from the **input** of the circuit.
 - ➔ The **collector** is connected to the **part of the circuit that must be switched on** (the positive side of the circuit).
 - ➔ The **emitter** is connected to the **negative pole battery/circuit.**

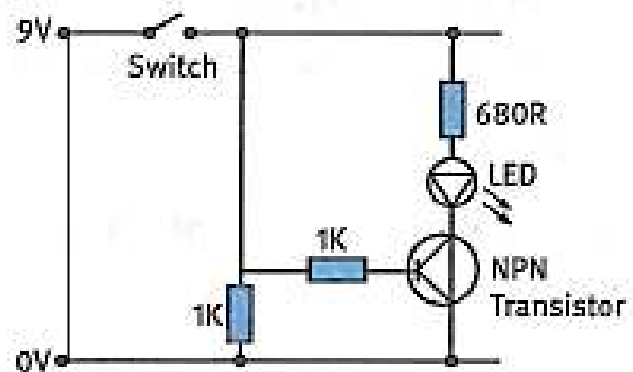
- A transistor **works as a type of switch** to turn current on and off.
- It can also **amplify a current**.
- A **NPN transistor** have **electrons**.
- It is **polarity sensitive** (a definitive positive and negative pole).
- It has a relatively **small base current**, the **resistance between the collector and the emitter is changed**.
- As the **base current increases**, the **collector emitter resistance decreases**.

USES OF TRANSISTORS:

- As **switches**: The **output is either on or off depending on the input current**, which usually comes from a sensor. Transistors used in this way are called NPN transistors. So, it is an electrically controlled switch
- As **amplifiers**: The **output current is an enlarged version of the input current**.
- It is used in many electronic applications, e.g., radios, amplifiers, and motherboards.

A SIMPLE TRANSISTOR CIRCUIT

- A **closed switch** allows **current to flow from the battery (9 V) into the base terminal of the transistor via the resistor (1 K)**.
- The **resistor is used to protect the transistor from power damage**.
- The **current flows through the collector to light up the bulb (LED)** and out to the emitter (0 V).



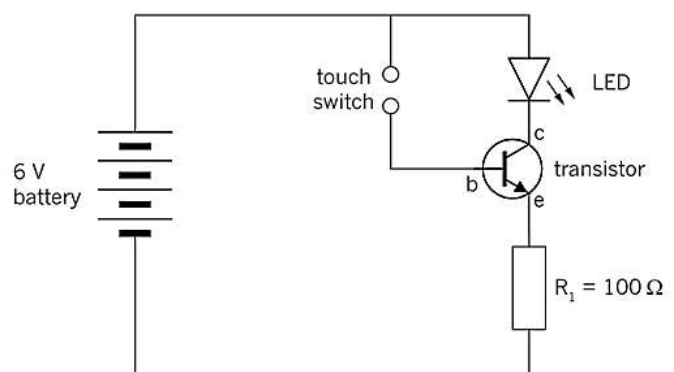
DEMONSTRATION BY TEACHER

Resources

A LED
Touch switch
6 V battery
100 Ω resistor
BFY 51 transistor
Connecting wire

METHOD

Connect the components as indicated on the circuit diagram and answer the questions.



3.19.1 Explain how the different parts of the transistor are connected in this circuit.

The collector is connected to the LED, the emitter is connected to the resistor, and the base is connected to the blue wire at the right.

3.19.2 The photo below shows a circuit built according to the circuit diagram in 3.19.1.

Explain what you expect to see when the touch switch is activated in the circuit below.

The LED will light up (assuming its terminals are connected correctly to the battery and that the finger has sufficient moisture to complete the loop with the base and emitter in it).

3.19.3 What would happen in the circuit if you touched the two terminals of the switch with one finger?

The LED lights up.

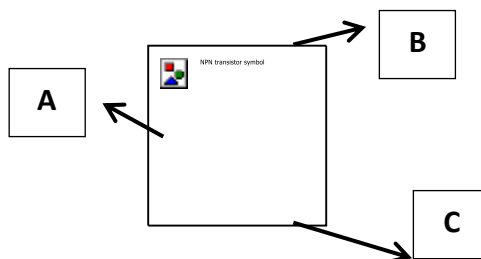
3.19.4 Explain the function(s) of the transistor

Transistors work in 2 ways:

- they turn current on/off
- and they amplify current – make current bigger, e.g., TV, radio.



3.20 Name the three legs of the transistor by labelling the diagram below and explain how each leg is connected to the circuit.



Labels	Name of leg	How leg is connected to the circuit
A	Base	Connected to the input of the circuit
B	Collector	Connected to the part of the circuit that must be switched on (the positive side of the circuit).
C	Emitter	Connected to the negative side of the circuit (to the negative pole of the battery).

WEEK 4: WHAT IS RESISTANCE?

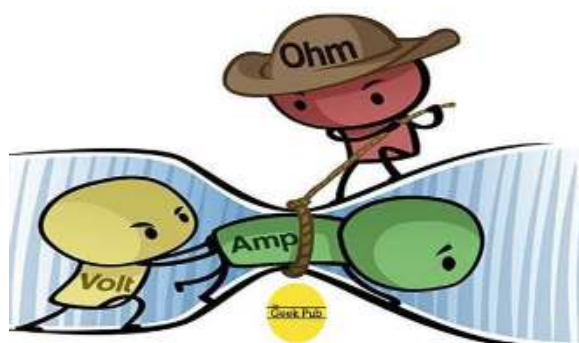
- It is the **ability of a substance to reduce the flow of electric current**.
- It is measured in ohms (Ω).
- All the **components in an electric circuit** have a certain amount of **resistance**, and this **reduces the amount of current** that is **able to flow around the circuit within a certain time**.
- When the current flows and **resistors oppose the current**, the **resistors get warm**. If a resistor heats up, it is doing work. When a substance **resists an electric current**, **it converts some of the electrical energy into heat or light**.

Key words

- **resistance** – the ability of a substance to reduce the flow of electric current
- **resistors** – small electronic components that are used to reduce the flow of current in electrical circuits

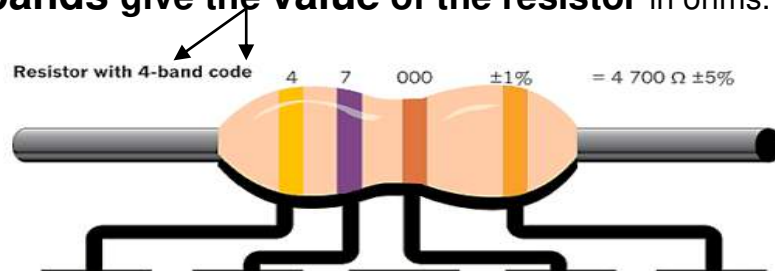
WHAT IS A RESISTOR?

- Resistors are the most **commonly used components in electronics**, as they are useful to **control current**.
- Resistors are made of **materials with a high resistance to electricity flow** and come in the form of thin wires or films.
- **Resistors also have precise resistance values that don't change** much in different environmental conditions.
- The **most commonly used resistors** look like tubes, with **two wires to connect it to the circuit**.
- Resistors are **electronic components that oppose the flow of current**.
- Resistors have **three or four colour-coded stripes** painted on them that **show how much resistance** they give.
- A **bulb** does not look like a resistor, but it offers resistance, so it can be called a resistor.
- Even though a **buzzer** in a circuit offers only very little resistance, it is also a resistor in a circuit.



HOW TO DETERMINE THE VALUE OF A RESISTOR

- To calculate the value of a resistor you need to use the colour coded charts below.
- The **first TWO bands** give the **value of the resistor** in ohms.



Colour	1st Band (1st digit)	2nd Band (2nd figure)	3rd Band (multiplier)	4th Band (tolerance)
Black	0	0	10^0	
Brown	1	1	10^1	
Red	2	2	10^2	$\pm 2\%$
Orange	3	3	10^3	
Yellow	4	4	10^4	
Green	5	5	10^5	
Blue	6	6	10^6	
Violet	7	7	10^7	
Gray	8	8	10^8	
White	9	9	10^9	
Gold			10^{-1}	$\pm 5\%$
Silver			10^{-2}	$\pm 10\%$

- The **third band** indicates the **number of zeros**
- The fourth band on a resistor shows the accuracy rating as a percentage.** This is also called the “**tolerance**”.
- The band is **gold (5 %)** or **silver (10 %)**, depending on the **tolerance**.

Kilo means multiply by a thousand, for example $1 \text{ km} = 1\,000 \times 1 \text{ m}$.
 Mega means multiply by a million.

- **Units of measurement: ohms, kilo-ohms, and mega-ohms**

- $1 \text{ k}\Omega = 1\,000 \Omega$
- $1 \text{ M}\Omega = 1\,000 \text{ k}\Omega = 1\,000\,000 \Omega$

READ RESISTOR VALUES

- Start by identifying the colour of each band on the resistor.

For example,
the colours of the three bands shown in Figure 10.6 are as follows:

- **BAND 1 IS YELLOW.**
- **BAND 2 IS VIOLET.**
- **BAND 3 IS BROWN.**

- Then, study the resistor colour-code chart and write down the number value of each band:

- **Band 1 is YELLOW** = value of **4**.
- **Band 2 is VIOLET** = value of **7**.
- **Band 3 is BROWN** = value of **0**.

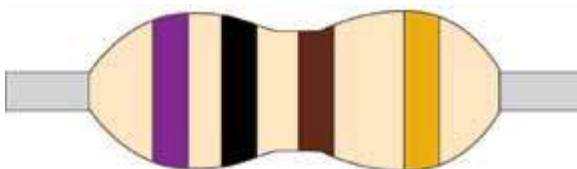
TOTAL VALUE OF RESISTOR = 470Ω

This is the '**multiplier**' – the number 1 means you must write down one zero.
If the number had a number 3, you would write down three zeroes.

- Put the three numbers together:** the resistance of the resistor shown in Figure 10.6.

4.1.1 Calculate the resistance of each of these resistors:

a)



- Band 1 is VIOLET** = value of **7**
- Band 2 is BLACK** = value of **0**
- Band 3 is BROWN** = value of **0**.

TOTAL VALUE OF RESISTOR = 700Ω

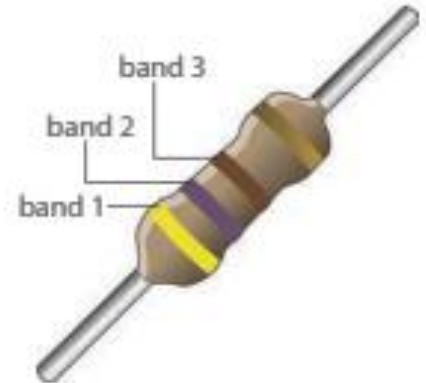
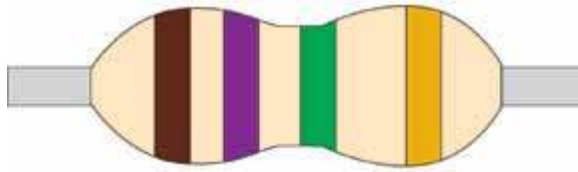


Figure 10.6 A resistor with colour bands. Band 1 is the outermost of the group of three, band 2 is second from the end and band 3 is third from the end.

Colours of the three bands	Value of band
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

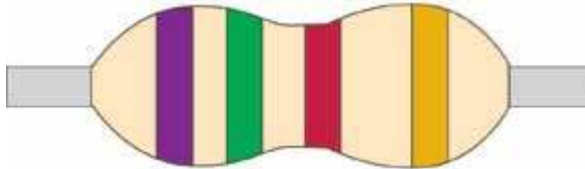
b)



Band 1 is **BROWN** = value of **1**
 Band 2 is **VIOLET** = value of **7**
 Band 3 is **GREEN** = value of **00000**
 Band 4 is **GOLD** = **TOLERANCE OF 5 %**.

TOTAL VALUE OF RESISTOR = 1 700 000 Ω $\rightarrow$ 1 700 k Ω

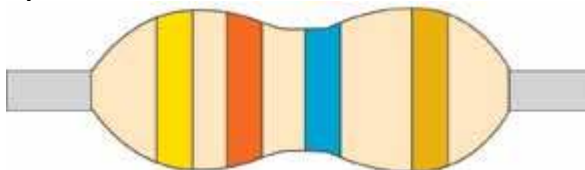
c)



Band 1 is **VIOLET** = value of **7**
 Band 2 is **GREEN** = value of **5**
 Band 3 is **RED** = value of **00**
 Band 4 is **GOLD** = **TOLERANCE OF 5 %**.

TOTAL VALUE OF RESISTOR = 7 500 Ω $\rightarrow$ 7,5 k Ω

d)



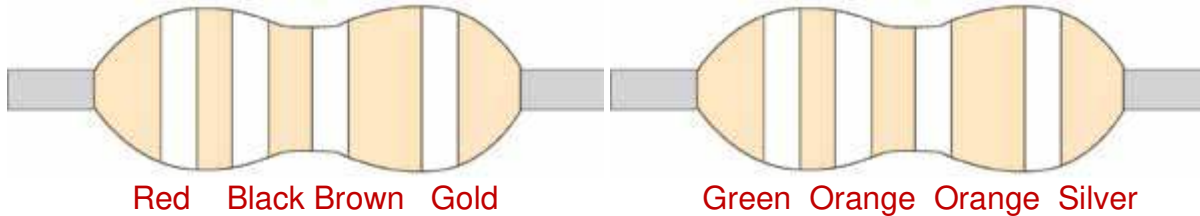
Band 1 is **YELLOW** = value of **4**
 Band 2 is **ORANGE** = value of **2**
 Band 3 is **BLUE** = value of **000 000**
 Band 4 is **GOLD** = **TOLERANCE OF 5 %**.

TOTAL VALUE OF RESISTOR = 42 000 000 Ω $\rightarrow$ 4 300 M Ω

4.1.2 Fill in the colour codes on these blank resistors to show the given resistance, or write the colour of each band under the resistor if you don't have coloured pencils or pens.

a) $200\ \Omega$
Tolerance of 5 %

b) $530\ \text{k}\Omega$
Tolerance of 10 %



4.2 Use the information in **TABLE 1** below to determine the resistance of the resistors in

TABLE 1			
Colours	Band 1	Band 2	Band 3
Black	0	0	
Brown	1	1	0
Red	2	2	00
Orange	3	3	000
Yellow	4	4	0000
Green	5	5	00000
Blue	6	6	000000
Violet	7	7	0000000
Grey	8	8	00000000
White	9	9	000000000

	TABLE 2				ANSWER
	Band 1	Band 2	Band 3	Band 4	
4.2.1	YELLOW	BLUE	BROWN	SILVER	460 Ω
4.2.2	ORANGE	WHITE	ORANGE	RED	39 000 Ω 39 kΩ
4.2.3	BROWN	BLACK	RED	GOLD	1000 Ω 1 kΩ
4.2.4	GREEN	GREY	VIOLET	SILVER	58000000 Ω 58 mΩ

4.3 Describe the function of a resistor as a component in an electrical circuit.

It reduces the current through the circuit, and reduces the voltage drop across other circuit components that are in series with the resistor.

- 4.4 Use the following **Word Bank** to complete the sentence by inserting the correct words in the spaces:

Word Bank
Circuit
Large
OHMS (Ω)
Control
Small

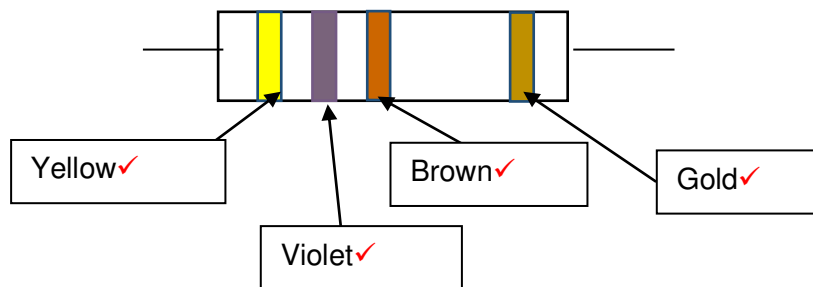
Resistors **control** the flow of current through a **circuit**.

Resistance is measured in **OHMS (Ω)**.

When resistance is high, the flow of current is **small**.

When resistance is low, the flow of current is **large**.

- 4.5 Draw a fixed resistor, indicating the colour of the bands, which has a resistance of 670Ω and a 5% tolerance.



WEEK 5: SENSORS / INPUT DEVICES

- Sensors are important electronic **input devices** or **senses change** in the **environment and respond by producing a change of voltage**.
- These **changes could be temperature, light, moisture or movement**.
- E.g. a movement sensor detects movement and responds by converting kinetic energy into light energy.

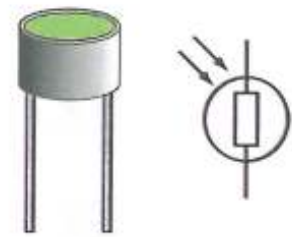
A. **LDR**

B. **THERMISTOR**

C. **CAPACITATOR**

A. Light Dependent Resistors (LDR)

- A light-dependent resistor, also called an LDR.
- Its **resistance depends on the amount of light it receives.**
- **Resistance increases in the absence of light and decreases its resistance in the presence of light.**
- It can therefore be **used to detect light and trigger warning devices in cases where light may cause problems.**
- An LDR has **two terminals** that can be inserted any way around into a circuit, so it is a **non-polar device**.



USES OF LDRs:

- to **amplify the LDR signal to an output device** (such as a **loudspeaker, motor**)
- to **switch an output device** (such as a **lamp, buzzer, or motor**) on or o.
- **Circuit of a day/night switch**

Day/night switches are often used to turn on street and outside lights once it gets dark. It has an advantage above time switches, since the time settings can go wrong, and the amount of daylight does not remain constant during different weather conditions.

In this example, a **light-dependent resistor (LDR)** is the input device, an **NPN transistor** is the control device, and an **LED** is the output device.

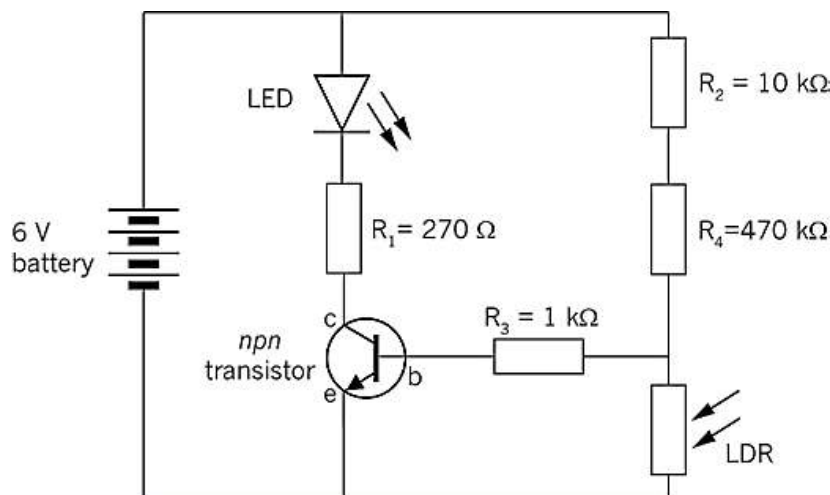


Figure 6: Circuit diagram of a day/night switch

ACTIVITY 5

Answer the following questions

- 5.1 Write four examples of when it would be useful to have a device that detects the amount of light and does something in response to it.

A few examples:

Safety lights that switch on when the ambient light intensity drops below a certain level.

Detect if something has moved past a point where a beam of light is shone on a circuit with an LDR

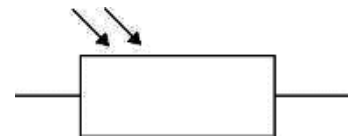
Car lights that automatically switch on when it gets darks and switch off when it is light.

An alarm clock that wakes you up when the ambient light becomes higher than a certain intensity

- 5.2 What is the role of the LDR in the circuit?

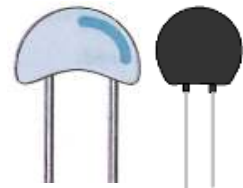
It causes the positive potential at the base of the transistor to increase as its own resistance increases, relative to the resistance R3 (in parallel with R3). This closes the circuit between the collector and emitter of the transistor and the LED lights up as its terminals are now in electrical contact with the poles of the battery.

- 5.3 Draw the symbol for a Light-dependent resistor (LDR)



B. THERMISTORS

- A thermistor is an electronic device that can **sense the temperature of its environment**. It is a **sensor**, so it is an **input device**.
- A **variable resistor / rheostat** can be adjusted to give **different amounts of resistance**.



- The **volume control** on a radio uses a variable resistor to change the amount of current. This varies the amount of electrical energy that is converted into sound energy.

- A **thermistor** is a **heat-sensitive resistor**.
- Two types of thermistors are made:**

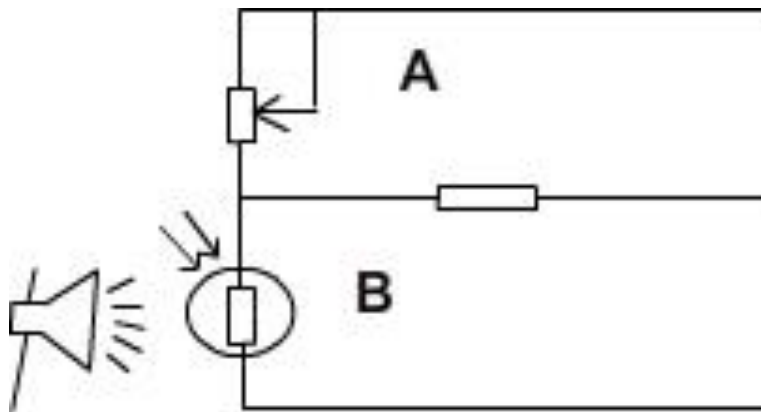


→ The **resistance of + t thermistors increase with temperature**.

→ The **resistance of – t thermistors decrease with temperature**.
When a – t thermistor in a circuit gets warm, its resistance decreases.
As its resistance decreases, more and more current flows through it.

USES OF THERMISTORS:

- The main purpose of a thermistor is **to give a circuit the ability to sense changes in temperature.**
 - A thermistor is a component which has the **ability to change its resistance as temperature changes.**
 - Thermistors are used in some **fire alarms** to sense an increase in temperature.
 - to **amplify the signal** (make the signal stronger) **to an output device such as a lamp, loudspeaker, or motor.**
 - to **switch an output device such as a lamp, loudspeaker, or motor, on or off.**
- 5.4 List four examples of situations in which electronic devices that use a thermistor of either type would be useful.
- A few examples:
 - Switching a kettle off automatically when the water boils.
 - Switching on fans or extra fans in an appliance when its temperature becomes too high, for example to prevent a computer from overheating and being damaged by the heat.
 - Switching an air conditioner or a fridge on or off automatically.
 - Setting off a fire alarm.
- 5.5 The circuit diagram below shows how this circuit works when daylight fades and a relay circuit turn on the streetlights.



5.5.1 What is component A called?

Pre-set or Variable resistor

5.5.2 What is component B called?

Light-dependent resistor (LDR).

5.5.3 Name the component that acts as a sensor.

LDR.

5.5.4 How does lower light intensity affect the resistance of the component?

As the light fades, its resistance increases.

5.5.5 Which component is used to adjust the sensitivity?

The pre-set resistor.

5.6 HEAT-ACTIVATED SWITCH

A thermistor can be used in a heat-controlled switch for a fire alarm. When the thermistor is heated up, its resistance is decreased and the transistor starts conducting a current, switching on the LED.

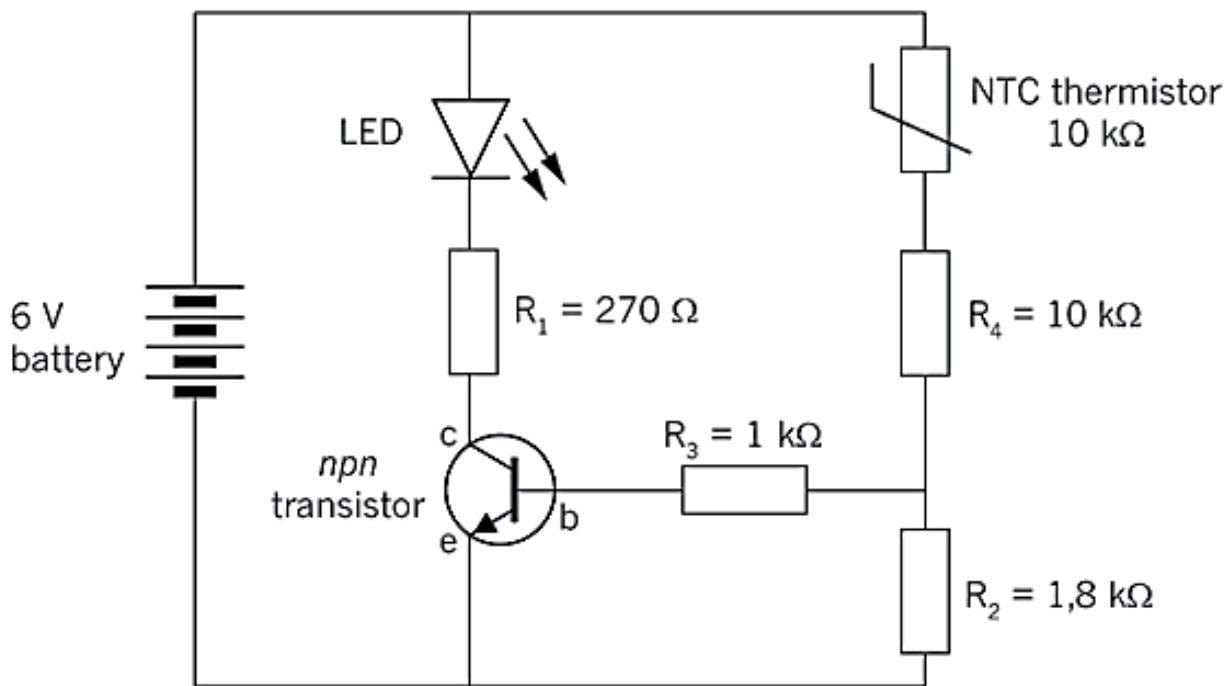


Figure 9: Diagram of a simple fire alarm with an NTC thermistor

5.6.1 What is the role of the thermistor in the circuit?

When it becomes hot due to a fire its resistance decreases, and this causes the LED to light up.

5.6.2 Describe how the transistor is connected to the circuit to amplify the current.

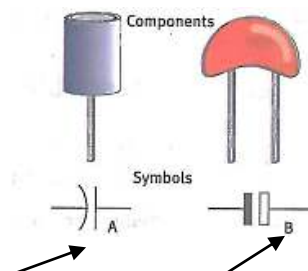
When the resistance of the thermistor decreases, the positive potential at the base of the transistor increases. The transistor will now allow current through. The LED is now in a closed loop containing the battery, the collector and emitter of the transistor, and will light up.

C. CAPACITATOR



Figure 3D: Different types of capacitors.

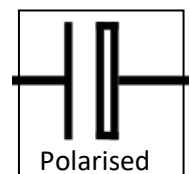
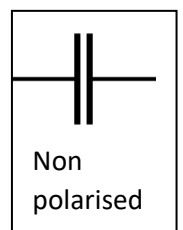
- A capacitor is an electronic **device that stores and releases energy**.
- Capacitors are **used to smooth the flow of current in circuits**.
- Capacitors are **control devices**.
- When a **circuit that includes a capacitor is switched on**, the **capacitor gets charged** up with **electrical energy from the circuit**.
- When the **source of energy is cut off** the capacitor **slowly discharges** its energy **back into the circuit**.
- **Capacitance is the measure of the energy a capacitor can store.**
Capacitance is measured in farad (F) Because the farad is such a large unit, practical values usually have the prefixes m (milli-), μ (micro-), n (nano-) or p (pico-).
- The symbol **“C”** is used for capacitance.
If a capacitor can store a **lot of energy**, we say it has a **high cap**.
- A capacitor **consists of two metal plates separated by an *insulator* called a *dielectric***.
- When capacitors are **connected in parallel**, the **total area of the metal plates on each side is increased**, so the **total capacitance is increased**.
- When capacitors are **connected in series**, the **distance between the opposite plates is increased**.
And because capacitance is inversely proportional to the distance between the plates, the total capacitance is reduced to less than that of the smallest capacitor.



- Capacitors can be **non-polarised (non-electrolytic)** or **polarised (electrolytic)**.

NON-POLARISED (NON-ELECTROLYTIC): capacitors can be **connected in any way** without malfunctioning. They have a **low capacitance value**.

POLARISED (ELECTROLYTIC) capacitors have **positive (+) and a negative (-) leads**. The leads must be **connected correctly in a circuit**. They have a **high capacitance value**.



USES OF A CAPACITOR:

Used in many electronic applications as:

- **Time delays or timers** e.g., **traffic lights, photograph timers and electric cookers**

CHARGE AND DISCHARGE OF A CAPACITOR

- The charging and discharging of a capacitor can be observed by building the circuit in the diagram below.
- When the **switch** is switched to **position A**, the **current will flow from the + of the battery, through LED1, through the switch to one plate of the capacitor**.
- The **negative of the battery is connected to the other plate of the capacitor through the resistor R1**. While the **capacitor is charging, LED1 will be ON**.

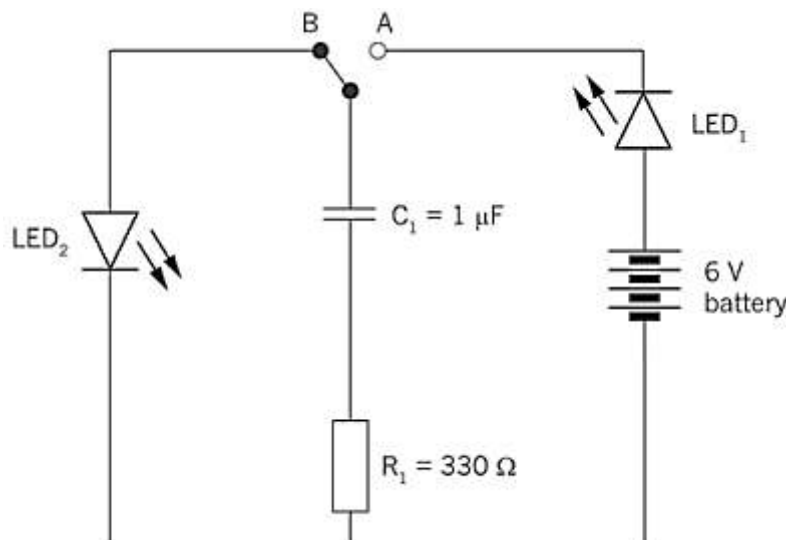


Figure 12: Capacitor charging and discharging circuit

- After the capacitor has been charged and the **switch** is switched to **position B**, a **current will now flow from the + plate of the capacitor through LED2 and will discharge through the resistor R1**.
- While the **capacitor is discharging, LED2 will be ON**.

5.7 Answer the following questions about capacitors.

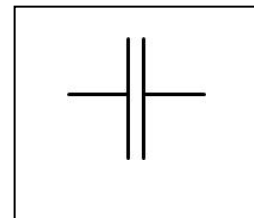
5.7.1 Draw the circuit symbol for a non-polarised capacitor.

5.7.2 What is the function of a capacitor in a circuit?

It stores electric charge.

5.7.3 Does a capacitor conduct AC (alternating current) or DC (direct current)?

AC (alternating current)



5.7.4 What is meant by the capacitance of a capacitor?

The capacitance refers to the amount of charge it can store.

5.7.5 What unit of measurement is used for capacitance?

Farad (F)

5.7.6 What do we call the non-conducting layer within a capacitor?

Dielectric

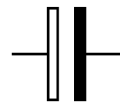
5.7.7 Name the two types of capacitors we find.

Fixed value non-polarised and fixed value electrolytic

5.7.8 What is meant by 'polarised'?

Polarised means the component has specific positive and negative connections.

5.7.9 Draw the symbol of an electrolytic capacitor.



WEEK 6: DRAW THE FOLLOWING CIRCUITS

6.1 LED, 470Ω resistor, switch, and 4,5V series battery.

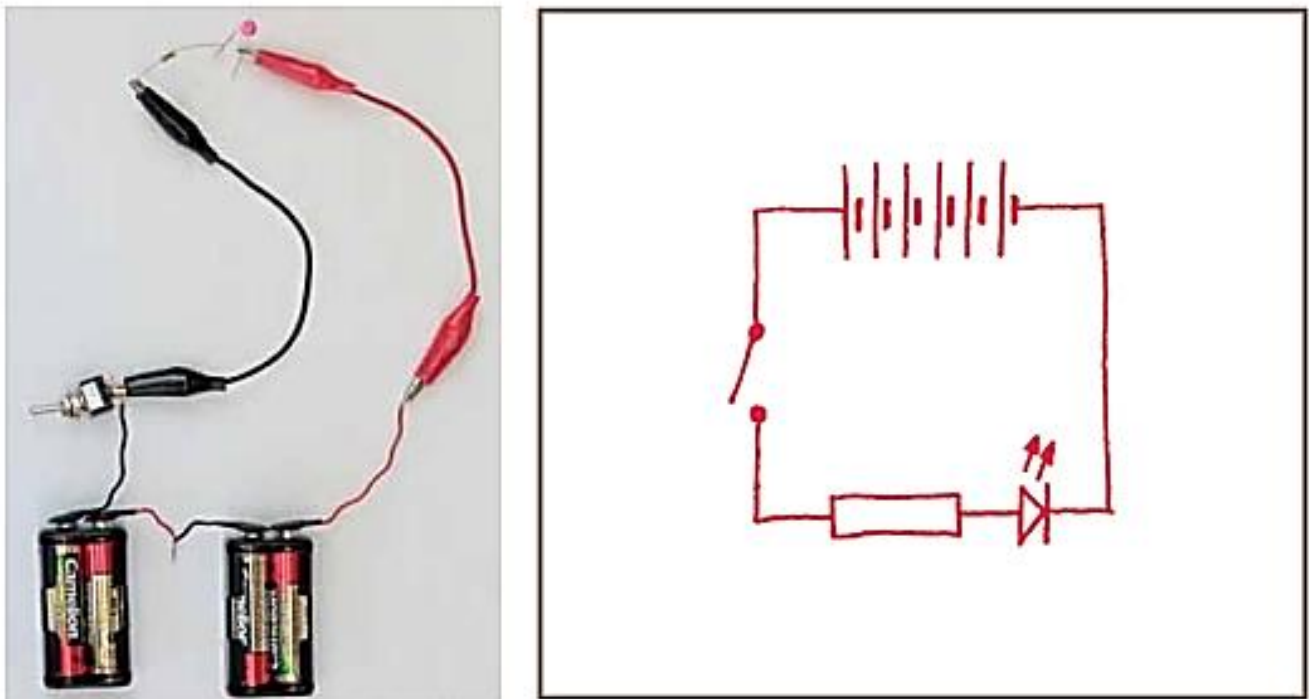
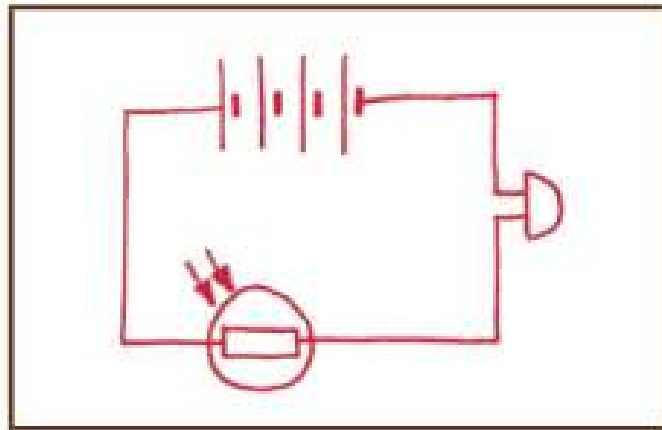


Figure 3: A circuit with an LED, a battery, a switch and a resistor

6.2 LDR, buzzer, 3V series battery.



Figure 4: A circuit where the current is regulated by a light-dependent resistor

6.3 Study the control circuit and a time-delay circuit below.
Answer the following questions.

NPN transistor, buzzer or bell,
thermistor, variable resistor, 1k Ω
resistor, 6V
series battery

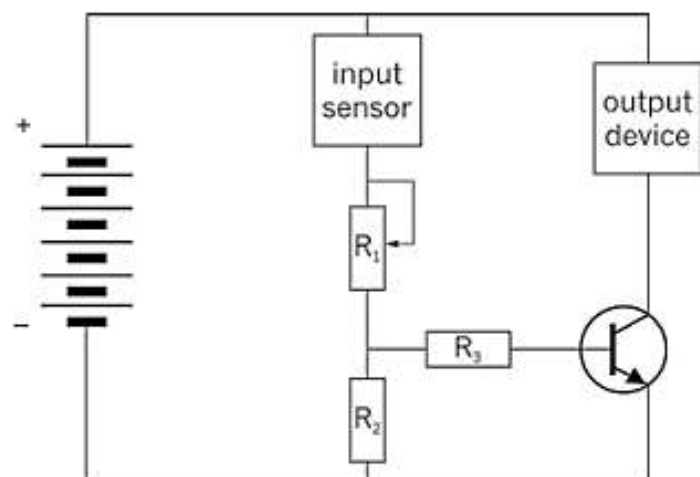


Figure 5: The circuit diagram for the control circuit

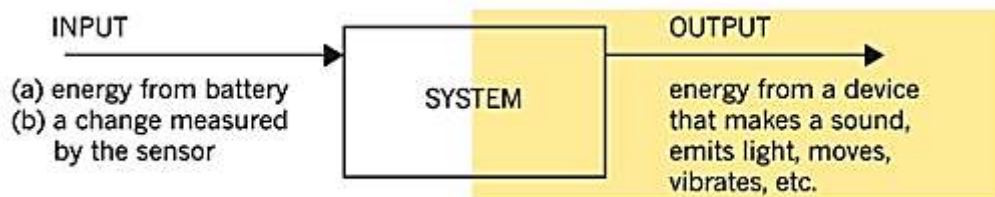


Figure 6: A systems diagram of a control circuit

Figure 7 shows how
the circuit in Figure 5 is
the same as the systems
diagram.

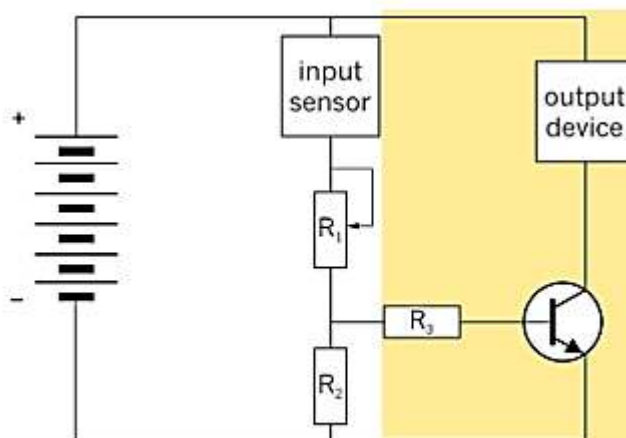


Figure 7

6.3.1 What type of electronic component will you use as the input sensor?

A thermistor

6.3.2 What type of device will you use as the output device?

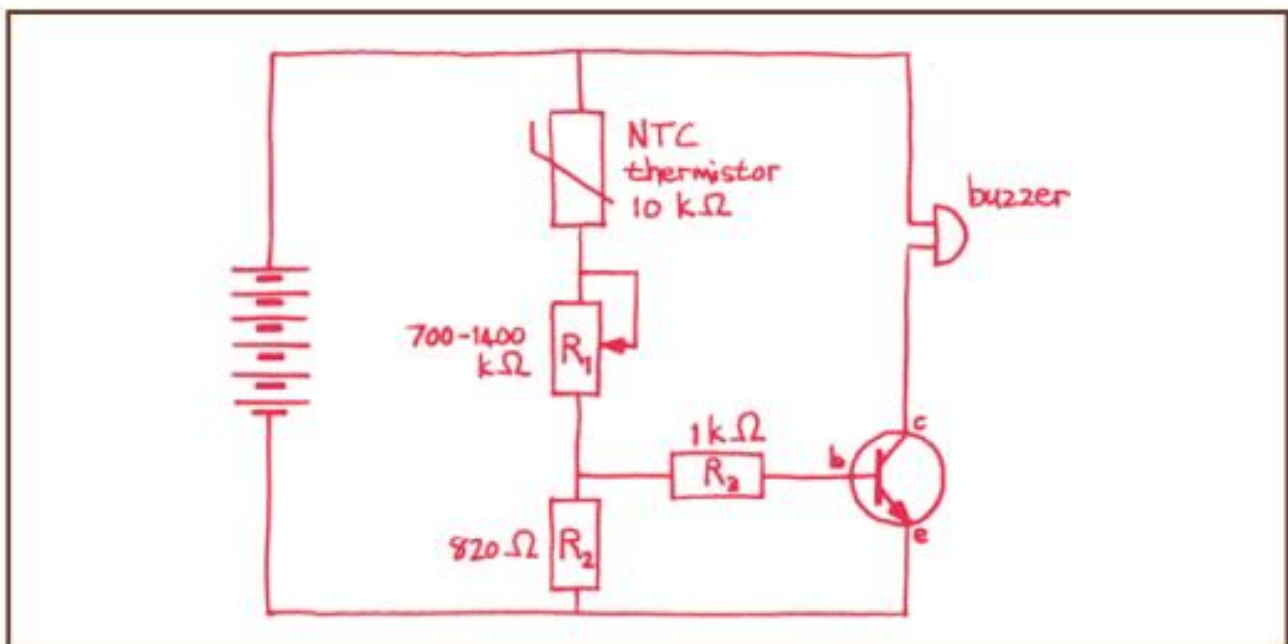
A buzzer/ beeper/ speaker

6.3.3 What voltage does the battery supply to the circuit?

$$6 \times 1,5 \text{ V} = 9 \text{ V}$$

6.3.4 Draw a circuit diagram for a **fire alarm** (a circuit with a sensor and a transistor)

- Show the correct symbols for the components you will use as the input and the output sensors.
- Show the voltage of the battery.
- Show the emitter ("e"), base ("b") and collector ("c") of the transistor.



6.4 Study the time-delay circuit below. Answer the questions on the circuit.

Four 1,5 v cells in series, or a 9 V battery,
Two LEDs,
A 470 Ω resistor,
A 1 000 μF capacitor, and
An SPDT switch.

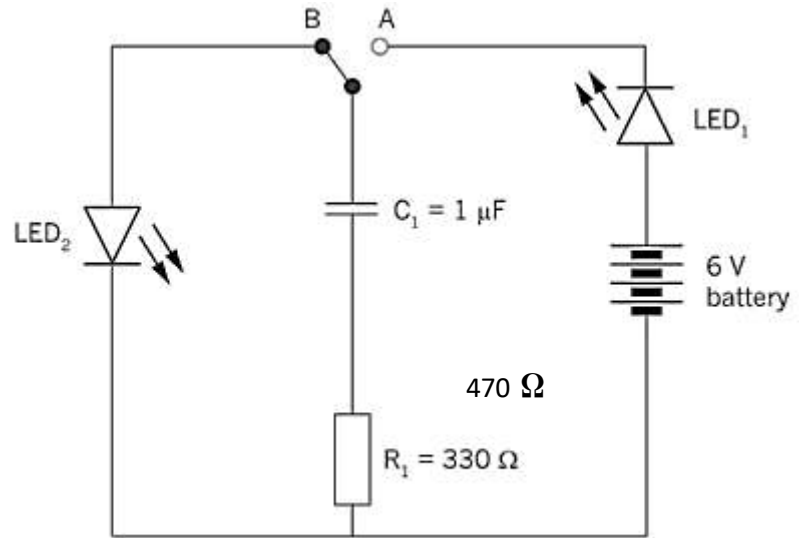


Figure 9: A time-delay circuit

6.4.1 Describe in detail what would happen to the LEDs if the switch were pushed to A?

When you **switch the SPDT switch to position A**, **LED 1 will initially be bright, but then grow dimmer and dimmer until it does not glow at all.**

6.4.2 Give a reason for your answer in 6.4.1.

The **reason** for this is that **the capacitor is initially discharged, so current can flow through the circuit on the right while the capacitor is charging.**

6.4.3 What will happen if you push the switch to position B?

When you **switch the SPDT switch to position B**, **LED 2 will initially be bright as the capacitor discharges through the circuit on the left. LED 2 will grow dimmer and dimmer until it stops glowing** altogether since the charge on the capacitor will get smaller as it discharges, until it has no charge left.

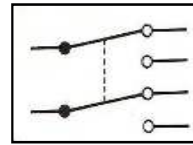
INFORMAL TEST

ANSWER THE FOLLOWING QUESTION ON ELECTRONIC COMPONENTS

1.1 Choose the correct answer by UNDERLINING the correct answer. (6)

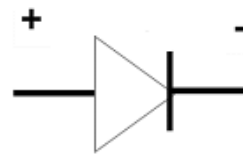
1.1.1 What type of switch is represented by the symbol below?

- a. Single pole double throw (SPDT)
- b. Double pole single throw (DPST)
- c. Double pole double throw (DPDT)
- d. Single pole single throw (SPST)



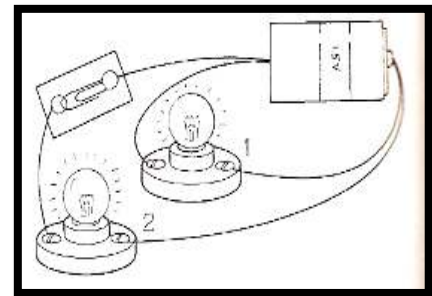
1.1.2 The symbol represents the following electrical component.

- a. Thermistor
- b. Diode
- c. LED
- d. Transistor



1.1.3 When the switch in the circuit is open

- a. both bulbs will glow
- b. bulb 1 will glow
- c. bulb 2 will glow
- d. There will be no output



1.1.4 Power is work done by the flow of electric current. Electrical power is measured in

- a. Joules
- b. Volt
- c. Watt
- d. Ampere

1.1.5 Which symbol represents ohm?

- a. ©
- b. £
- c. Ω
- d. Σ

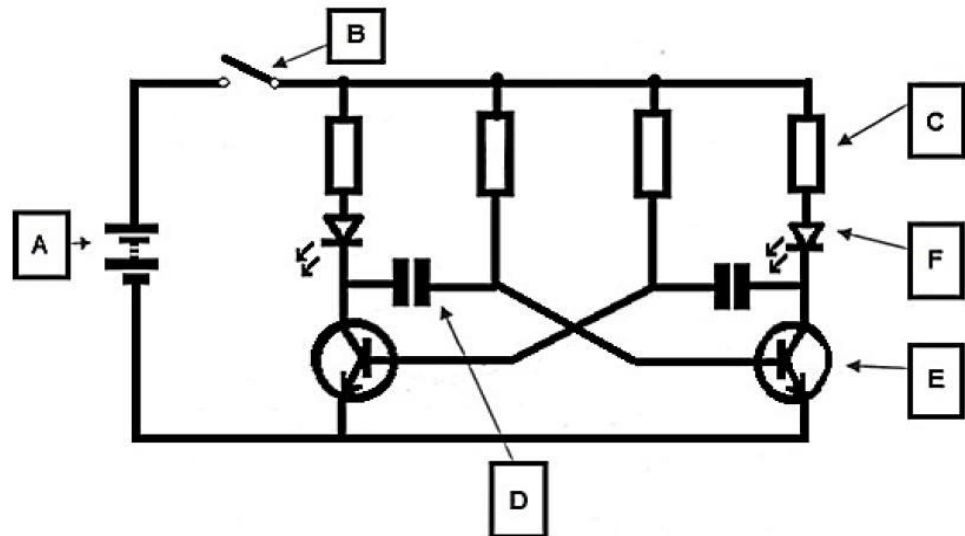
1.1.6 This is the type of resistor whose resistance changes as the light intensity falling on it changes.

- a. Thermistor
- b. Capacitor
- c. Transistor
- d. Light-Dependant Resistor (LDR)

2. Study the electronic circuit below and answer the questions. (6)

2.1 Identify all the different components marked A–F.

- A) Battery ✓
 B) SPST switch ✓
 C) Resistor ✓
 D) Capacitor ✓
 E) Transistor ✓
 F) LED ✓



3. Choose the correct electronic component from the list below to fill in the missing gaps in the statements that follow: (2)

LIST: RESISTOR / LDR / LED / CAPACITOR / THERMISTOR

An increase in temperature will result in less resistance to the current flowing through a thermistor. ✓

A drop in light levels will result in an increase in resistance to the current flowing through an LDR. ✓

4. State whether the following statements are TRUE or FALSE. (8)

GIVE THE CORRECT ANSWER WHEN FALSE.

4.1.1 Diodes are electronic components that act like one-way valves.

TRUE ✓

4.1.2 LEDs are not polarity sensitive. They can be connected any way round in a circuit.

FALSE, ✓ LEDs are polarity sensitive with a positive and negative pole that must be connected correctly in a circuit. ✓

4.1.3 To protect an LED from too much current, a transistor has to be added to the circuit.

FALSE, ✓ a RESISTOR has to be added to the circuit. ✓

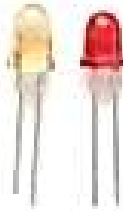
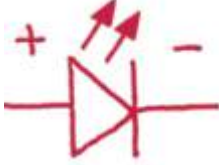
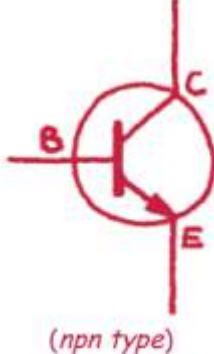
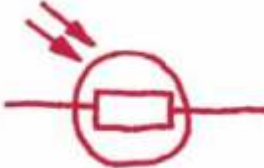
4.1.4 LEDs are output devices.

TRUE ✓

4.1.5 The short leg of the LED is the positive leg.

FALSE, ✓ the long leg is the positive leg. ✓

5. Name the component in the picture and draw the correct circuit symbol next to the component. Write a brief description of the main uses of the component. (18)

Name of component	Picture	Symbol	Use
5.1.1 LED			Ensures that current can only flow in one direction and produces light from electrical energy.
5.1.2 Transistor		 (npn type)	Acts as a switch or amplifier that is electrically controlled.
5.1.3 Light-Dependent Resistor (LDR)			Changes its resistance depending on the intensity of light it absorbs.
5.1.4 Capacitor			Stores electric charge.
5.1.5 Thermistor			Changes its resistance depending on the temperature.
5.1.6 Electric motor			Converts electrical energy into rotational movement (kinetic energy).

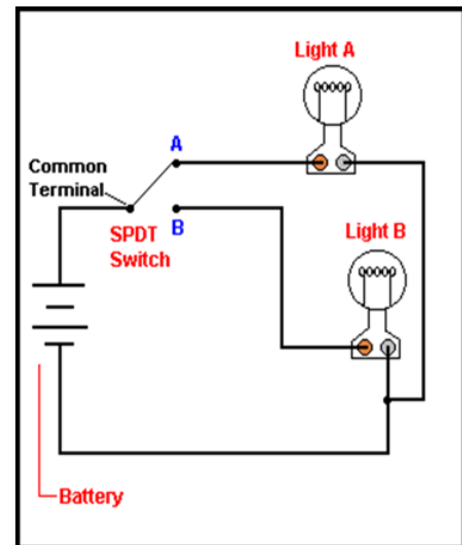
6. Study the diagram of the circuit below and answer the questions: (3)

6.1 Which type of switch is used in this circuit?

SPDT ✓

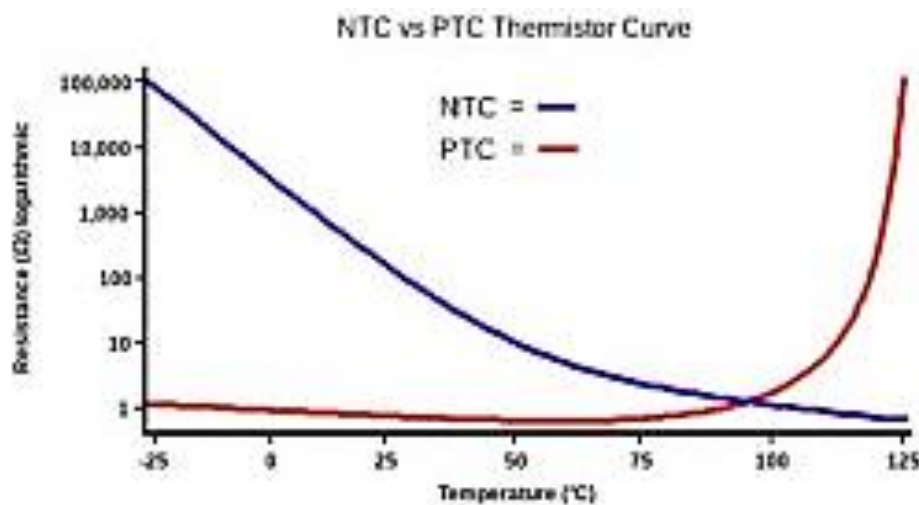
6.2 Explain what will happen when the switch is moved back and forth between A and B.

Light bulb A goes on and B goes off, ✓
Bulb B goes on and A goes off. ✓



7. Study the graph and answer the questions. (4)

The graph indicates the behaviour of a $+t$ and a $-t$ thermistor.



7.1 Explain in a short sentence what the graph is communicating about the behaviour of the $+t$ (PTC) thermistor.

With a $+t$ thermistor the resistance of the thermistor increases ✓
as the temperature increases. ✓

7.2 Complete the description of the function of a $-t$ (NTC) thermistor:

When the temperature increases ✓ the resistance decreases. ✓

