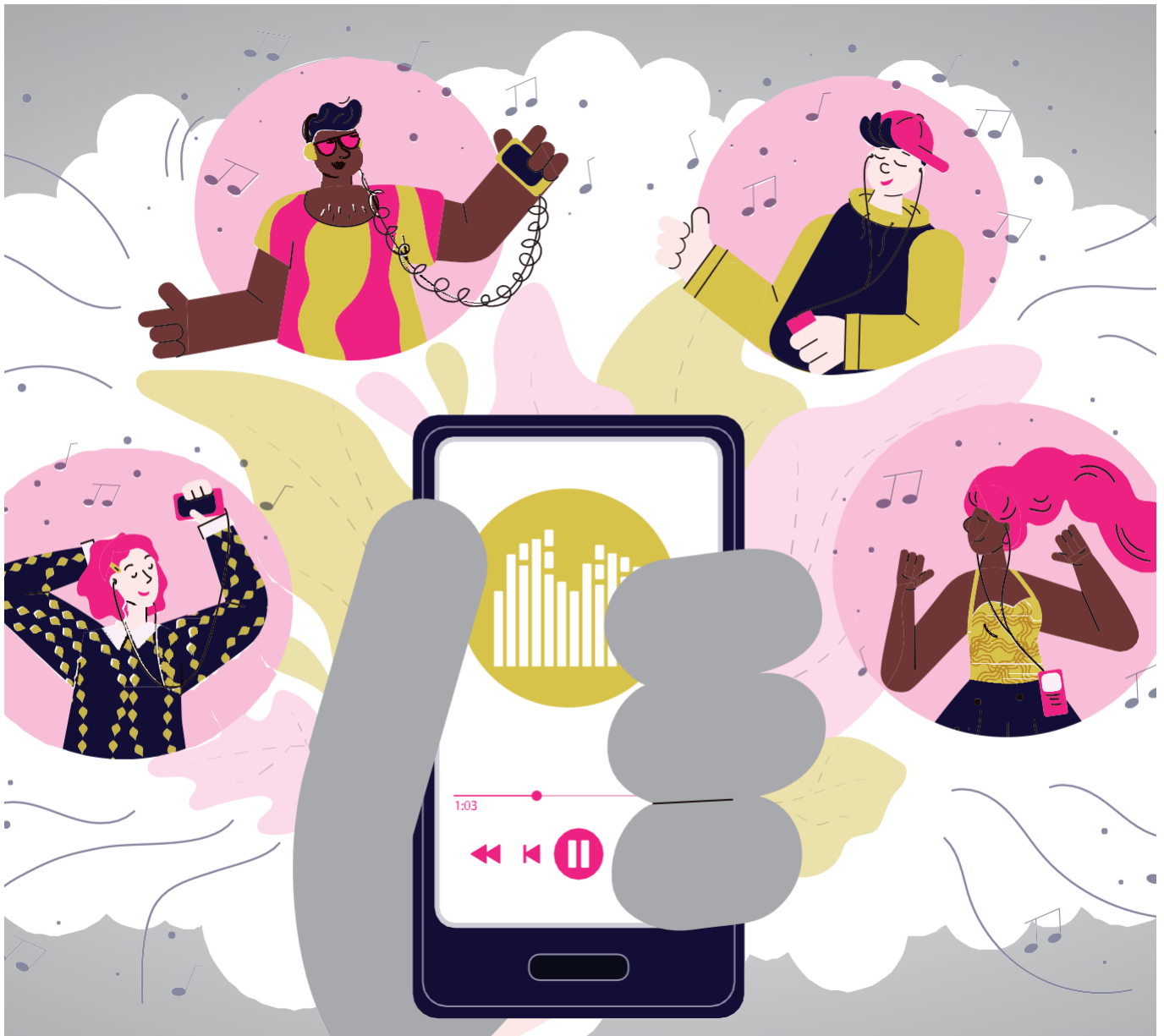


GEC INTEGRATED GRADE 9 PROJECT TEACHER'S RESOURCE PACK



3 ENTREPRENEURSHIP
EMPLOYABILITY
EDUCATION

PROJECT-BASED LEARNING | TECH, MATH & NS



basic education
Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

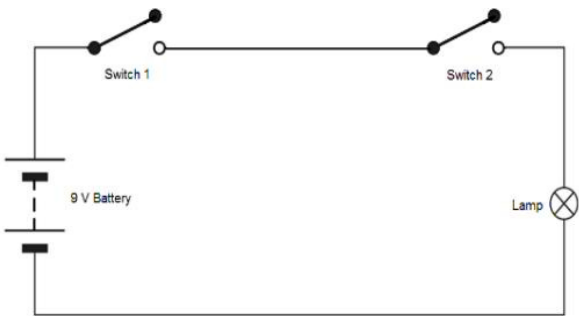
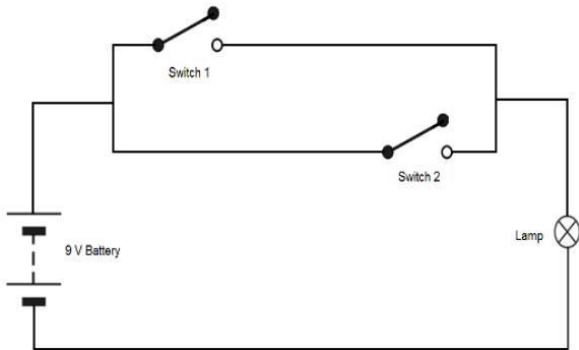
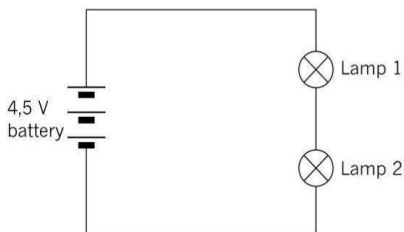


**GRADE
2026**

9

TECHNOLOGY GRADE 9 TERM 3

Electrical Systems & Control Investigation Skills

Content	Explanation
Revision 1: Component Symbols Components are the parts that we connect in an electric circuit. The simplest circuit always has: - a power source such as a cell, - a conductor, and - a load that provides resistance, such as a lamp Cells in Series - Switches in Series  Switches in Parallel, Cells in series  How will you draw cells connected in parallel? Lamps in series 	Cells in series Two or more cells can be connected in series to increase the voltage - The circuit. <i>Figure 2</i> 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. In series means the cells are connected end-to-end and the current flows through each cell in turn.  <i>Figure: Two cells in series connected to a lamp</i> Cells in parallel Two or more cells can also be connected in parallel. A parallel circuit has two or more different paths for the current to travel along. <i>Figure 3</i> below shows two cells connected in parallel in a circuit. - 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.  <i>Figure: Three cells in parallel connected to a lamp</i>

Lights in parallel

The applied voltage is the same across each lamp.

We can use **two or more switches** to **control components** in a circuit in more complex ways.

In a logic circuit, an **open switch** is regarded as having a **value of 0**, and a **closed switch** as having a **value of 1**.

If the circuit is not completed, the output is in the **OFF state** and has a **value of 0**. If the circuit is completed, the output is in the **ON**

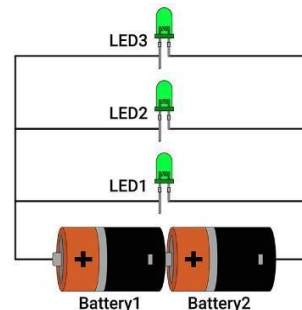
Lamps in series

Two or more lamps can also be connected in series



Lamps in parallel

Two or more lamps can also be connected to the cell in parallel, as shown in the pictures below.



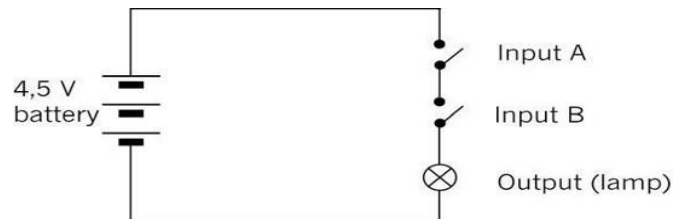
The positive terminal of the cell is directly connected to the A side of the lamps and the negative terminal to the B side of the lamps.

Switches in series

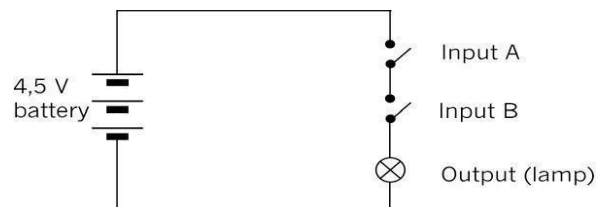
In the circuit on the right, there are **two switches in series**. This gives us four different switch combinations. They are:
 Switch A and B both open
 Switch A open and B closed
 Switch A closed and B open and
 Both switches closed. **State** and has a **value of 1**.

Switches in series and parallel

In a circuit with one switch, the switch controls whether the current flows through the circuit or not. If the switch is open, no current flows, as the circuit is not completed. The closed switch allows the current to flow.

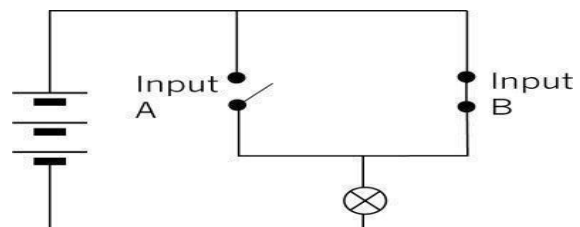


Do you see that the current cannot flow through the circuit if either switch A or switch B is open? Both must be closed for the lamp to glow.



Switches in parallel

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

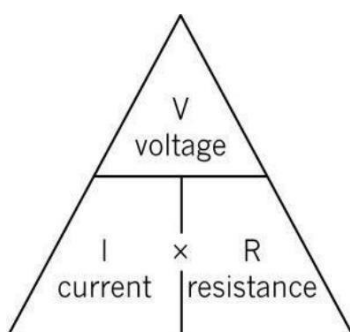


Circuit with two switches in parallel

The current can go through the closed switch, even if the other switch is open.

Refresh Ohm's Law

There is a special relationship between the voltage, current, and resistance in any circuit. You can control any one of these three **variables** by changing the other two variables. Ohm's Law states that as voltage **increases**, the current **increases** if the resistance is **constant**.



When the voltage and current are known, the resistance can be calculated with: **$R =$**

When the resistance and current are known, the voltage can be calculated with: **$V = I \times R$**

When the resistance and voltage are known, the current can be calculated with: **$I =$**

In the formula for Ohm's Law:

V is the **potential** or **voltage difference** measured in **volts (V)**

I is **current** measured in **amps** and **(A)**

R is resistance measured in **ohms (Ω)**

Links of videos to assist	https://www.youtube.com/watch?v=pqVpY1oS4gA https://www.youtube.com/watch?v=0N0sl5tZ6vs https://www.youtube.com/watch?v=6Maq5lyHSuc https://www.youtube.com/watch?v=XSukRnxGy5c https://www.youtube.com/watch?v=RQ3djos_LY8 https://www.youtube.com/watch?v=O8GgRIIB1Yc https://www.youtube.com/watch?v=umKfmw__mSA
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WORKSHEET

Use prior knowledge and complete the following questions:

- Draw a circuit diagram of the circuits in the space provided on the right.



Two cells in series connected to a lamp

- Below shows three cells connected in series in a circuit. Draw the circuit.



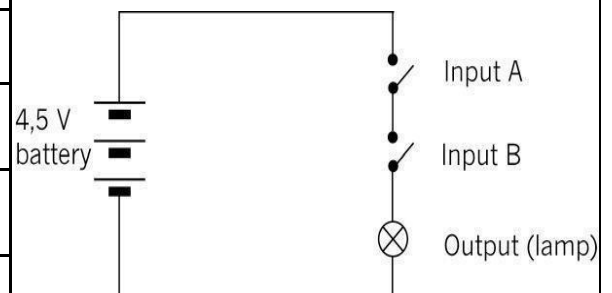
Three cells in parallel connected to a lamp

- Draw a circuit diagram of the circuit below in the space to the right of it.



Three cells in parallel connected to a lamp

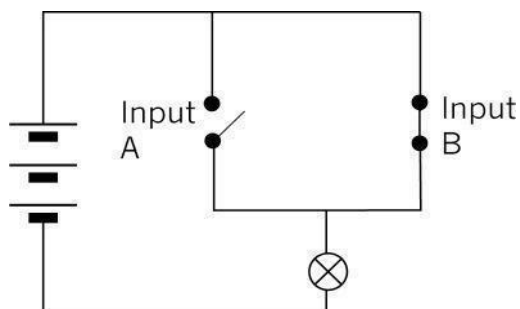
Input A	Input B	Output
0	0	0
0	1	0
1	0	
1	1	



In the table above on the right, "0" means off or open, and "1" means on or closed. Complete the table to show all the different combinations possible in the circuit above

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

Input A	Input B	Output

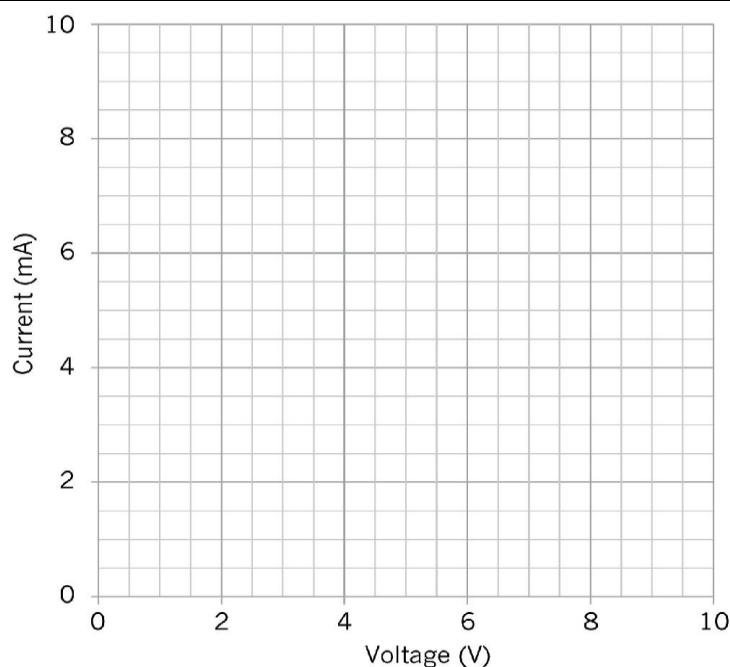


Action research:

(as voltage increases, current increases if resistance is constant)

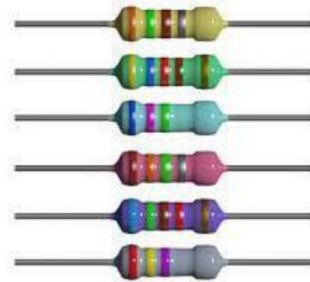
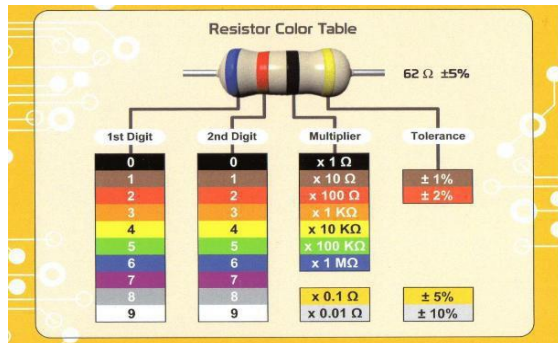
1. One cell connected to a 20W resistor – readings on voltmeter and ammeter
2. Two cells connected to a 20W resistor – readings on voltmeter and ammeter
3. Three cells connected to a 20W resistor – readings on voltmeter and ammeter
4. Plot the readings on a graph and determine the relationship between potential difference and current strength while keeping the resistance constant

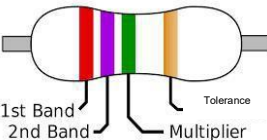
	ONE CELL	TWO CELLS	THREE CELLS
VOLTAGE			
CURRENT			

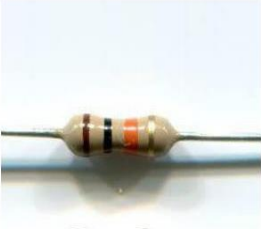


TECHNOLOGY: Electrical Systems

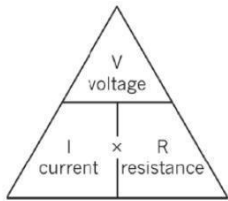
Electronic Systems and Control Investigation skills



Content	Explanation																							
General																								
What is a resistor? Symbol 1  Symbol 2 	- A resistor is a specially designed component that is normally used in a circuit to limit 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 - zigzag line. - The value of a resistors is measured in ohms (Ω) - The first three bands indicate the value of the resistor and the fourth is an accuracy of the resistor as a percentage. (Tolerance)																							
Explanation 	[How do you remember the values of the different bands on the resistor]? Remember the following sentence: BB ROY of Great Britain has a Very Good Wife. – simple hay? Refrain it... <table><tr><td>B – black</td><td>(0)</td><td>G – green</td><td>(5)</td></tr><tr><td>B – brown</td><td>(1)</td><td>B – blue</td><td>(6)</td></tr><tr><td>R – red</td><td>(2)</td><td>V – violet</td><td>(7)</td></tr><tr><td>O – orange</td><td>(3)</td><td>G – grey</td><td>(8)</td></tr><tr><td>Y – yellow</td><td>(4)</td><td>W – white</td><td>(9)</td></tr></table>				B – black	(0)	G – green	(5)	B – brown	(1)	B – blue	(6)	R – red	(2)	V – violet	(7)	O – orange	(3)	G – grey	(8)	Y – yellow	(4)	W – white	(9)
B – black	(0)	G – green	(5)																					
B – brown	(1)	B – blue	(6)																					
R – red	(2)	V – violet	(7)																					
O – orange	(3)	G – grey	(8)																					
Y – yellow	(4)	W – white	(9)																					

Example 1 	1st Band = Red 2 2nd Band = Violet 7 3rd Band = Green 5 zeros (4th Band = Gold 5% Red = 2 Violet = 7 Green 00 000 [2 700 000Ω])	
Example 2 	1st Band = Brown 1 2nd Band = Black 0 3rd Band = Orange 3 zeros	
Example 3 	1st Band = 2nd Band = 3rd Band = (4th Band)	
Convert Ohm to Kilo Ohm to Mega Ohm	2 700 000Ω 2700 kΩ [divide Ω by 1000] 2,7 mΩ [divide Ω by 1 000 000]	10 000Ω 10 kΩ 0,01 mΩ
A light-emitting diode (LED) is a special kind of diode that	= 330Ω? 1st Band=Orange + 2nd Band=Orange + 3rd Band=Brown = 720Ω? 1st Band=Violet + 2nd Band=Red + 3rd Band=Brown	

Refresh Ohm's Law



There is a special relationship between the voltage, current, and resistance in any circuit. You can control any one of these three **variables** by changing the other two variables. Ohms law states that a voltage increases, the current increases if the resistance is **constant**.

In the formula for Ohm's Law

V is the potential or voltage difference measured in volts

I is the current measured in amps, and

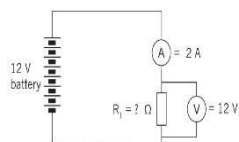
R is resistance measured in ohms.

When the voltage and current are known, the resistance can be calculated with: **$R =$**

When the resistance and current are known, the voltage can be calculated with: : **$V = I \times R$**

When the resistance and voltage are known, the current can be calculated with: **$I = V/R$**

Example



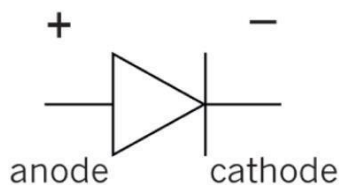
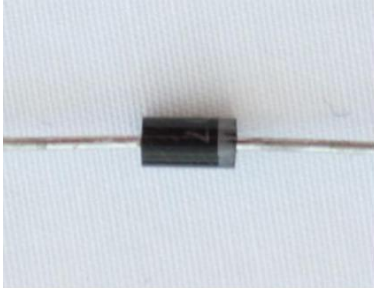
Answer:

$$\begin{aligned} R &= \frac{V}{I} \\ &= \frac{12 \text{ V}}{2 \text{ A}} \\ &= 6 \Omega \end{aligned}$$

Remember to ALWAYS start with the formula...

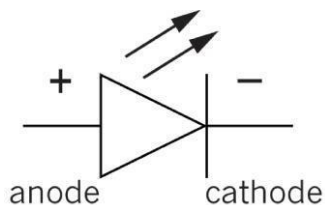
Diodes:

is a component that allows current to flow in **one** direction only



LED:

allows current to flow in **one** direction only and gives light and is used as an indicator that a circuit is **ON**



Diodes

A diode is a component with two terminals that can be connected in a circuit. The function of a diode in a circuit is to allow an electric current to flow in the forward direction and to block current in the opposite direction. 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".

Diodes are normally used to prevent damage to other components in circuits. For example, some components have positive and negative terminals and will be damaged if a current goes through them in the wrong direction. A diode can protect against a current flowing the wrong way if a battery was put in incorrectly to power the components. If you put batteries into a radio incorrectly, a diode will prevent damage to the radio.

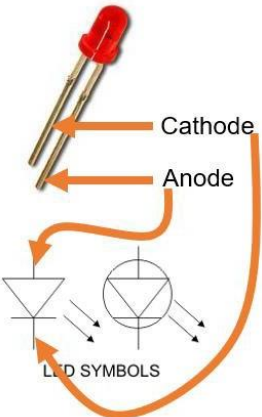
Light-emitting diodes (LED)

A light-emitting diode (LED) is a special kind of diode that glows when electricity passes through it. 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.

- LED serves as indicator to show that a circuit is on.
- E.g. The little red light on the front of a television screen. You also find them on digital arm watches and Pocket calculators.
- The LED allows the current to flow only in one direction.
- The LED indicates the cathode and the anode is the longer leg of the two.

The LED operates with a current as little as 20 mA. The arrow symbol for the LED indicates the direction of current flow. LED is used today where bulbs were used in the past. They are used in homes in the place of domestic bulbs.

LEDs last much longer, are more effective and much more energy sufficient.



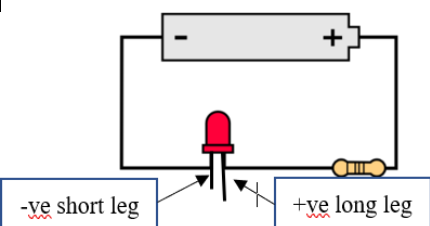
The diagram shows a physical red LED with two legs. The longer leg is labeled 'Anode' and the shorter leg is labeled 'Cathode'. Below this, two standard electronic symbols for LEDs are shown, with arrows indicating light emission. An orange line connects the physical LED to the symbols.

More about LEDs

The long leg is known as the anode and is the positive leg of the LED.

The short leg is known as the cathode and is the negative leg of the LED

This is how to connect the Led in a circuit



The circuit diagram shows a battery with a negative (-) terminal on the left and a positive (+) terminal on the right. A wire connects the negative terminal to the short leg of a red LED, which is labeled '-ve short leg'. Another wire connects the long leg of the LED to a resistor, which is then connected to the positive terminal of the battery. This long leg is labeled '+ve long leg'.

TECHNOLOGY: Electronic Systems Investigate & Design

Components	Description
Transistor: ONLY npn-type	A transistor is a device that can act as a switch and it can amplify a small current.
Sensors:	Important input devices
LDR – Light Dependent Resistor	A component whose resistance decreases with light – dark: high resistance; bright light: low resistance.
Thermistor:	A component whose resistance varies with temperature. Two types exist: +t: resistance increases with increasing temperature -t: resistance decreases with increasing temperature.
Touch- or Moist-detector:	A component that can be bridged using a 'wet' finger, thus completing the circuit, indicating the touch.
Capacitor:	A component which can store and then release electrical energy.

Draw the following circuits in the given spaces

Circuit 1: LED, 470 Ω resistor, switch, 4,5V series battery	
Circuit 2: LDR, buzzer, 3V series battery	
Circuit 3: NPN transistor, buzzer, thermistor, variable resistor, 1k Ω resistor, 6V series battery	
Circuit 4: 6V series battery, LED, 470 Ω resistor, 1000 μ F capacitor, switch	

WORKSHEET

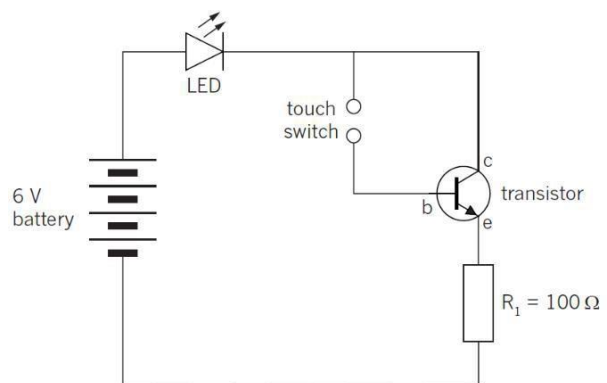
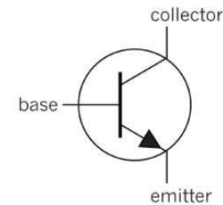
Transistors

Transistors are very important building blocks of modern electronic devices. They enable us to design smaller and cheaper electronic devices.

- A transistor is a semiconductor device that consists of three layers.
- Each layer has its own connection point with a specific name: collector, base and emitter.

A transistor works as a type of switch to turn current on and off. It can also amplify a current. A npn transistor acts as if there is a switch between the collector and the emitter. When the voltage drop between the base and the emitter is smaller than 0,6 V, the resistance between the collector and the emitter is very high, so only a very small current pass through. When the voltage drop between the base and the emitter goes higher than 0,6 V, the resistance between collector and emitter suddenly decreases by a large amount and then a strong current flow through the transistor.

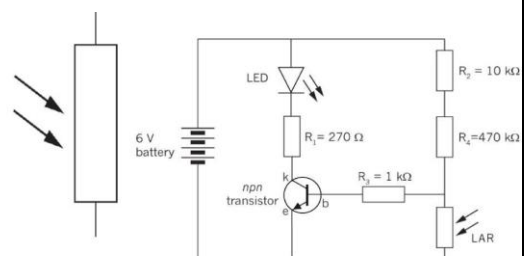
The transistor works like a switch because a tiny current through the base, going to the emitter, switches on a much larger current through the collector so it is an electrically controlled switch. Transistor is short for “trans-resistor” and this explains how it works. With a relatively small base current, the resistance between the collector and the emitter is changed. As the base current increases, the collector emitter resistance decreases.



Light-dependent resistors (LDR)

A light-dependent resistor, also called an LDR, is a resistor of which the resistance decreases when it is exposed to light of a higher intensity. It can therefore be used to detect light and trigger warning devices in cases where light may cause problems. • When an LDR is in the dark, its resistance value will be very high, around 1 MΩ.

When an LDR is exposed to a light of high intensity, the resistance value will decrease. It could drop from 1 MΩ to 2 kΩ. A LDR has two terminals that can be connected to a circuit in either direction.

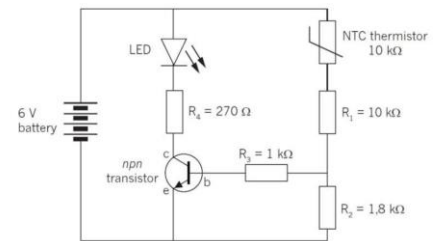
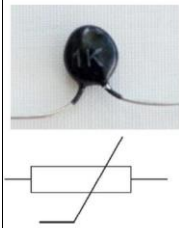


Thermistors (temperature-sensitive resistors)

The resistance value of this resistor depends on the temperature it is exposed to. There are two types of thermistors:

- A “negative-temperature coefficient” type thermistor, where the resistance value decreases with an increase in temperature. This is also called an “NTC” or “-T” thermistor.
- A “positive-temperature coefficient” type thermistor, where the resistance value increases with an increase in temperature.

This is also called a “PTC” or “+T” thermistor.



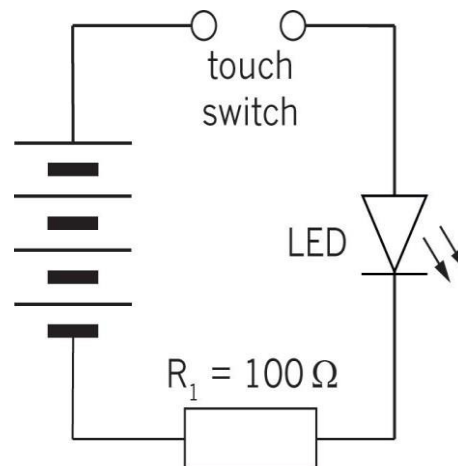
Touch switch

Suppose you want to make a switch that is ON or closed when you touch its two terminals with your finger and OFF or open when you don't touch it.

Look at the circuit diagram in the figure for a touch switch such as the one described. The purpose of this circuit is to light up the LED when you touch the touch switch with your finger.

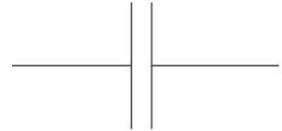
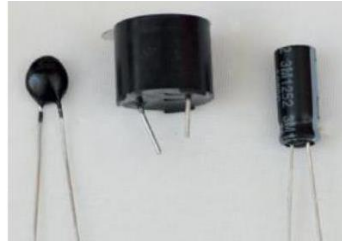
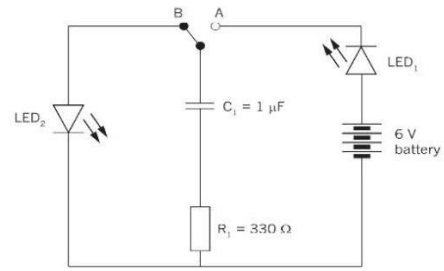
Unfortunately, this circuit won't work well, since your finger is a very weak conductor. In other words, it has a very high resistance so the current will be very small when you touch the switch. Therefore, the LED will only emit a dim light.

Test what will happen when u use a wet finger.



Capacitors

A capacitor stores the potential energy that results from separating positive and negative charges. A capacitor consists of two metal plates separated by an insulator called a dielectric. The ability of a capacitor to separate electric charge is called its capacitance. Capacitance is measured in farad. The symbol "C" is used for capacitance. Because the farad is such a large unit, practical values usually have the prefixes m (milli-), μ (micro-), n (nano-) or p (pico)



Wire Stripping

Building the Alarm (example)

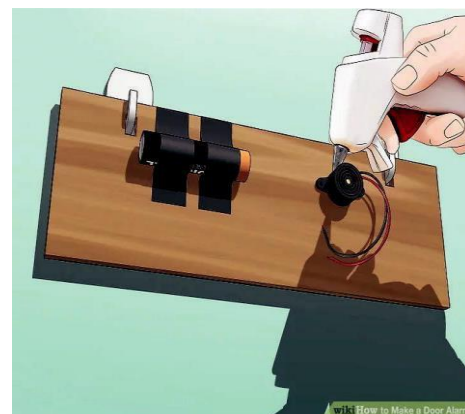
Strip the ends of each strand. Each wire should be covered in an insulated coating. This can be stripped off with your wire strippers. Place two inches (5 cm) of wire into the slot on the strippers that is marked for the gauge of wire you are using. Close the strippers firmly and pull the wire through to remove the insulation. Do this for both ends of each strand.

Scissors or a utility knife can also be used to remove insulation. Cut the insulation until you hit the metal wire on the inside, then peel off the insulation. If the insulation doesn't come free easily, use a pair of pliers to grip the insulation firmly and pull it off.



Step 1

Tape the battery and buzzer onto your wooden board. Use electrical tape to attach these to the wood. The tape should not interfere with or cover any of the connections for the electrical circuit for the buzzer, nor should it cover the positive (+) or negative (-) ends of the battery. Your buzzer may come with screw holes. For a sturdier alarm, you can screw your buzzer into the wood. Be careful to use short nails so these don't protrude through the board.

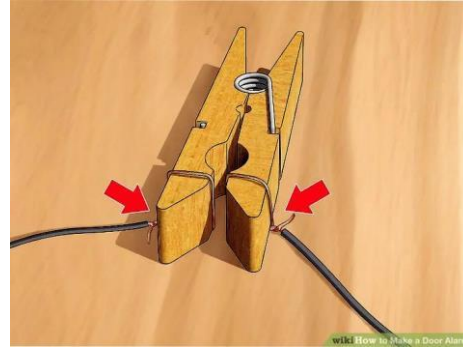


Step 2

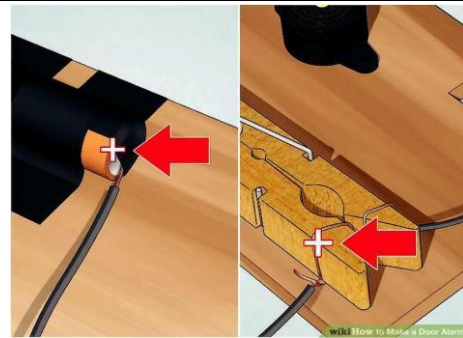
Wrap the stripped wire around the ends of the clothespin. Wrap one stripped end of two pieces of wire around frontmost divot of the top of the clip- end of the clothespin. Do the same to the bottom of the clip-end of the pin with a separate wire.

Twist the stripped wires around the pin until they are tight.

When the pin closes, the wires should touch. This will complete the circuit that sets off your alarm.

**Step 3**

Connect the bottom-pin wire to the battery. Position the wire so it is directly touching the positive (+) end of the battery. Use a piece of electrical tape to fasten the wire in place. If your battery is in a dock or cradle, attach the wire to the positive connector or wire for the cradle and tape it in place.

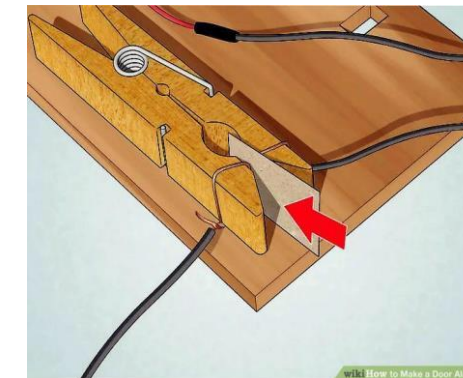
**Step 4**

Connect one non-battery wire to the buzzer. There should be a small opening in the buzzer where you can insert your wire. There should be two connectors, positive and negative. Touch one of your top clothespin wires directly to the positive input for the buzzer.

Alternatively, your buzzer may have wire leads coming off of it. Strip these, if necessary, and twist your non-battery wire to the positive buzzer wire.

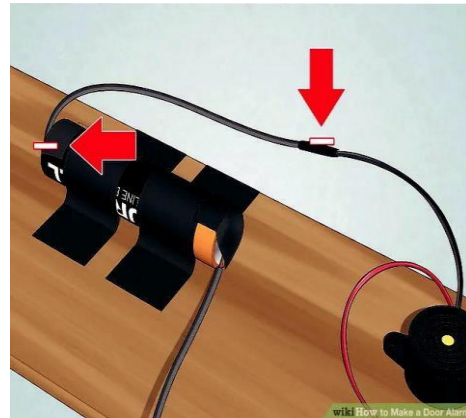
**Step 5**

Break the circuit with a piece of cardboard. Cut a medium sized piece of cardboard to insert between the wires wrapped around the clothespin. Insert the cardboard so that the wires on the clothespin do not touch when it is closed. This will stop the buzzer from going off. Any non-conductive material will work to break your circuit. Try small pieces of paper, wood, or rubber. You may need to fold thin cardboard so there is more distance between wires. Very thin cardboard may not reliably keep the circuit broken



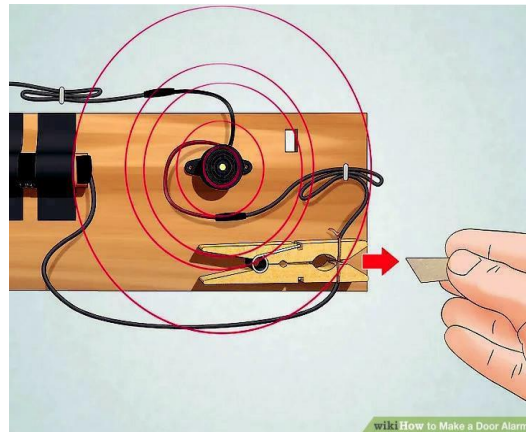
Step 6

Connect the remaining wires. Attach the stripped end of one of your remaining free clothespin wires to the negative (-) end of the battery. Fasten it with electrical tape. Then, in the same fashion as the first, attached the final clothespin wire to the negative (-) input for the buzzer. After you finish attaching the wire to the buzzer, cover any remaining bare wires with tape. While the circuit is engaged, touching bare wire will result in a shock. Be careful not to knock out the circuit breaker between the wires of your clothespin. Doing so will complete the circuit, and likely cause a small shock when you try to attach the wire to the buzzer.



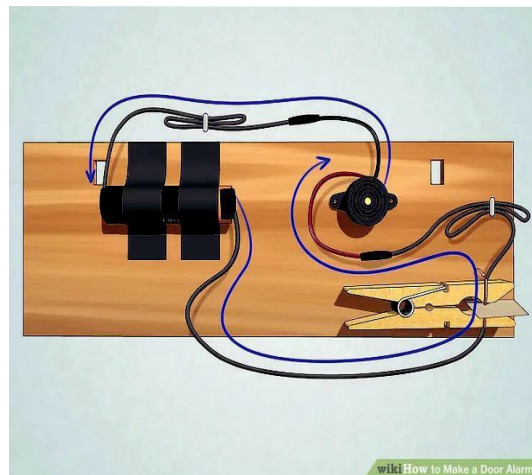
Step 7

Test the switch by completing the circuit. Lay your alarm on a flat surface. Open the clothespin and remove the circuit breaker (piece of cardboard). When the clothespin closes, the circuit should complete and the buzzer turn on. The ends of stripped wire on the clothespin should be in good contact. If they aren't or are just barely touching, wrap more wire around the clothespin. When adjusting the clothespin wires, disengage your battery from the circuit to prevent getting shocked.



Step 8

Check connections and the battery if the buzzer doesn't activate. If the buzzer doesn't activate, one of the connections is likely loose. Reinsert the breaker (cardboard) and refasten all connections. After that, if the alarm still doesn't work, replace your current battery with a new one. To improve connections between wires, wrap wires together. After that, tape bare wires to prevent accidental shocks. To improve the connection between connectors, use pliers to coil the end of the wire in a small circle. The circle should be small enough to fit against the connector. Tape the wire circle to the connector.



In some cases, you may have a faulty buzzer.

Test your buzzer by hooking it up to a traditional power source as directed in the buzzer directions. If it doesn't work, your buzzer is fault.

Part 3: Installing the Alarm

Step 1

Glue the clothespin to the board. Remove your board from the wall. Your battery and buzzer should already be taped to it. Glue the clothespin so it is positioned somewhat close to the battery and buzzer. Follow the glue directions and allow the glue to dry completely before moving on.

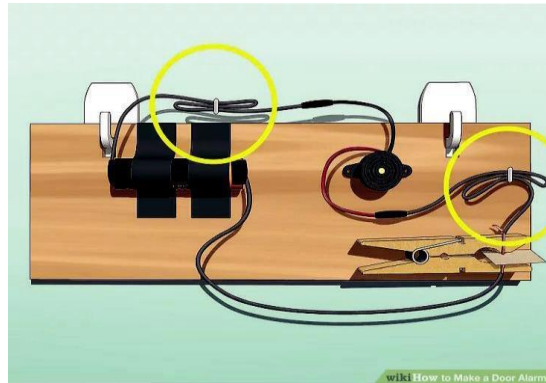
A clothespin is small enough that general purpose glue or hot glue should work to fasten it. For best results, you may want to use a sturdy glue or a wood glue.



Step 2

Manage excess wires with tape and hang the board. Wires sticking out in all directions can be a hazard. They can snag on objects or be easily pulled out.

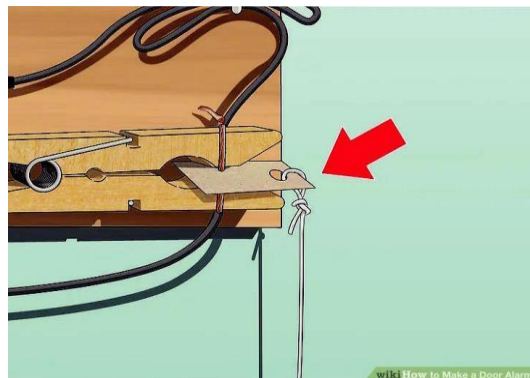
Damaged wires will deactivate your alarm. Tape your wires to the board to prevent them from snagging or being pulled out. Then re-hang the board on the wall.



Step 3

Attach the string to the piece of cardboard in the clothespin. Tape a piece of string to the cardboard. Alternatively, use scissors to make a small hole in the cardboard and tie the string to the hole in the cardboard in a simple knot.

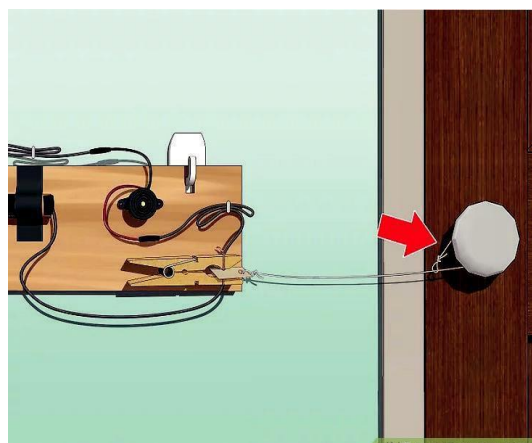
Make sure the string is firmly attached to the cardboard. The door may be opened suddenly. If weakly fastened, the string may pull free while the cardboard remains. In this case, the alarm will not go off.



Step 4

Fasten the other end of the string to your door. Attach the string to the doorknob or tape it to a part of the door. Adjust the length of the string so that when the door opens, the string is pulled.

When the cardboard pulls out, the alarm will go off. If your door is painted or made of a nice material, you may not want to tape the string to it. Some tape, when peeled away, can damage paint or wood.



How to Make a Simple Electric Bell at Home | School Science Project Working Model Ideas

<https://www.youtube.com/watch?v=NZGfJun4yTg>

RESOURCE LIST

Technology Resources

Scenario 1: The Security & Alarm System (Intrusion)	Scenario 2: Fire Alarm with Visual and Audible Alert
Switch	Switch
9v battery	9v battery
LED, Buzzer	LED, Buzzer
Conducting wire with crocodile clips	Conducting wire with crocodile clips
NPN Transistor	NPN Transistor
Light Dependent Resistor	Thermistor NTC (Negative Temperature Coefficient) 10K Ω
4 Resistors 1k Ω , 330 Ω , 4.7k Ω , 10K Ω	2 Resistors 330 Ω , and 10K Ω
Recyclable cardboard	Recyclable cardboard
Glue gun with glue sticks	Glue gun with glue sticks
Ruler, pencil, eraser	Ruler, pencil, eraser
2D grid paper, 3D grid paper	2D grid paper, 3D grid paper

Alternative: if schools are situated far from electrical shops in rural areas, the electrical/electronic components can be replaced with symbols pasted on cardboard. Then learners build unplugged circuits on cardboard and test cardboard circuits on simulators; PHET Simulator or Tinker Cad.

Resources for Natural Science

- 1.5 volts batteries (3-6 per circuit)
- Battery holders
- Connecting wire with crocodile clips
- Switch toggle or push-button switch
- Fixed Resistor (120 Ω to 330 Ω preferable 220 Ω)
- Multimeter/or Ammeter and voltmeter for measuring current and voltage
- Graph paper
- Circuit board if available

Resources for Mathematics

- Scientific calculators
- Graph paper
- Rulers and geometry sets
- Printed worksheets

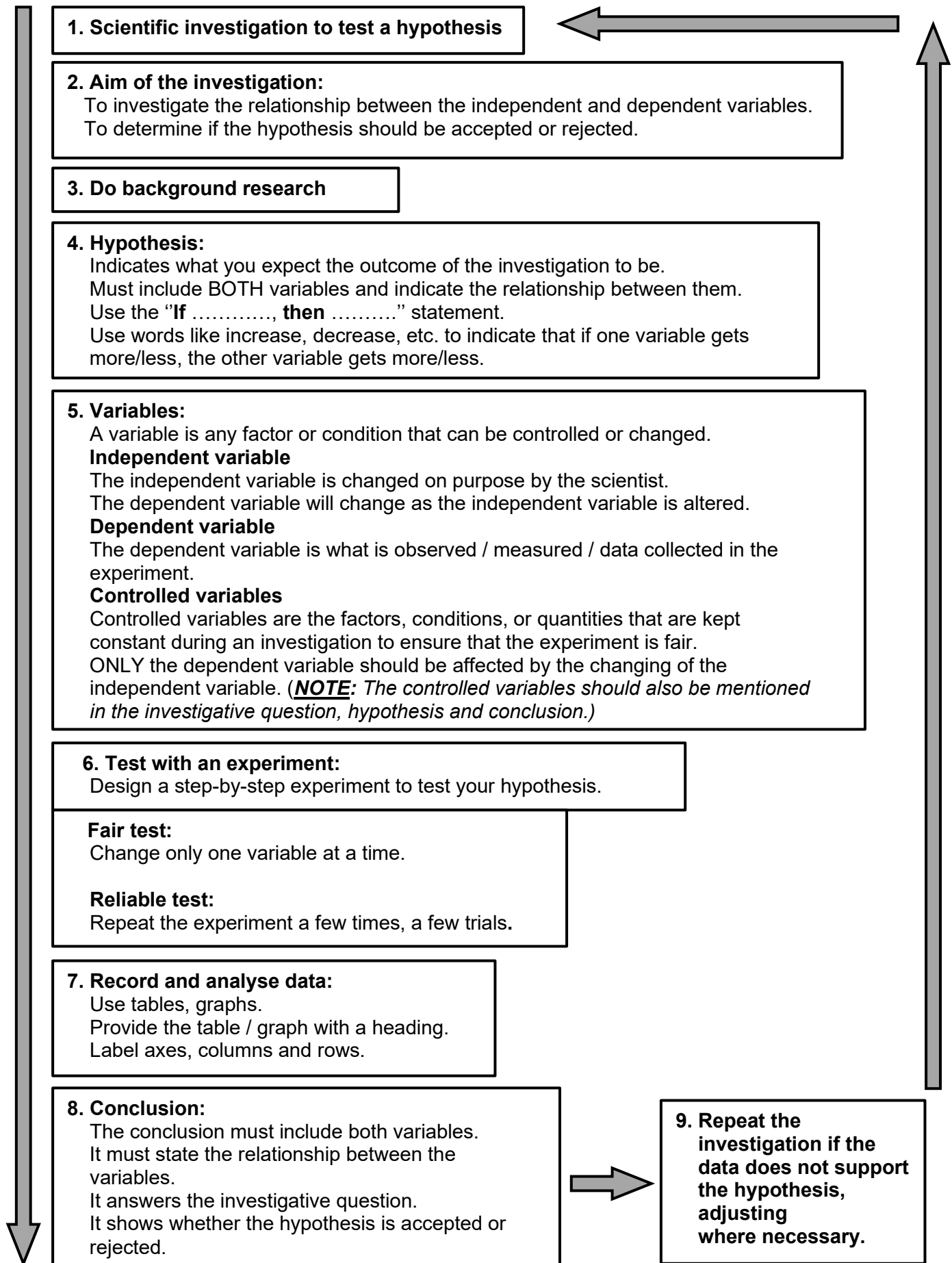
QUOTATION OF MATERIALS – WORKSHEET 10

FROM: LTech Stationary, 2 Sesame Street, Rivonia Sandton, Johannesburg, 2100, South Africa

Quote #: 0000001 | Quote Date: 16/08/2026 | Due Date: 29/08/2026

Item No	Description of Item	Quantity	Unit Price (incl. VAT)	Amount
1	Battery holder	4		R336,00
2	Glue Sticks 100g		R59,00	R295,00
3	LED (pack of 100)	1		R352,00
4	Glue Gun	1	R169,00	R169,00
5	Battery Pack of 4 (Duracell)	2	R96,00	
6	Buzzer	1	R26,95	R26,95
7	Connecting wire per meter	1	R5,00	R5,00
8	Resistors	2	R12,35	
9	Acrylic Poster Paint (6 colours)	2	R225,00	
10	Cardboard (2m x 2m)	1	R25,88	R25,88

NATURAL SCIENCES: The Scientific Method



Links of videos to assist:

PhET simulation can also be used to build the circuit and take readings:

<https://phet.colorado.edu/en/simulations/circuit-construction-kit-dc-virtual-lab>

OR

https://phet.colorado.edu/sims/html/ohms-law/latest/ohms-law_en.html

YouTube videos:

<https://www.youtube.com/watch?v=WEqu2vxjyFc>

OR

<https://www.youtube.com/watch?v=Vh3XGz7hgU4>

NOTICE TO MATHEMATICS EDUCATORS

Educators are requested to take special note that **statistics and probability** are officially scheduled for weeks 5–8 of the term. However, it is strongly recommended that this content be taught earlier, during weeks 1–4.

This adjusted teaching sequence should be followed by **geometry of 2d shapes**, and thereafter **area and perimeter**. The purpose of this reorganisation is to ensure a smoother transition between the project work and the formal teaching of new content in term 3.

Furthermore, it must be noted that the **term 3 project** is designed to assess content covered across **terms 1–3**. As a result, while administering the project, educators will encounter and should reinforce concepts from both term 1 and term 2, in addition to current term 3 content.

SUPPORT FOR WORKSHEET 1B: STATISTICS AND PROBABILITY

This worksheet focuses primarily on Mathematics Data Handling (descriptive statistics, measures of central tendency, range, percentages, probability, and data representation). It integrates with a Technology scenario (burglary or fire incidents) to make data analysis meaningful and contextual. The worksheet develops Critical Thinking (interpreting trends, risk assessment, predictions) and Metacognition (explaining what statistics reveal about real-world trends).

STATISTICS

Data is raw information that has been collected, without any organization of analysis. It is unprocessed. Statistics refers to the process of collecting, organizing, summarising, representing and analyzing information. It means gathering and recording information and then presenting it in a way that is meaningful to others.

DEVELOPING QUESTIONS

The first step in the statistical process is to develop or pose questions. When developing/posing the question, you must first identify the main question, followed by sub-questions.

COLLECTING DATA

Methods of collecting data:

1. **Observation** – e.g. counting the number of people entering a store. This is the method of collecting data by watching and recording the results. The advantage of this method is that you don't interact with people to get the response.
2. **Interview** – e.g. asking your fellow learners their opinion of the design for your matric jacket. The interviewer asks the interviewee questions and records the response. The advantage of this method is that the interviewer may ask further questions if the response is vague.
3. **Survey** – e.g. learners complete a questioner on cool drink perverseness for the tuck shop. A questionnaire is a tool used to conduct a survey and can be completed online, in person, by telephone etc. Questions should not be long and must be clear. Answer must also be concise. Questionnaires must be anonymous and confidential. Questionnaires should be short and simple and not bias. This is a list of questions used to collect data from the respondents. Participants do not have to identify themselves. The advantage of using this method is that you get the information directly from the participants.

Population – the entire group of interest e.g. all the learners at school.

Sample – a representative part of the population e.g. randomly selects a number of people per grade. A sample must be representative, randomly chosen, large enough and free from bias.

SUMMARISING DATA

MEASURES OF CENTRAL TENDENCY

- Mean
- Median
- Mode

Mean	= $\frac{\text{sum of all the values in a data set}}{\text{number of values in the data set}}$
Median	= middle value of data set, if organized in ascending order (small to big) If uneven number of values in data set – use middle value 1 3 5 6 8 Median = 5 If even number of values in data set – get average of 2 middle values (add together and divide by 2) 1 3 5 7 8 9 Median = $\frac{5+7}{2} = 6$
Mode	= the value in the data set that appears the most = there may be more than one mode or no mode at all

MEASURES OF DISPERSION

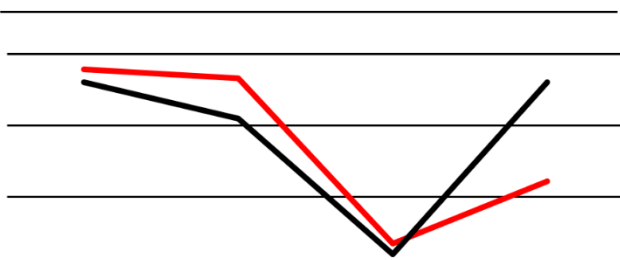
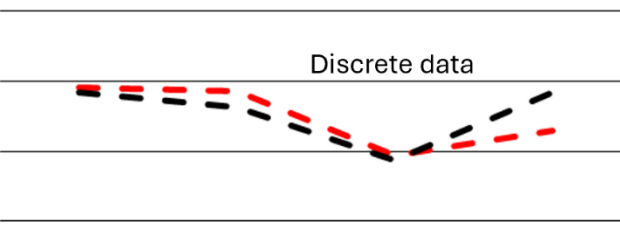
- Extremes
- Outliers

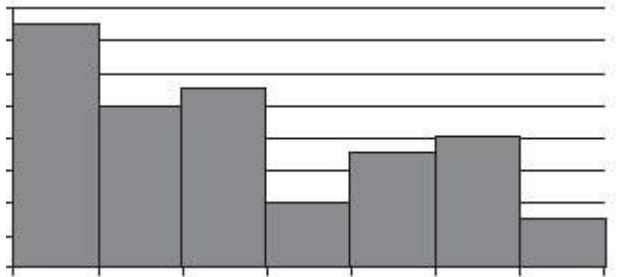
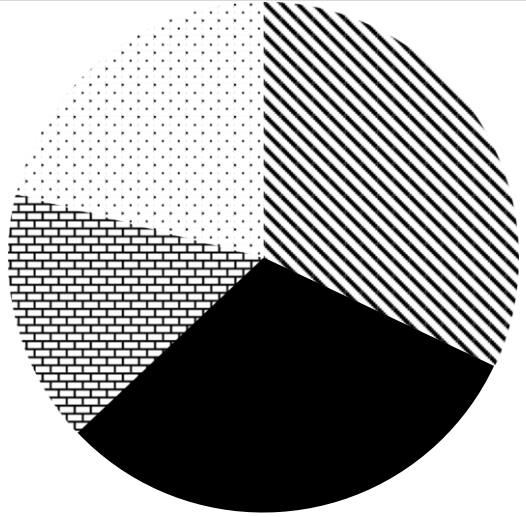
Extremes	Extremes are: • The minimum value • The maximum value They determine: • The range • The overall spread of the data set However, extremes may sometimes be unusual values (outliers) The range is the simplest measure of dispersion. Range = Highest value – Lowest value Example: Data: 4, 7, 9, 12, 15 Range = 15 – 4 = 11 Important: • The range depends only on the two extreme values. • It is very sensitive to outliers.
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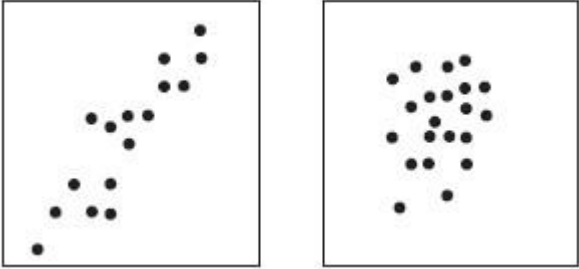
Outliers	Outliers An outlier is a value that is: • Much smaller or much larger than the rest of the data • Very different from other values Data: 5, 6, 7, 8, 9, 10, 50 Here, 50 is an outlier because it is much larger than the rest. • Range becomes large. • Mean increases significantly. • IQR remains relatively stable.
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REPRESENTING, INTERPRETING AND ANALYSING DATA

The following representations of data can be drawn:

Line graphs: Broken line graphs	In data handling we use line graphs to show the relationship between two quantities. A line graph is formed by using lines to join data points which have been mapped on a grid. It is used to show the change of information over time. A line graph shows the trend between plotted points.	 Continuous data
		 Discrete data

Single bar graphs			
Multiple (double) bar graphs	A bar graph is used to represent data that is sorted into categories. Display data is compared in categories. Each bar shows the number of items in that category and there are spaces between the bars.		
Compound (stacked) bar graphs			
Histograms	Histograms are different from bar graphs in that they represent continuous data. Data that is displayed on a histogram is also grouped. There are no spaces between the bars.		
Pie Charts	Pie charts are circular graphs, divided into sectors. They are used to show the parts that make up a whole. They can be useful for comparing the size of relative parts. The information is often presented as percentages that must add up to 100%. They are often used in media to show clear and important differences, but they cannot show shape and spread of data.		

Scatter plots	A scatter plot is the most useful graph for studying the relationship (correlation) between two variables.	
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PROBABILITY

1. What is Probability?

Probability is the chance that an event will happen. It tells us how likely or unlikely something is to occur.

Examples:

- Probability that it will rain tomorrow
- Probability of getting a head when tossing a coin
- Probability of drawing a red card from a deck of cards

Probability can be written as a fraction, decimal or percentage.

2. Probability Scale

Probability is measured from 0 to 1.

0	– Impossible event
Between 0 and 1	– Possible event
1	– Certain event

Examples:

- Sun rising tomorrow: 1
- Getting a 7 on a die: 0
- Tossing a head on a coin: 0.5

3. Equally Likely Outcomes

Outcomes are equally likely when each outcome has the same chance of occurring.

Example:

Rolling a fair die gives six outcomes: 1,2,3,4,5,6.
Probability of rolling a 3 = $\frac{1}{6}$.

4. Formula for Probability

Probability = (Number of favourable outcomes) / (Total number of possible outcomes)

Example:

A bag contains 5 red marbles and 3 blue marbles.

Total marbles = 8

$P(\text{red}) = 5/8$

$P(\text{blue}) = 3/8$

5. Compound Events

A compound event occurs when more than one event happens.

Examples:

- Tossing two coins or rolling two dice.

Compound probabilities can be shown using tree diagrams or two-way tables.

6. Tree Diagrams

A tree diagram shows all possible outcomes step by step.

Example: Tossing two coins

Possible outcomes: HH, HT, TH, TT

Total outcomes = 4

Probability of two heads = $1/4$

Probability of one head and one tail = $2/4 = 1/2$.

7. Example:

Coin and Die

A coin is tossed and a die is rolled.

Total outcomes = 12.

Example probability of getting Head and 3 = $1/12$.

8. Two-Way Tables

Two-way tables organise data involving two variables.

Example:

Cameras Installed – Vandalism 10, No Vandalism 90

No Cameras – Vandalism 15, No Vandalism 85

Total incidents = 200

$P(\text{Vandalism}) = 25/200 = 0.125 = 12.5\%$

9. Experimental Probability (Relative Frequency)

Experimental probability is found by performing an experiment.

Relative Frequency = Number of times the event occurs / Total number of trials.

Example:

A coin tossed 20 times gives 12 heads.

Relative frequency of heads = $12/20 = 0.6$.

10. Theoretical Probability vs Relative Frequency

- Theoretical probability is calculated mathematically.
- Relative frequency is obtained from actual experiments.

For example, theoretical probability of heads = 0.5 but experimental results may vary.

11. Why Results May Differ

Differences occur due to:

- Small number of trials
- Random variation
- Experimental error

With more trials, results get closer to theoretical probability.

12. Predicting Relative Frequency

Probability can predict expected results.

Example:

Probability of rolling a 6 on a die = $1/6$.

If rolled 60 times, about 10 sixes are expected.

13. Key Vocabulary

- 1) Outcome – possible result
- 2) Event – specific result
- 3) Sample space – all possible outcomes
- 4) Probability – chance of an event
- 5) Relative frequency – experimental probability
- 6) Compound event – two or more events together

Understanding & Summarising Data (Question 1 & 2 – 30–40 min): Start with the table. Teach students to identify max/min directly from the values. For range: Emphasise it shows spread/variability of incidents. For mean: Stress showing all addition steps + division; discuss why mean is useful for “average trend”. For median: Teach ordering the five values and selecting the middle (3rd) one. Metacognition link: “What does the mean tell us about whether incidents are generally rising, falling, or stable?”

Percentage Change & Prediction (Question 3 – 20 min): Revise formula clearly: Percentage decrease = $(\text{decrease} \div \text{original value}) \times 100$. For prediction: New value = 2024 value $\times (1 + 9/100)$ = 2024 value $\times 1.09$. Model both calculations with working shown (method marks are key).

Probability & Tree Diagram (Question 4 – 25 min): Teach tree diagrams step-by-step: First branch = Cameras (Yes/No), second branch = Vandalism (Yes/No). Write probabilities as fractions on branches (e.g., $P(\text{Cameras}) = 100/200 = 1/2$). Joint probabilities at the end of branches (e.g., Cameras AND Vandalism = $10/200$). Discuss risk: Compare conditional probabilities $P(\text{Vandalism} \mid \text{Cameras})$ vs $P(\text{Vandalism} \mid \text{No Cameras})$.

Representing Data – Double Bar Graph (Question 5 – 20–30 min): Teach structure of a double bar graph:

- Horizontal axis: Categories (Cameras Installed / No Cameras Installed).
- Vertical axis: Number of community centres (scaled appropriately, e.g., 0–100).
- Two bars per category: one for “Vandalism”, one for “No Vandalism” (use different colours/shading and a key).
- Title, labels, neat scale. Emphasise accurate heights (10, 90, 15, 85).

SUPPORT FOR WORKSHEET 6B: MEASUREMENT & GEOMETRY

Explain:

- A net is a 2D layout that folds into a 3D shape.

For this structure:

- 1 base (15×15)
- 4 side faces:
 - 2 faces: 15×8
 - 2 faces: 15×8
- No top

Scale Drawing

Scale given:

1 cm represents 5 cm

Teach:

- Divide real measurements by 5

Example:

- 15 cm $\rightarrow$ 3 cm
- 8 cm $\rightarrow$ 1.6 cm

Emphasise accuracy and ruler use.

Diagonal of a Rectangle

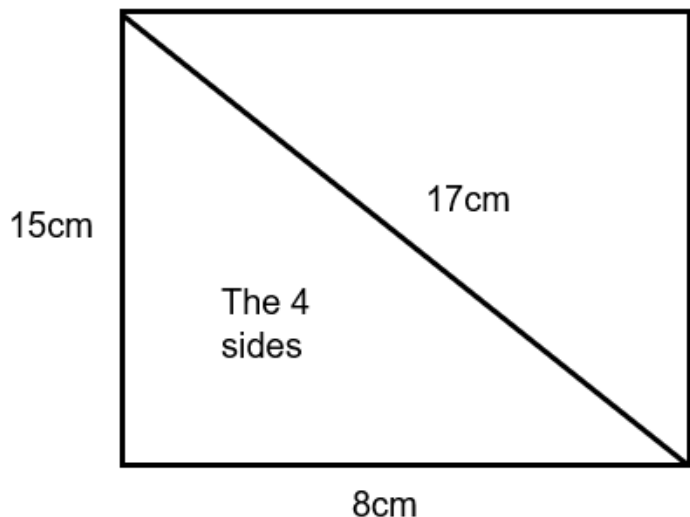
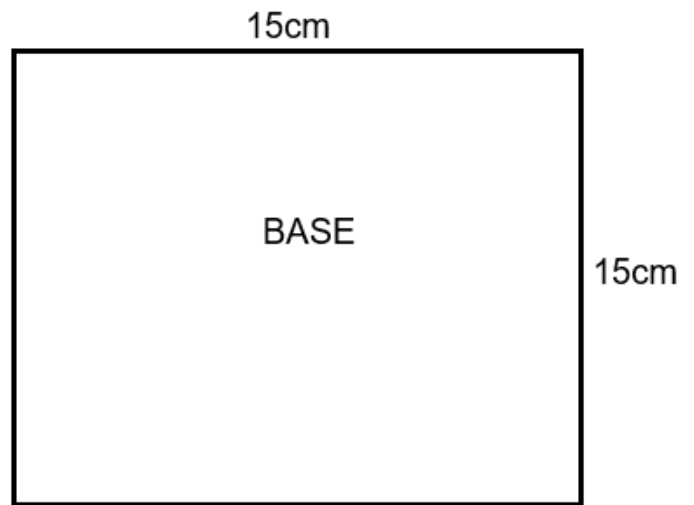
Introduce Pythagoras' Theorem:

To calculate diagonal:

$$d = \sqrt{l^2 + b^2}$$

For 15 cm $\times$ 8 cm:

$$\begin{aligned} d &= \sqrt{15^2 + 8^2} \\ &= \sqrt{225 + 64} \\ &= \sqrt{289} \\ &= 17 \text{ cm} \end{aligned}$$



Radius = half of diameter

- Learners must interpret:
 - Distance from **circle edge to vertex** = 6 cm

Given:

- Vertex $\rightarrow$ centre distance = half diagonal
- $= \frac{17}{2} = 8.5$ cm

Then:

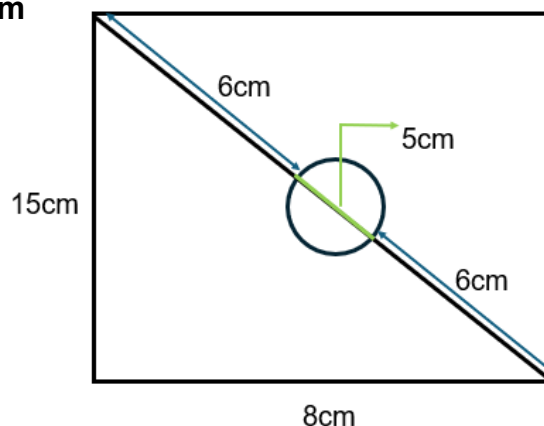
- Radius = $8.5 - 6 = 2.5$ cm

OR

- Vertex $\rightarrow$ centre distance = half diagonal
- Diameter = $17 - 6 - 6$
 $= 5$ cm

Then:

- Radius = $5 \div 2$
 $= 2.5$ cm



SUPPORT FOR WORKSHEET 9B: FUNCTIONS AND RELATIONSHIPS AND GRAPHS

This worksheet focuses on the **mathematics** of linear relationships (direct proportion), determining equations from graphs/tables, rearranging formulas, and applying Ohm's Law ($V = IR$) through calculations and reasoning. It builds on Worksheet 9A (where students presumably plotted a V vs I graph from experimental data for a resistor at constant temperature).

The worksheet integrates **Grade 9 CAPS Physical Sciences** (Electricity) with **Mathematics** topics: linear functions ($y = mx + c$), gradient, direct proportion, and algebraic manipulation. It assesses **21st Century Skills** through justification (communication & critical thinking) and reflection on relationships (metacognition).

Prior Knowledge Required (Mathematics Focus):

- Direct proportion: Two quantities are directly proportional if one is a constant multiple of the other ($y = kx$; graph is a straight line through the origin).
- Gradient (slope) of a line: $m = \Delta y / \Delta x$ (rise over run). For V-I graph, gradient = $\Delta V / \Delta I = R$ (resistance).
- Equation of a straight line: $y = mx + c$ (here, usually $c = 0$ for ideal Ohm's Law through origin).
- Rearranging formulas (changing the subject): Using inverse operations, balancing equations.
- Substitution into formulas and solving for unknowns.
- Interpretation: What doubling/halving one variable does to another when the third is constant.

Revision of Direct Proportion & Linear Graphs (15–20 min): Revise that in a direct proportion, doubling one variable doubles the other. Plot quick examples (e.g., cost vs number of items). For the V-I graph from 9A: Stress it should be a straight line through (0,0) if resistance is constant. Gradient is constant → direct proportion.

Determining the Equation from Graph/Table (Question 1 – 20 min): Teach the method: Choose two points (first and last recommended for accuracy over range). Calculate gradient $m = (V_2 - V_1) / (I_2 - I_1)$. Then $y = mx + c$. Test c by substituting a point (should be ≈ 0). Emphasise: In real experiments, there may be small intercept due to measurement error, but ideally $c=0$. Communication: Justify “direct proportion” by saying “V increases linearly with I; ratio V/I is constant (equal to R)”.

Ohm’s Law as a Formula & Rearrangement (Question 2 – 15 min): Present $V = IR$ as a direct proportion between V and I (R constant). Teach rearrangement using the “triangle” or cover-up method, but show algebraic steps for marks:

- To make R subject: $V = IR \rightarrow R = V/I$ (divide both sides by I).
- Discuss: When R is constant, $I \propto V$ (direct). When V is constant, $I \propto 1/R$ (inverse).

Calculations (Question 3 – 20 min): Model the three standard rearrangements with units:

- $V = I \times R$
- $I = V / R$
- $R = V / I$ Stress: Always write the formula first, substitute values with units, then calculate. Answer with correct unit and reasonable significant figures.

Reasoning & Interpretation (Question 4 – 15 min): This is pure proportional reasoning (metacognition). Show that for constant R, $I = V/R \rightarrow$ if V doubles, I doubles (direct). Use ratio method: $I_2 / I_1 = V_2 / V_1$ (when R fixed).

SUPPORT FOR WORKSHEET 10A: FINANCIAL MATHEMATICS

This worksheet applies **financial mathematics** (percentages, VAT calculations, simple interest, and compound interest) to a realistic group project scenario involving purchasing materials for an electrical circuit. It strongly emphasises **mathematics** while linking to the previous worksheets on circuits and packaging. The worksheet assesses **21st Century Skills**: Critical Thinking (comparing options and justifying choices), Communication (completing tables accurately and explaining comparisons), and Metacognition (understanding the real cost implications of interest and VAT in project budgeting).

Prior Knowledge Required:

- Calculating with percentages: Finding missing quantities when total amount is given (unit price or quantity).
- VAT inclusive pricing: Prices already include 15% VAT (standard South African rate as of 2026).
- Simple Interest formula: $A = P(1 + i n)$ or $I = P \times r \times t$.
- Compound Interest formula: $A = P(1 + i)^n$ (annually compounded).
- Comparing two financial options and justifying with calculations and reasoning.
- Accurate table completion, including subtotals and grand total.
- Working with money: Rounding to 2 decimal places (cents).

Introduction & VAT/Percentage Calculations (20–25 min): Explain that all unit prices include 15% VAT. Revise how to find missing values:

- Given Amount and Quantity $\rightarrow$ Unit Price = Amount $\div$ Quantity.
- Given Unit Price and Amount $\rightarrow$ Quantity = Amount $\div$ Unit Price.
- Given Unit Price and Quantity $\rightarrow$ Amount = Unit Price $\times$ Quantity. Model one row on the board (e.g., Item 1: Amount R336 for 4 items $\rightarrow$ Unit Price = $336 \div 4 = \text{R}84.00$). Stress neat table completion and consistent 2 decimal places.

Completing the Table & Total + VAT (25 min): Teach students to calculate all missing values first, then sum the **Amount** column for the subtotal (pre-VAT is not needed directly since prices are inclusive). For total VAT: Since all prices include 15% VAT, VAT = Total Amount $\times (15/115)$ or equivalently Total $\times 0.13043478\dots$ (but better to use fraction or calculator method). Show both methods:

- VAT portion = Total $\times 15/115$.
- Or Total = Pre-VAT $\times 1.15 \rightarrow$ Pre-VAT = Total / 1.15 $\rightarrow$ VAT = Total – Pre-VAT.

Simple vs Compound Interest (25–30 min): Revise the difference clearly:

- **Simple Interest:** Interest earned only on the original principal each year. Linear growth.
- **Compound Interest:** Interest earned on the principal + previously accumulated interest. Exponential growth. Use the formulas explicitly and show step-by-step working. For comparison: Calculate both totals and the difference; justify using “cheaper” and reference to the amounts.

Consolidation & Metacognition (10 min): Group discussion: “Why is compound interest more expensive for the borrower?” “How does understanding VAT help in real project budgeting?” “Which option would you choose and why, considering cash flow?”

Natural Sciences: Graph paper for the graph in Worksheet 9

