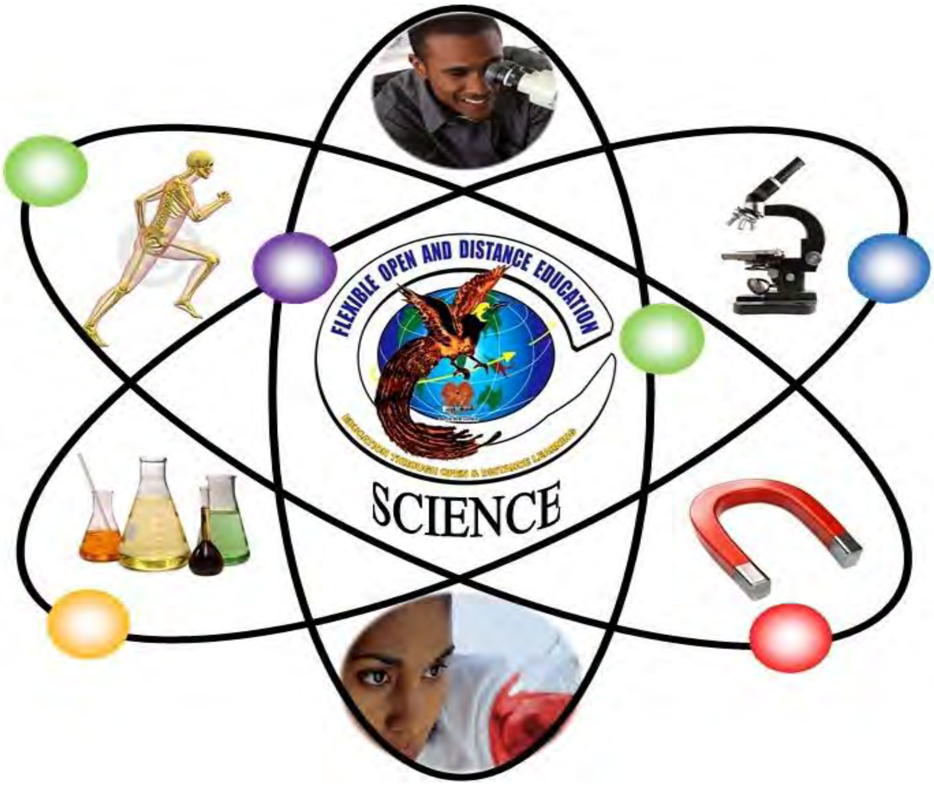
DEPARTMENT OF EDUCATION

GRADE 10

SCIENCE

STRAND 1



WORKING SCIENTIFICALLY

FLEXIBLE OPEN AND DISTANCE EDUCATION
PRIVATE MAIL BAG, P.O. WAIGANI, NCD
FOR DEPARTMENT OF EDUCATION
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GRADE 10

SCIENCE

UNIT 1

WORKING SCIENTIFICALLY

IN THIS UNIT YOU WILL LEARN ABOUT:

TOPIC 1: MEASUREMENT
TOPIC 2: SCIENTIFIC APPROACH

Acknowledgement

We acknowledge the contributions of all secondary teachers who in one way or another have helped to develop this Course.

Our profound gratitude goes to the former Principal of FODE, Mr. Demas Tongogo for leading FODE team towards this great achievement.

Special thanks to the staff of the Science Department of FODE who played active roles in coordinating writing workshops, outsourcing lesson writing and the editing processes involving selected teachers of Central Province and NCD.

We also acknowledge the professional guidance provided by Curriculum and Development Assessment Division throughout the processes of writing and the services given by members of the Science Review and Academic Committees.

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DIANA TEIT AKIS
PRINCIPAL

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SECRETARY'S MESSAGE

Achieving a better future by individual students and their families, communities or the nation as a whole, depends on the kind of curriculum and the way it is delivered.

This course is a part of the new Flexible, Open and Distance Education curriculum. The learning outcomes are student-centred and allows for them to be demonstrated and assessed.

It maintains the rationale, goals, aims and principles of the national curriculum and identifies the knowledge, skills, attitudes and values that students should achieve.

This is a provision by Flexible, Open and Distance Education as an alternative pathway of formal education.

The course promotes Papua New Guinea values and beliefs which are found in our Constitution, Government Policies and Reports. It is developed in line with the National Education Plan (2005 -2014) and addresses an increase in the number of school leavers affected by the lack of access into secondary and higher educational institutions.

Flexible, Open and Distance Education curriculum is guided by the Department of Education‟s Mission which is fivefold:

- To facilitate and promote the integral development of every individual
- To develop and encourage an education system that satisfies the requirements of Papua New Guinea and its people
- To establish, preserve and improve standards of education throughout Papua New Guinea
- To make the benefits of such education available as widely as possible to all of the people
- To make the education accessible to the poor and physically, mentally and socially handicapped as well as to those who are educationally disadvantaged.

The college is enhanced through this course to provide alternative and comparable pathways for students and adults to complete their education through a one system, two pathways and same outcomes.

It is our vision that Papua New Guineans‟ harness all appropriate and affordable technologies to pursue this program.

I commend all the teachers, curriculum writers and instructional designers who have contributed towards the development of this course.

UKE KOMBRA, PhD
Secretary for Education

COURSE INTRODUCTION

Dear Student,

Welcome to the Grade 10 Science Course with FODE. We hope that you will find this Course interesting.

About this Course
Your Grade 10 Course consists of Six (6) Unit Books, Six (6) Assignments and an Examination.

- Units 1 to 6 have Lessons on different Topics. You will also find Practice Exercises and Answers to the Practice Exercises in each unit. You will correct your own Practice Exercises using the answers given at the end of each topic.

- Each unit has a corresponding Assignment consisting of Topic Tests on each Topic and a Unit Test on what is covered in a unit. Your Distance Teacher will mark the assignment.

The marks you score in the six assignments and the final examination will count towards your Final result.

Repeat Assignment and Cancellation
If you score less than 50% in any assignment, you will repeat that Assignment. If you fail three consecutive assignments, you will not be allowed to continue with the course. Therefore, you need to;

- revise well before doing the assignments

- answer all the questions to complete the assignments and

- check the answers carefully before sending them in for marking

Plan well, work regularly
Students at school have regular hours of study. They also have a teacher to help them with their work, but you have to work on your own. So, plan well and work regularly. It should you take you between 8 and10 weeks to complete this course.
Whenever you need help ask your;
- friends
- any high school teachers near you
- distance teachers near you or
- the Provincial coordinator

Another good idea is to study together with other students who are studying Grade 9 Science. In this way, you can successfully complete the course. We, in the Science Department at FODE, wish you well in your studies.

All the best!

UNIT INTRODUCTION

Dear Student,

Welcome to Unit 1 of the Grade 10 Science Course! This Unit, Working Scientifically is a skills course and requires a lot of concentration. If you study well, you will learn a lot and find this unit an enjoyable one.

This Unit is based on the Lower Secondary Schools Science Curriculum.

There are two topics which are comprised of 14 Lessons. They are:

- **Measurement and**
- **Scientific Approach**

Each topic has Seven (7) Lessons. The lessons in the first topic discuss about the different unit systems used in measurement. They will also tackle accuracy, reliability and errors in measurement. You will also learn about the measurements of different physical quantities.

The second Topic also has seven Lessons and discusses about the rules for working safely in the science classroom. It will deal with first aid, observations and predictions as well as how to present data. You will also learn how to conduct a fair test which is part of a science report and how to write.

Remember, you have to do all the activities and complete the Practice Exercises after each lesson. Answers to Practice Exercises are at the end of each Topic.

If you have any problems in understanding any of the lessons, please inform the Science Department at FODE Headquarters. This will help the teacher to revise the lessons for the next edition.

You may now study the Study Guide provided on the next page.

All the Best!

STUDY GUIDE

Follow the steps given below to work through the lessons.

Step 1 Start with Topic 1 and work through it in order. You may come across new terms in your lessons which are written in bold with an asterisk (*). For example in Lesson 1, you will come across **arbitrary***. Words like this will require you to look up their meanings in the glossary section at the end of this book.

Step 2 When you complete Lesson 1, do Practice Exercise 1.

Step 3 After you have completed the Practice Exercise, correct your work. The answers are given at the end of each Topic.

Step 4 Then, revise well and correct your mistakes.

Step 5 When you have completed all the 4 steps, tick the check box for Lesson 1, on the Contents page, like this:

☑ Lesson 1: Unit Systems

Then, go on to the next Lesson. Repeat this process until you complete all the Lessons in the Topic. When this is done, revise using the Review Section.

Remember, as you complete each lesson, tick the box for that lesson on the Table of Contents page. This will help to check your progress.

Assignments: Topic Tests and Unit Tests

When you have completed all the lessons in a Topic, do the Topic Test for that Topic, in the Assignment Book. The Unit Book tells you when to do this.

When you have completed the entire Topic Tests for the Unit, revise well and do the Unit Test. The Assignment Book tells you when to do the Unit test.

When you have completed the entire Assignment Book, check and revise well before sending it to the Provincial Centre for marking.

If you have any questions, write them on the Student‟s page. You will receive a response and advice from your teacher when he/she returns your marked assignment.

The Topic Tests and the Unit Test in each Assignment will be marked by your Distance Teacher. The mark you score in the Assignment will count towards the final result. If you score less than 50%, you will repeat that Assignment.

Remember, if you score less than 50% in three consecutive Assignments, your enrolment will be cancelled. So, work carefully and ensure that you pass all the Assignments.

TOPIC 1

MEASUREMENT

In this topic you will learn about:

- **unit systems**
- **reliability and accuracy**
- **length**
- **time and temperature**
- **mass and weight**
- **volume**
- **density**

INTRODUCTION TO TOPIC 1: MEASUREMENT

Measurement techniques have been of immense importance ever since the start of human civilization, when measurements were first needed to regulate the transfer of goods in barter trade to ensure that exchanges were fair.

The very first measurement units were those used in barter trade to quantify the amounts being exchanged and to establish clear rules about the relative values of different commodities. Such early systems of measurement were based on whatever was available as a measuring unit. For purposes of measuring length, the human torso was a useful tool, and gave us units of the hand, foot and cubit. Although generally adequate for barter trade systems, such measurement units are of course imprecise, varying as they do from one person to the next. Therefore, there has been a progressive movement towards measurement units that are defined much more accurately.

Measuring devices

- What is the standard SI for measuring volume?
- Before the density of an object can be found, what two measurements are required?
- The curved surface of a liquid when viewed through a graduated cylinder is called a __________.
- How many metres in one kilometre?

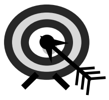
The first improved measurement unit was a unit of length. It can be measured in yards, metres, or several other units. Apart from the major units of length, subdivisions of standard units exist such as feet, inches, centimetres and millimetres, with a fixed relationship between each fundamental unit and its sub-divisions.

As a result of this, an internationally agreed set of standard units (SI units or Syst` mes Internationales d‟Unit´ s) has been defined, and strong efforts are being made to encourage the adoption of this system throughout the world.

In this Topic, you will find the answers to these questions and all other questions relating to measurement.

Lesson 1: Unit Systems

Welcome to Lesson 1. In this lesson, you will learn about the unit systems of measurement. People use measurements every day, that you may not realise it or even think about it. When you see, feel, hear, smell and taste, measurement has become an important part of our lives.



Your Aims:

- define measurement and arbitrary units
- recognise arbitrary units used in measurement
- estimate measurements using arbitrary units
- identify the different metric or SI units
- state the disadvantages of using arbitrary units to SI units

What is Measurement?

Measurement is a collection of quantitative data. A measurement is done by comparing a quantity with a standard unit. For example, the length of a piece of string can be measured by comparing the string against a metre stick.

You measure things in many different ways. If you go to the market you will see strings of small fish, bundles of green vegetables, piles of sweet potatoes and tomatoes. The sellers used their judgments to estimate the size of each. So this will vary from one seller to another, from day to day and from market to market and the buyer will choose the biggest bundle of strings to get the best value. The piles of fruits, bundles of vegetables and strings of fish are all **arbitrary units.** Arbitrary unit means that you cannot adjust your equipment and therefore you cannot tell us how your data compares to other data. **Arbitrary** means you produced it, and it is unofficial.

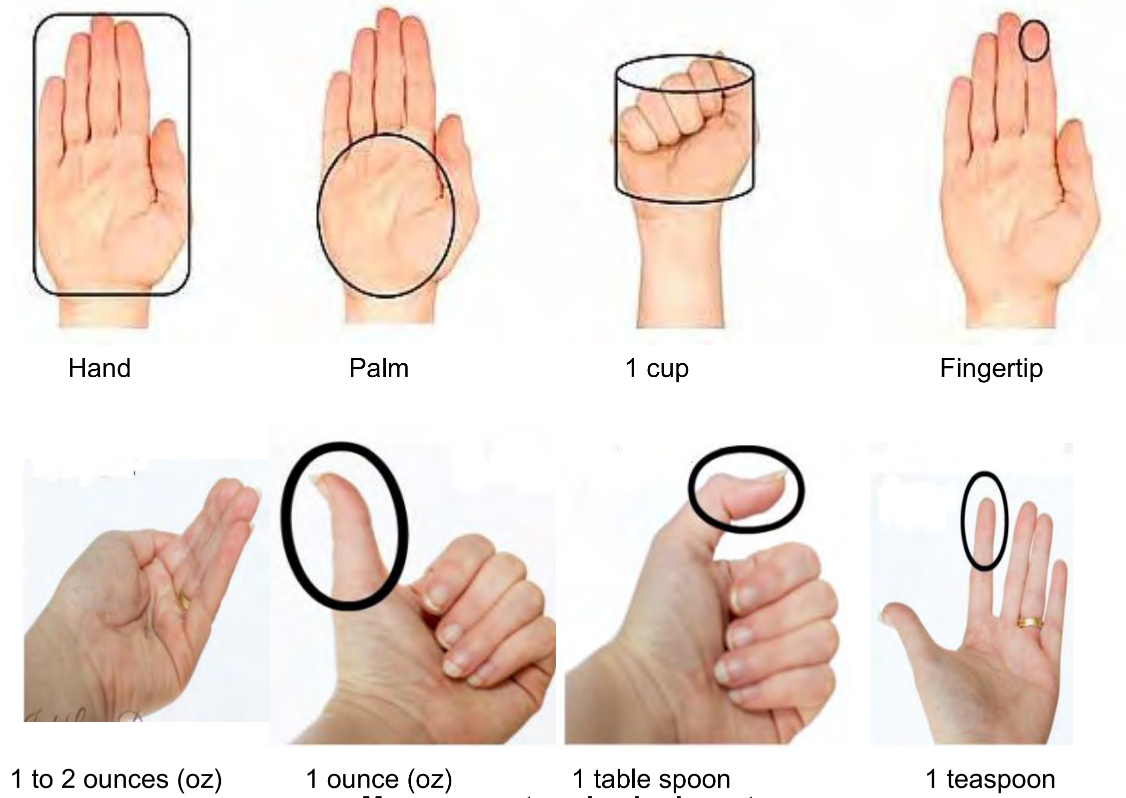
Unit of measurement
Thousands of years ago, people realised that they must use **unit** to measure. What is a unit? A **unit is any measurement that represents 1 of a physical quantity.**

Examples:
1 metre is a unit.
1 second is also a unit.
1 m/s (one meter per second) is also a unit, because there is one of it and so on.

It is also common to drop the "1" in front and just talk about the type of measurement as a unit .Example: a commonly used unit of time is the seconds (you would not say "1 second")
Unit is one of the general terms used in **measurement**.

Units of Measurements are standardised way of measure objects.

The earliest way of measuring distances was to use different parts of the body and which was developed independently by people in different cultures.

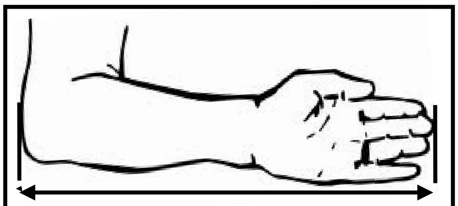


Measurements using body parts

Some methods of measurement using body parts are still in use today. For example the **Tolai people** of East New Britain measure their traditional shell money using the **arm span** or **pokono** as the unit of length. But one of the problems of this system is that, not all people have the same arm span. The taller you are the longer is your arm compared to a shorter person who has short arm. In other words the arm span is a variable unit of measurement.

span

To overcome the problem of variable measurements, ancient Egyptians used the royal cubit to build pyramids around 2700 BC which became one of the first recorded examples of using units. A **cubit** was the length of a man"s forearm from elbow to the tip of the outstretched middle finger in which: **1 cubit =** 7 palms.



cubit

The royal cubit was based on the forearm of one man-probably that of a king. A piece of metal was cut exactly to this length and kept in a safe place and many exact copies of this length were then made in a wood or metal. These copies became the first rulers and the cubit became a standard unit of measurement.

Systems of measurement
Units can be grouped together to make a **system.**

Example: the **metre**, **kilogram** and **second** (together with a few other units) together make up the **"SI" Metric System of Measurement.**
Example: the **inch**, **foot, yard** and **mile** are the units of length in the **Imperial System of Measurement.**

What are imperial and metric units of measurement?
The **metric** and **imperial** are systems of measurement. The **imperial system** units of measures are grouped into arbitrary base units, such 3, 8, 12, 16, 32, and others, while the metric system is always in base ten.

Unlike the metric system, the imperial system has different standards in different regions. For example, a gallon in the USA is smaller than a gallon in the UK, whereas a litre is exactly the same size everywhere.

The Imperial system is based more on human traits; for example, one foot has been adapted from the standard foot size in European places. The imperial system is very difficult to remember and use, because it has arbitrary definitions.

For example, for imperial distance measurement there are:

- 12 inches in a foot
- 3 feet in a yard
- 220 yards in a furlong
- 8 furlong in a mile
- 3 miles in a league (this unit is no longer in use in any nation.)
- 10 hectometre in a kilometre

The **metric system** always uses base 10, which makes remembering and usage much easier.

For example, for metric distance measurements there are:

- 10 centimetres in a decimetre
- 10 decimetres in a metre
- 10 metres in a decametre
- 10 decametres in a hectometre
- 10 hectometres in a kilometre

The metric system has three main units:

m **=** metre for length
kg **=** kilogram for mass
s **=** second for time

Activity: Now test yourself by doing this activity.

Personal Measures

1. Measure the following body parts using centimetres (cm) or inches (in). Try to do both if you can.

   You will need:
   - A ruler (for smaller measures)
   - A tape measure (for larger measures)
   - Pen and paper
   - Yourself!

a.

1 large step

cm = ___________

in = ___________

b.

across 4 fingers together

cm = ___________

in = ___________

c.

hand span (finger to thumb)

cm = ___________

in = ___________

d.

(i) length of a foot

cm = ___________

in = ___________

(ii) length of fore arm

cm = ___________

in = ___________

2. Using the Measures

Now you get to use them! Measure each of the following items in the table, first using your personal measures and then using a ruler or tape measure to see how close you can get! The first item is done for you as an example.

Table 1.1

Item	**Estimate using a Personal Measure**	**Actual using a ruler or tape measure**
Paper clip (width)	3 fingernails = 3cm	3.5cm
Teaspoon (length)		
Fork (length)		
Pencil (length)		
Table (width)		
Table (length)		

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 1.

Summary

You have come to the end of Lesson 1. In this lesson you have learnt that:

- the main difference between imperial and metric systems of measurement is that imperial systems are arbitrary, meaning they are not based on any scientific measurements while metric systems are based on scientific measurements.
- to understand the world around us, it is necessary to know how items are measured, and the units they are measured in represent.

NOW DO PRACTICE EXERCISE 1 ON THE NEXT PAGE.

Practice Exercise 1

Answer the following questions.

A. Circle the letter of the correct answers.

1. Every measurement consists of a number and a/an__________.

A. unit B. decimal

C. standard D. exponent

2. Imperial system of measurement make up includes

A. inch, foot, and yard.
B. inch, foot and meter.
C. mile, second, and yard.
D. meter, kilogram and second.

3. In the SI system of measurement the basic unit for mass is __________.

A. foot B. inch

C. meter D. kilogram

4. __________ is a collection of quantitative data.

A. Metric B. System

C. Arbitrary D. Measurement

5. One cubit is equal to

A. one palm.
B. seven palms.
C. one large step.
D. four digits or fingers in width.

B. Briefly answer the following questions.

1. What is the difference between Imperial and Metric/SI system of measurement?

____

____

____

2. Give one advantage of using metric over imperial system of measurement.

____

____

____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1

Answers to Activity

1. Answers will vary based on the individual‟s body measurements.

a. 1 large step

cm = 58.5

in = 23

b. across 4 fingers together

cm = 6

in = 2.5

c. hand span (finger to thumb)

cm = 7

in = 3

d. (i) length of a foot

cm = 20.2

in = 8.5

(ii) length of fore arm

cm = 37

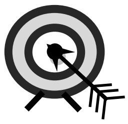
in = 15

2. Answers will vary based on the sizes of items that are present and used in your own place of study.

Item	Estimate using a Personal Measure	Actual using a ruler or tape measure
Paperclip (width)	3 fingernails = 3 cm	3.5cm
Teaspoon (length)	2 x 4 fingers together= 12 cm	13 cm
Fork (length)	3 x 4 fingers together =18 cm	18.5 cm
Pencil (length)	2 hand span = 14 cm	14.5 cm
Table (width)	4 feet = 34 inches	36 inches
Table (length)	9 hand span = 27 inches	29 inches

Lesson 2: Reliability and Accuracy

Welcome to Lesson 2. One of the key ideas that is essential to understand of measurement is that measurement it is always an estimate. What does this mean? Can you not obtain an exact measurement of something? Most often, answers always depend on the context and the purpose for which you are conducting measurements.



Your Aims:

- define parallax error and zero/ magnitude
- identify possible causes and magnitude of errors
- state the ways of minimising errors
- record accurate data from reading instruments

Errors in Measurement

Any measurement made with a measuring device is approximate. If you measure the same object two different times, the two measurements may not be exactly the same. The difference between two measurements is called a **variation** in the measurements.

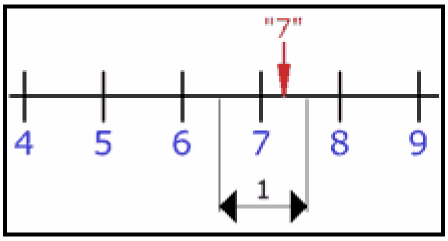
Another word for this variation or uncertainty in measurement is **error**. This error is not the same as a mistake. It does not mean that you got the wrong answer. The error in measurement is a mathematical way to show the uncertainty in the measurement. It is the difference between the result of the measurement and the true value of what you were measuring.

Accuracy and reliability

Accuracy describes how well a measuring instrument determines the variable it is measuring or how reliable and correct a particular measurement is. In terms of first hand investigations **reliability** can be defined as repeatability or consistency. **Consistency** means that you do the same thing in the same way each time you do it so that the result is **reliable.** If an experiment is repeated many times it will give identical results if it is reliable. If another person took the same measurements under the same conditions they would get the same results. When readings are **accurate** and **consistent** then the results will be **reliable** and you can be more confident that they are correct, therefore to make better conclusions.

Degree of accuracy

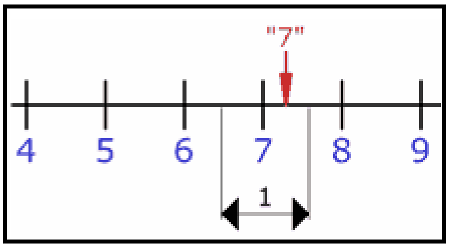
Accuracy is how close a measured value is to the actual (true) value, which means the readings are taken carefully so that the results show the true picture .Accuracy depends on the instrument you are measuring with. But as a general rule: **The degree of accuracy is half a unit each side of the unit measure**.



Examples: When your instrument measures in "1"s then any value between **6½** and **7½** is measured as **"7"**

Plus or Minus ±

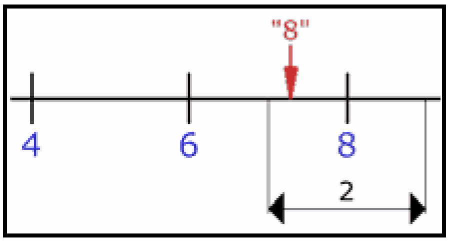
We can show the error using the "Plus or Minus" ± sign:



When the value could be between **6½** and **7½**

7 ±0.5

The error is ±0.5

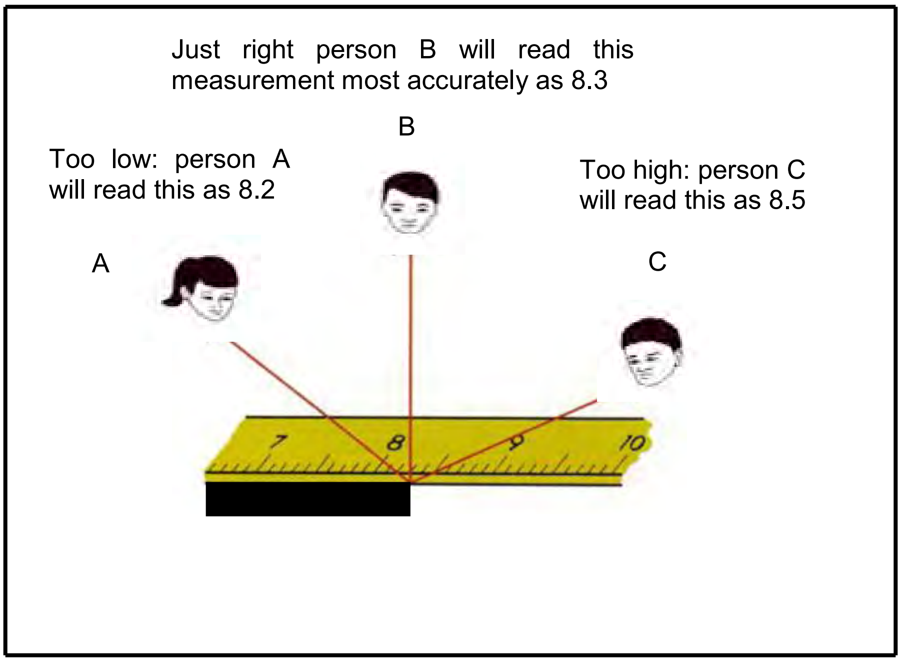


When the value could be between **7** and **9**

8 ±1

The error is ±1

The inaccuracy of measurement is caused by reading a scale from an incorrect position called **parallax error**. Parallax is a significant source of a reading error which refers to when the readings vary depending on how your eye is lined up with the object and the reading device, example, measuring a rectangular solid using the metre stick.



Measuring a rectangular solid using meter stick

You should notice the set of readings shown on the above figure varied depending on how your eye lined up with the object and the metre stick. This is called **parallax**.

Parallax error occurs when the line of sight or measure is not at right angles (perpendicular) to the objects being measured. Any distance between the object and the measuring reference (for example a ruler) will cause a misreading. This error will increase as the distance between the object and the reference increases.

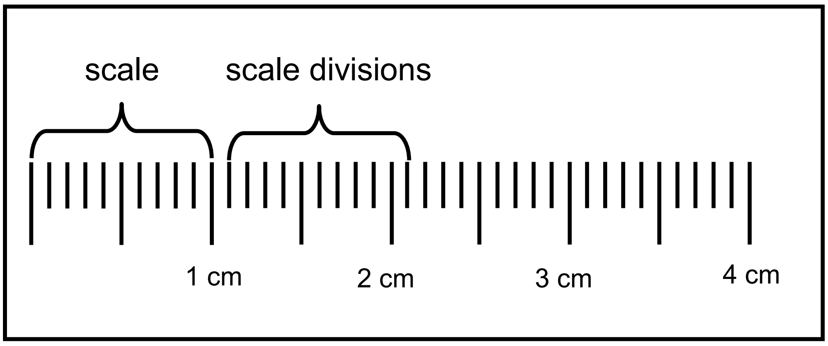
A person sitting in the passenger seat of a car for instance may glance at the speedometer and think the driver is going above the speed limit by a couple of km/hr, when in fact the driver sitting directly in front of the speedometer, can see that the speed of the car is right on the speed limit.

Errors can also be caused when an instrument is not calibrated or measured correctly. When an instrument is made it must be calibrated correctly or set up so that it gives the correct reading. Different instruments sometimes give different readings when we would expect them to give the same reading.

For example, if you weigh yourself on two different sets of scales you will often get two different readings. This is because one or possibly both, of the scales has not been calibrated correctly. Even if you do not make any mistake in your reading there will still be a **calibration error.** However you can reduce the effect of this kind of error by always using the same measuring instrument. Then if the instrument is giving incorrect readings at least the calibration error will be same each time you make a measurement.

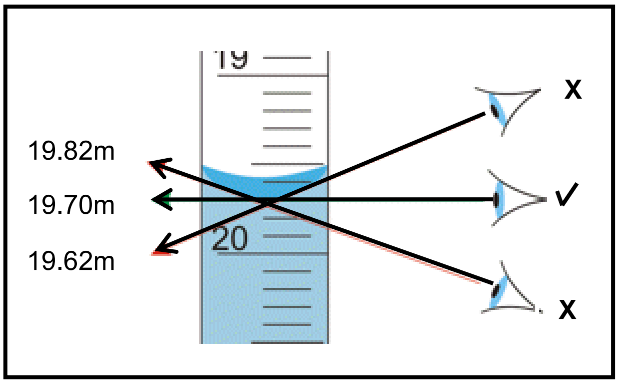
How to take good measurements

- Make sure you know the value of each scale division. All instruments have a **scale** with numbers so that a reading can be taken. A scale is divided by small lines called **scale division**.



The diagram above shows a section of a metric ruler

- When you take a reading bring your eye close to the scale and look directly at the scale from the front. If you look from above or below or from the side you will get a different reading. For example, when reading a volume in a measuring cylinder you must lower your head so that your eye is level with the meniscus as shown.



How to read a meniscus

- When the reading falls between two scale divisions you will need to decide which is the closest or you may be able estimate a fraction of a scale division.
- Concentrate and be careful. Repeat the reading if necessary to increase your confidence that is correct.
- Write down your result straight away using neat handwriting.
- Remember that every measurement has two parts: the number and the unit.

Precision Unit

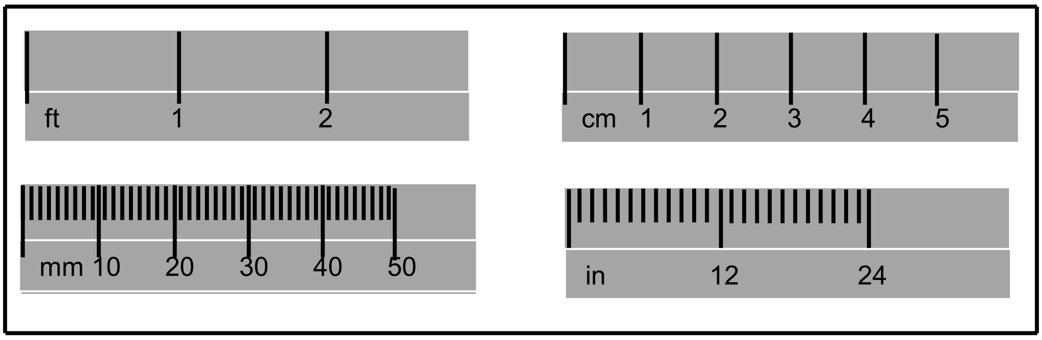
We discussed how a scale can be partitioned into smaller divisions. How are partitioning related to precision? **Precision i**s the smallest unit to which measurement is possible with a particular tool. **Unit** is the basic standard used in measurements. The precision of a measurement is directly related to the partitioning of the measuring instrument.

> The **precision of a measuring instrument** is determined by the smallest unit to which it can measure. The precision is said to be the same as the smallest division on the scale of the measuring instrument.
>
> **Tip**: Think about what you would do to a measuring instrument if you wanted to measure something more precisely.

Activity: Now test yourself by doing this activity.

A. **Examine the rulers below (not drawn to scale) and identify the precision unit.**

Write the answers on the spaces provided below.



a. _________ b. _________

c. _________ d. _________

B. The maximum possible error of a measurement is always half the size of the precision unit. For example, if the precision unit is 1cm, the maximum possible error is 0.5cm; if the precision unit is 4cm, the maximum possible error is 2cm, and others.

What is the maximum possible error for each ruler above?

a. ____________ b. ____________
c. ____________ d. ____________

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 2.

Summary

You have come to the end of lesson 2. In this lesson you have learnt that:

- errors in the measurement of physical quantity indicate the difference between the results of the measurement from its actual value.
- accuracy and reliability play important roles in the measurement of any physical quantity. Calibration of instrument is done to find its accuracy.
- when experiment is performed and some data are obtained, then it is required to analyze these data to find error, accuracy and general reliability of the experimental measurements.

NOW DO PRACTICE EXERCISE 2 ON THE NEXT PAGE

Practice Exercise 2

A. Circle letter of the best answer.

1. If your instrument measures in “1”s then any value between which two values would be measure as “5”?

   A. 3 ½ and 4 ½
   B. 4 ½ and 5 ½
   C. 5 ½ and 6 ½
   D. 6 ½ and 7 ½

---

2. If your instrument measures in “5” then any value between which two values would be measured as “45”?

   A. 40 and 50
   B. 37 ½ and 42 ½
   C. 44 ½ and 45 ½
   D. 42 ½ and 47 ½

---

3. Some pieces of laboratory equipments are called instruments because

   A. they are expensive.
   B. scientists like to play with them.
   C. they can be used for measurements.
   D. they must be tuned through calibration.

---

4. The accuracy on the scale is assumed to be ___________g.

   A. ± 0.01 B. ± 0.1
   C. ±10 D. ± 1

---

5. Reading a scale from an incorrect position is called

   A. error
   B. consistency
   C. parallax error
   D. calibration error

B. Answer the questions accordingly.

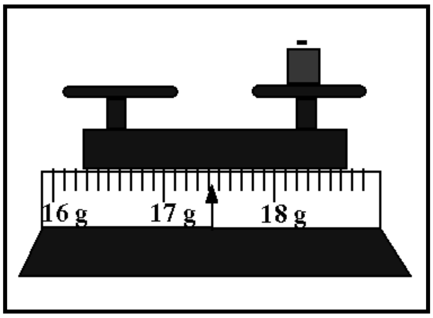
1. What is the difference between error and accuracy?

____
____
____
____

2. What is the difference between parallax error and calibration error?

____
____
____
____

3. Why is there a need of calibration on a measuring instrument?



____
____
____
____
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____
____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1

Answers to the Activity

A. a. 1ft b. 1mm

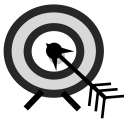
c. 1cm d. 1in

B. a. 0.5ft. b. 0.5mm.

c. 0.5cm d. 0.5in.

Lesson 3: Length

Welcome to Lesson 3. In this lesson, you will understand the difference between measuring and estimating lengths. This will help you to become more aware of linear measurements in the world and communicate better about the importance of these measurements.



Your Aims:

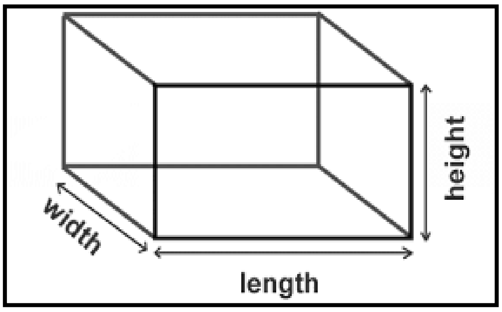
- define length
- identify some metric and imperial units used in measuring lengths
- identify instruments used to measure lengths
- analyse diagrams of length measured and reads scales correctly

What is Length?

Length is the distance from end to end. It also means the longer distance across two ends

- **Length:** Longer distance across
- **Width:** Smaller distance across
- **Height:** Vertical distance across

Spelling : Length and Width end with "th" but Height ends with "ht"



Metric length (used in PNG)
You can measure how long things are, or how tall, or how far apart they are. These are all examples of length measurement.

The most common measurements are:

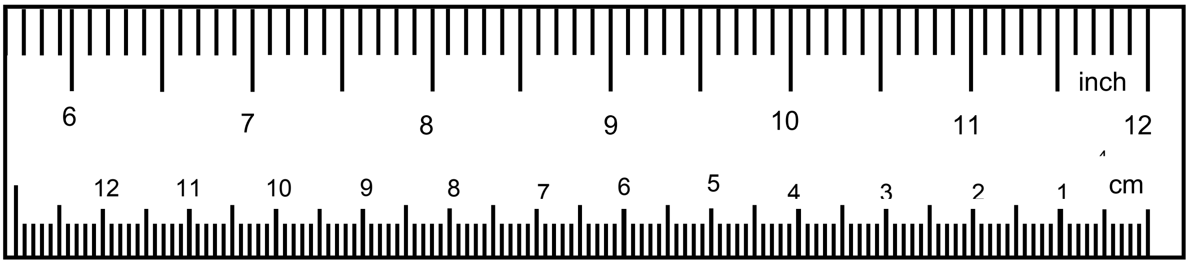
1. **Millimetre** - small units of length. This is a very small measurement. Example: the thickness of a credit card or about the thickness of 10 sheets of paper on top of each other.
2. **Centimetre** - when you have 10 millimeters, it can be called centimeter. Example: a fingernail is about one centimetre wide
3. **Metre** - is equal to 100 centimeters. Example: You might use millimetre or centimeter to measure how tall you are, or how wide a table is but you would not use them to measure length of football field, length of a house or size or playground. In order to do that you can switch to meters.
4. **Kilometre** - is equal to 1000 meters. Example: When you need to get from one place to another, you measure the distance using kilometres. The distance from one city to another or how far a plane travels would be measured using kilometres.

Imperial or US standard lengths
The most common measurements are:

- **inches**
- **feet**
- **yards**
- **miles**

Small units are called **inches.** An **inch** is defined as exactly **2.54 centimetres** (a metric measurement.
Example: the last joint of your finger or thumb is about an inch (depending on how big your fingers are!) Lots of things are measured in inches from rainfall to paper length. Measuring in inches provide us with a way to understand size of something.

A long time ago, people had to use their own feet to measure things. However since everyone has different sized feet, it did not let everyone understand the size or distance in the same way. Using 12 inches put together to make feet allows for everyone to have a more accurate picture of what exactly a foot of length is. When you have 12 inches together, it is known as **foot.**



1 foot = 12 inches	1 yard = 3 feet	1 mile = 1,760 yards = 5,280 feet

Miles are long distances and are mostly used to measure the distance between places. People refer to miles when they are driving, biking or jogging.

Final thoughts about metric system of measuring length
1 centimetre= 10 millimeters
1 metre = 100 centimeters
1 kilometre = 1,000 meters

Final thoughts about imperial system of measuring length
1 foot = 12 inches
1 yard = 3 feet = 36 inches
1 mile = 1,760 yards = 5,280 feet = 63,360 inches

Activity: Now test yourself by doing this activity.

A. Discover Lengths

This is simple, but very useful activity.

1. Measure the length, width, and height of everyday items using different instruments in millimetre or inches.

   You will need:
   - a ruler (for smaller items)
   - a tape measure (for larger items)
   - pen and paper

   1.1.1 Using a **ruler**.
   Make sure one end of the object is at the "0" mark and read the number at the other end. You can also count the little marks between the numbers for a more accurate answer.

Measuring the length of a fork

   1.1.2 Using a **tape measure**.
   A tape measure has a little right- angled "hook" at the start. You can use this to hold on to one edge while you pull the tape measure to the other edge. Make sure you measure straight across (or straight up and down) or your answer will be wrong.

Measuring the width of the table

2. Measure the following Items. Fill in the table below.

Item	Guess	Actual mm or in
Teaspoon (length)		
Fork (length)		
Pencil (length)		
Chair seat height		
Chair back (height)		
Table (width)		
Table (length)		
Table (height)		

Measuring height of the chair

B. List the items above from smallest to largest distance

1. ____________________
2 ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 3.

Summary

You have come to the end of lesson 3. In this lesson you have learnt that:

- length can be measured in metric units of millimeter, centimeter, meter and kilometer in which millimeters is the smallest unit.
- length can also be measured imperial units of inch which is the smallest unit, and next to unit is foot, yard and miles.
- length is the measurement of longer or smaller and vertical distance across.

NOW DO PRACTICE EXERCISE 3 ON THE NEXT PAGE

Practice Exercise 3

A. Circle the letter of the correct answer

1. The thickness of a credit card is about ___________.

   A. 1 m B. 1 in

   C. 1 cm D. 1 mm

---

2. The length of a ruler is 30 cm. How many millimetres is that?

   A. 3 mm
   B. 300 mm
   C. 3,000 mm
   D. 30,000 mm

---

3. Name the metric units of length in order of their size with the smallest first.

   A. meter, centimetre, millimetre, kilometre
   B. centimetre, millimetre, kilometre, metre
   C. millimetre, centimetre, metre, kilometre
   D. millimetre, metre, centimetre, kilometre

---

4. When you have 12 inches together it is known as __________.

   A. miles B. yard

   C. foot D. feet

---

5. __________ are long distances and are mostly used to measure the distance between places which are far away from each other.

   A. Inches B. Yards

   C. Miles D. Feet

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1

Answers to the Activity

A. Answers will vary based on the length of items that are available in your place of study.

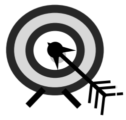
Guess	Item	Actual mm or in
130mm	Teaspoon (length)	132.08mm or 5.5in
190mm	Fork (length)	190.5mm or 7.5in
147mm	Pencil (length)	147.32mm or 5.8in
456mm	Chair seat (height	457.20mm or 18in
940mm	Chair back (height)	939.80mm or 37in
915mm	Table (width)	914.4mm or 36in
1800mm	Table (length)	1828.8mm or 72in
735mm	Table (height)	736.60mm or 29in

B. Items above from smallest to largest distance

1. Teaspoon (length)
2. Pencil (length
3. Fork (length)
4. Chair seat (height)
5. Table (height)
6. Table (width)
7. Chair back (height)
8. Table (length)

Lesson 4: Time and Temperature

Welcome to Lesson 4. In the previous lesson you learnt about length and how it is used. In this lesson you will continue to look at numbers in relation to time and temperature.



Your aims:

- define time and temperature
- enumerate metric and imperial units used in measuring the two quantities
- identify instruments used to measure time and temperature
- analyse diagrams of time and temperature being measured and read scales correctly

What is Time?

Time is the ongoing string of events taking place in the past, present and future. It is a concept that is quite difficult to define. It is something that continues from the beginning to the end. However, time itself has no end and will continue forever.

The Egyptians were the first to create a twenty-four hour day. The night was divided into 12 hours and the day was divided into 10 hours, while the two twilight hours were at dawn and sunset. A shadow clock was created to keep track of these times.

The Chinese, Babylonians, Greeks and Romans also created and used shadow clocks to tell the time. The Imperial System and the International System (SI) use seconds, minutes and hours as their standard units.

Time measurements
Time measurements are made in seconds, minutes, hours, days, months and years.

60 seconds	= 1 minute
60 minutes	= 1 hour
24 hours	= 1 day
7 days	= 1 week
52 weeks	= 1 year

Calculating time intervals
In the General Examination you might be asked to work out how long someone spends at work during the day or how long a bus trip lasts. **This is calculating a time interval.**

For most things we use the decimal system of counting -hundreds, tens and so on. Time is not counted like this because, instead of going up in tens; we used the following units in time.

- 60 seconds = 1 minute

- 60 minutes = 1 hour

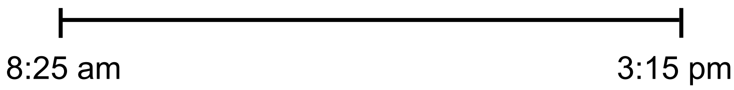
Lots of people make mistakes when doing time calculations. There are lots of different methods of calculating time intervals. It does not matter which one you choose, as long as you feel comfortable about using it. However, whichever way you decide to do calculations, it helps to stop you getting confused between time and decimal systems of counting.

Example 1:

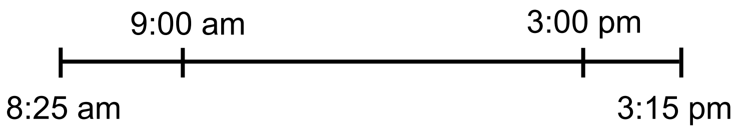
Daniel starts school at 8:25a.m. and finishes at 3:15p.m.. How long does his school day last? We will go over two ways of doing this, using **Time Lines** and **Counting On**.

Time Lines
This is where the time interval is shown on a time line.

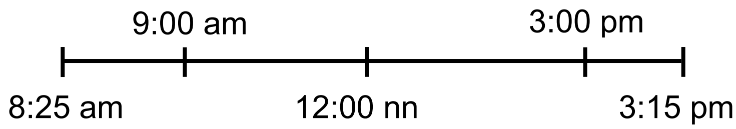
First draw a line with 8:25a.m. (when Daniel started school) at one end and 3:15 p.m.(when Daniel finished school) at the other.



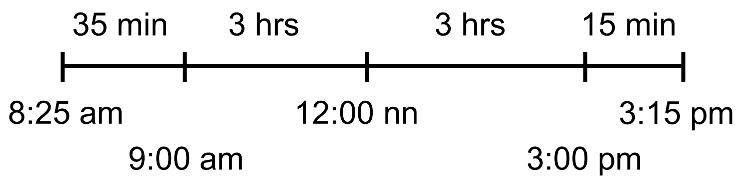
Next mark 9a.m. and 3p.m.on the line.



If you want to, mark in 12:00 noon.



Now calculate the time interval for each section.



Add them up.

3hrs + 3hrs = 6hrs

35mins + 15mins = 50mins

Remember the original question:

Daniel starts school at 8:25a.m.and finishes at 3:15p.m. How long does his school day last? **It is 6hrs and 50mins.**

Counting- on method

Start at 8:25a.m.and work out the number of minutes until 9:00a.m.

9:00a.m. – 8:25a.m. = 35mins

Next work out how many hours there are between 9:00a.m. and 3:00p.m.

12:00 noon- 9:00a.m. = 3hrs

12:00 noon – 3p.m. = 3hrs

Next calculate the number of minutes between 3p.m.and 3:15p.m.

3:15p.m. = 3:00p.m. = 15 mins

Finally add up the separate time intervals.

3hrs + 3hrs = 6hrs

35mins + 15mins =50mins

Example 2:

Amy used the internet from 10:08until14:75. How long was she on it for?

Add up the time intervals

1hr + 2hrs+ 57mins + 52mins + 52mins = 3hrs and 109min

Of course 109mins is a silly answer.

60 mins is one hour.

109 – 60 = 49

109 min = 1 hr +49mins

3hrs + 1hr + 49mins

The total time Amy spent on the internet was 4hrs and 49mins

Changing decimal time to actual time

You need to be able to do this so you can write down time correctly if you get a decimal answer after doing a sum.

For example if you get an answer on your calculator of 3.5hrs you should write it as 3hrs and 30mins.

60 seconds = 1 minute 60 minutes = 1 hour

Here are two example questions

1. Write 4.2mins in minutes and seconds.

   4.2mins = 4mins + 0.2mins

   0.2 of a minute

   = 0.2 of 60secs

   = 0.2 of 60 secs

   = 12secs

   So, 4.2mins = 4mins and 12secs

2. Write 6.85hrs in hours and minutes.

   6.85hrs = 6hrs + 0.85mins

   0.85 of an hour

   = 0.85 of 60secs

   = 0.85 x 60mins

   = 51mins

   So, 6.85hrs = 6hrs and 51mins

Time and temperature, are also related. As time continues temperature increases. Temperature is also something we deal with every day.

What is Temperature?

Temperature is the most measured unit. However, back in history people could only say it is cold, or it is hot without saying exactly how hot or cold the weather was. Therefore, temperature is the degree of hotness or coldness that can be measured using a thermometer. It is also the measure of how fast the atoms, molecules or ions are moving. Temperature is also measured in degrees on the Fahrenheit or Celsius scales.

It was only recently in 1592, when Galileo Galilee invented the first thermometer that precisely measured temperature. In 1714 Daniel Gabriel Fahrenheit invented both the mercury and alcohol thermometer. In the 18th century, Anders Celsius divided the freezing or melting point. From the 19th century onwards, it was further developed and refined to a proper temperature reading device.

For example, knowing the temperature and altitude at which water boils so that you can switch it off, how cold the weather will be so that you can wear a sweater or jacket and setting the air conditioner to a level you will feel comfortable to work in. Temperature is also how fast atoms in any substance moves (vibrates).

The Imperial system uses the Fahrenheit, while the metric system uses Celsius, but now officially uses Kelvin. However, in everyday normal life most people use Celsius.

The formulas used to convert between temperatures are as follows:

- $^{0}C = (^{0}F - 32) \times 5 \div 9$
- $^{0}F = (^{0}C \times 1.8) + 32$
- $K = {}^{0}C + 273$
- $^{0}C = K - 273$

Pure or distilled water boils at 90^{o}C, what is the equivalent in degree Fahrenheit?

$^{0}F = (^{0}C \times 1.8) + 32$

$= (90 \times 1.8) + 32$

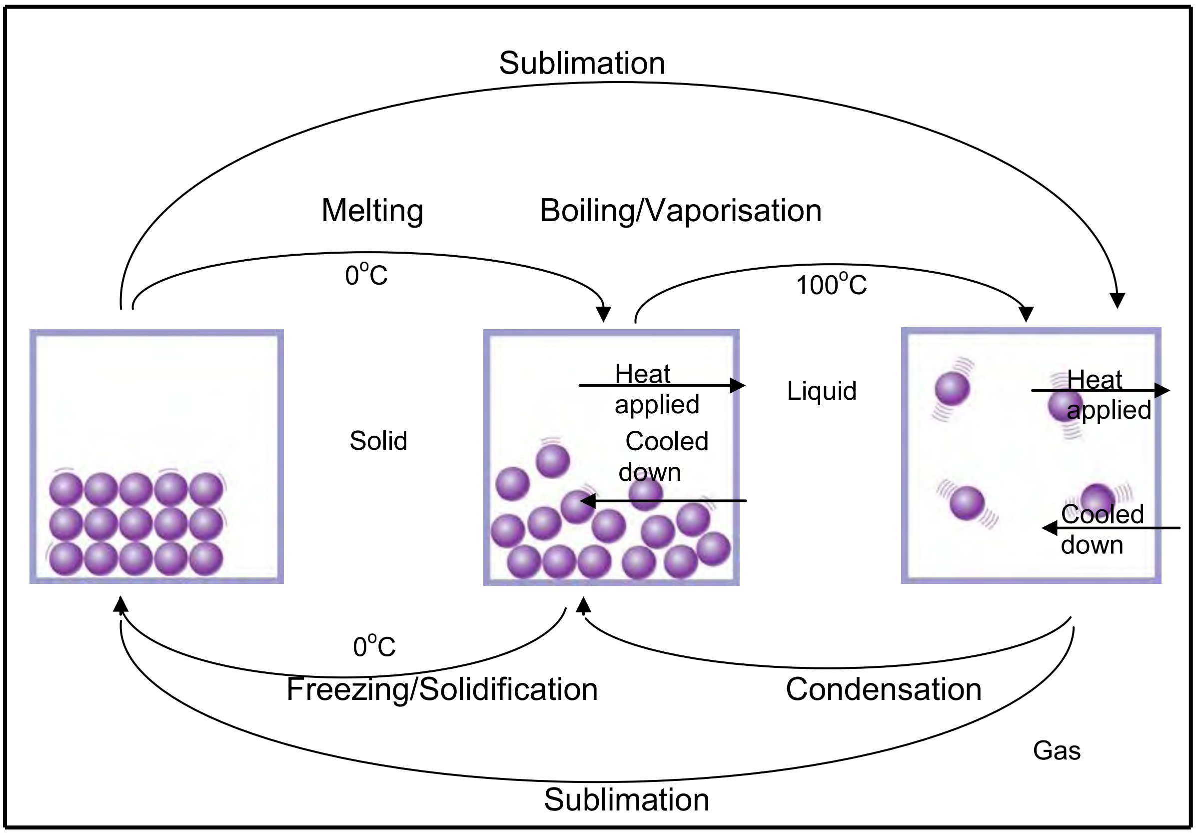
$= 162 + 32 =$ **194^{0}F**

The units of measurement used to measure temperature are degree Celsius, degree Fahrenheit and Kelvin.

Temperature in Terms of Atoms

Generally speaking, as temperature increases the movement (vibrations) of the atoms or molecules within the object also increases. The more movement within the atoms or molecules the higher the temperature is. The less movement of atoms or molecules the cooler the temperature is.

The diagram below shows what happens to water atoms/molecules when it is being heated up or cooled down. **Pure or distilled water boils at 100^{o}C and melts and solidifies at 0^{o}C, also at standard atmospheric pressure.**



Activity: Now test yourself by doing this activity.

Circle the letter of the correct answer from the alternatives listed

1. Which instrument listed below is **<u>not</u>** used for measuring temperature?

   A. Hygrometer
   B. Stop watch
   C. Dial Thermometer
   D. Digital Temperature Switch

---

2. Which of the list below contains units of measurements for temperature?

   A. Newtons, Grams, Kilojoules
   B. Grams, Kilograms, Milligrams
   C. Fahrenheit, Degree Celsius, Kelvin
   D. Centimetres, Millimetres, Kilometres

---

3. Time is the

   A. length of distance.
   B. force of an object
   C. how fast atoms vibrate.
   D. duration of how long something takes from start to end.

---

4. How many minutes equal an hour?

   A. 60 seconds B. 60 minutes
   C. 60 milliseconds D. 60 microseconds

---

5. When atoms vibrate faster, generally it means that they get

   A. hotter. B. colder.
   C. warmer. D. smoother.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 4.

Summary

You have to come to the end of lesson 4. In this lesson you have learnt that

- time is the duration at which takes something to occur, from the start to the end.
- temperature is the amount of vibration that occur within a molecule/atom or ion. When there is more vibration the temperature increases. When there is less vibration the temperature decreases.
- instruments that measure time are clocks, wrist watch, stop watch and hourglass.
- instruments that measure temperature are dial thermometer, hygrometer, digital temperature switch
- the unit of temperature is Kelvin. However, most people use degrees Celsius (^0C).
- the unit of time is seconds.

NOW DO PRACTICE EXERCISE 5 ON THE NEXT PAGE.

Practice Exercise 4

Answer the following questions:

1. What is time?

____

2. What is temperature?

____

3. Write the names and symbols of units of measurements for time.

	Name	Symbol
a.	______	______
b.	______	______
c.	______	______

4. Write the names and symbols of the unit of measurements for temperature.

	Name	Symbol
a.	______	______
b.	______	______
c.	______	______

5. What temperature does water

   a. melt? ______

   b. solidify / freeze? ______

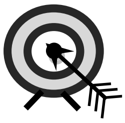
CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1.

Answers to Activity

1. B 2. A 3. C 4. B 5. A

Lesson 5: Mass and Weight

Welcome to Lesson 5. In the previous lesson you learnt about measuring time and temperature. You defined time as the measure of duration of events and the intervals between or for certain activities and the length of period that these activities last. Clocks, watches and digital timers are some instruments used to measure time. It is measured in seconds, minutes and hours. Temperature on the other hand is the measure of how hot something is. The thermometer is the common instrument used to measure temperature. It is commonly used by nurses and doctors at clinics and hospitals to determine how hot a sick person is. It is measured in degrees Celsius.



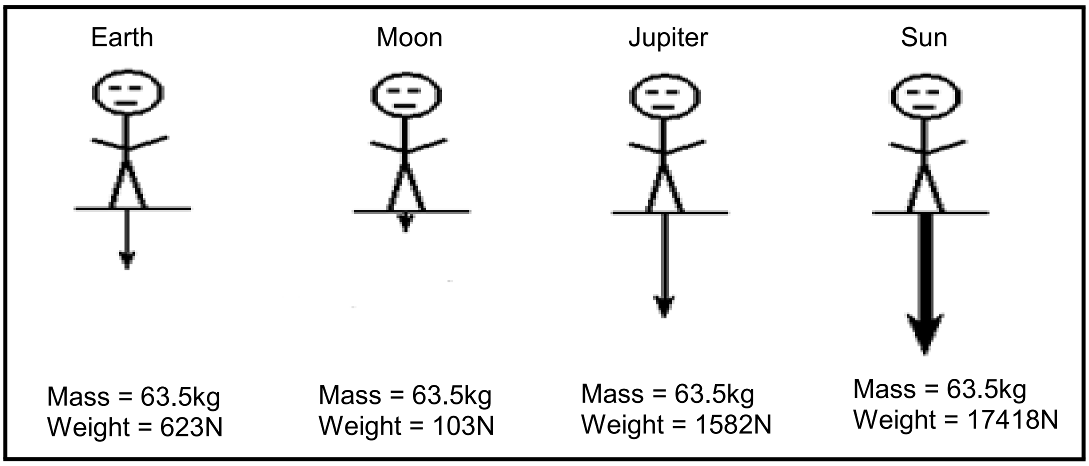
Your Aims:

- define mass and weight
- identify metric and imperial units used in measuring mass
- differentiate mass from weight
- name instruments used to measure mass and weight
- analyse diagrams of mass and weight measured
- read scales correctly

Weight and Mass

In everyday usage, the mass of an object is referred to as its weight though these are in fact different concepts and quantities. In scientific contexts, mass refers to the amount of "matter" in an object, whereas weight refers to the force experienced by an object due to gravity. In other words, an object with a mass of 1 kilogram will weigh 10Newton. Newton is the unit of force, while kilogram is the unit of mass on Earth (its mass is multiplied by the gravitational field strength). Its weight will be less on Mars (where gravity is weaker), more on Saturn, and negligible in space when far from any significant source of gravity, but it will always have the same mass.

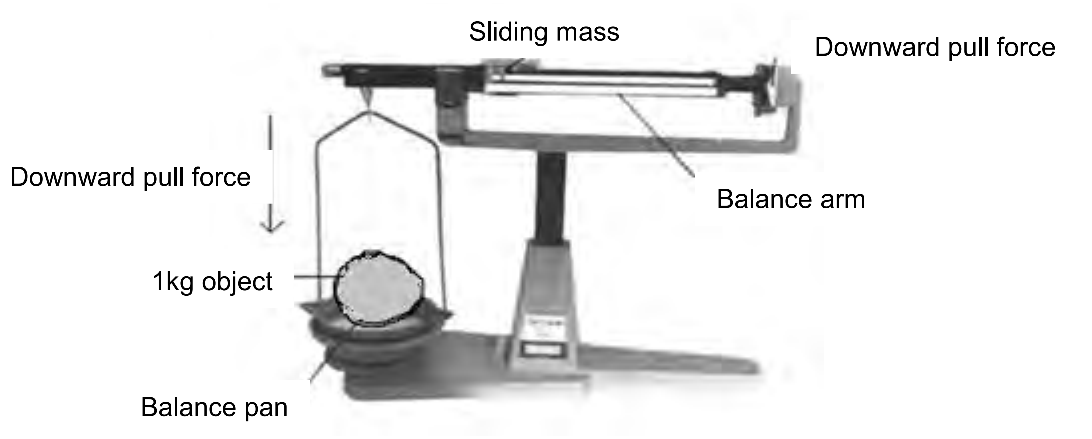
The diagram below illustrates how the mass of an individual may differ due to different gravitational pull forces in other planets.

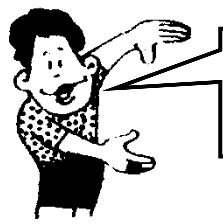


On Earth, every object has the downward pull force of gravity on it. This is called its weight. Like other forces, it is measured in newtons (N). On Earth 1kg has the weight of 10N, 2kg has the weight of 20N and 3kg has the weight of 30N and so on. In other words, on Earth, things weigh 10N for each kilogram of mass. Scientifically speaking, the Earth‟s gravitational field strength is 10N/kg.

Mass is the amount of material in an object. This is the measure of how much of a particular substance is present in an object. Mass is measured in grams or kilograms using a balance. The results are usually given in grams where 1 kilogram is equal to 1000 grams.

When a 1 kilogram object is placed on the balance, the gravitational or downward pull force acting upon the object makes the balance to give the reading as 1 kilogram. The 1 kilogram mass is said to have 10 Newtons of downward pull force acting upon the object. So, you can say that an object with a mass of 1 kilogram has 10 newtons of weight acting upon it as shown in the diagram below.





The downward pull or gravitational force acting on the 1kg objects has placed 10 newtons of force on the scale to move the scale reading to 1kg on the balance.

The mass of an object is a fundamental property of the object; a numerical measure of its inertia; a fundamental measure of the amount of matter in the object.

Mass and Weight Instruments

There are different types of balances used to measure the mass of an object. They range from an electronic balance, top-loading balance, suspended-pan balance, triple-beam balance, bathroom scale and others.

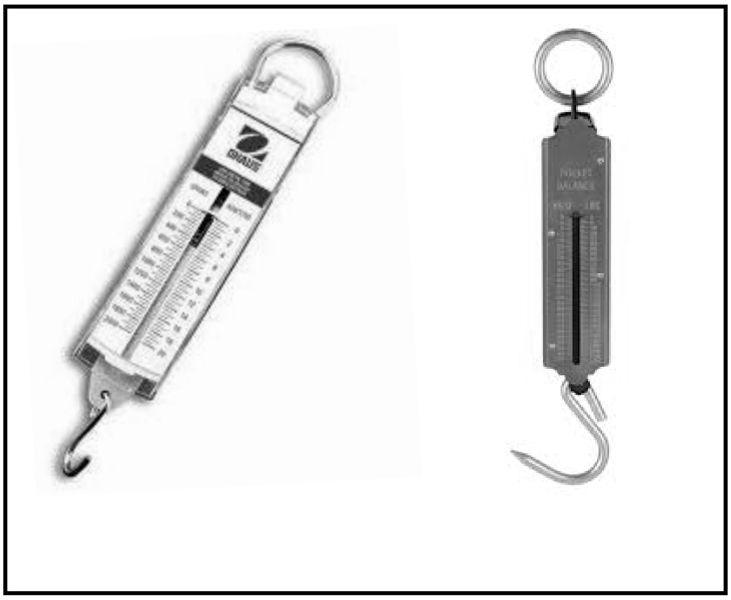
The diagram above illustrates the different instruments used for measuring masses of objects

A spring balance apparatus is simply a spring fixed at one end with a hook to attach an object to it. It works by Hooke's Law, which states that the force needed to extend a spring is equal to the distance that spring is extended from its rest position. Therefore the scale markings on the spring balance are equally spaced.

If two spring balance are hung one below the other in series, each of the scales will read the weight of the body hung on the lower scale. The scale on top would read slightly heavier due to being stretched by the weight of the lower scale.

Hooke's Law, states that the force needed to extend a spring is equal to the distance that spring is extended from its rest position.

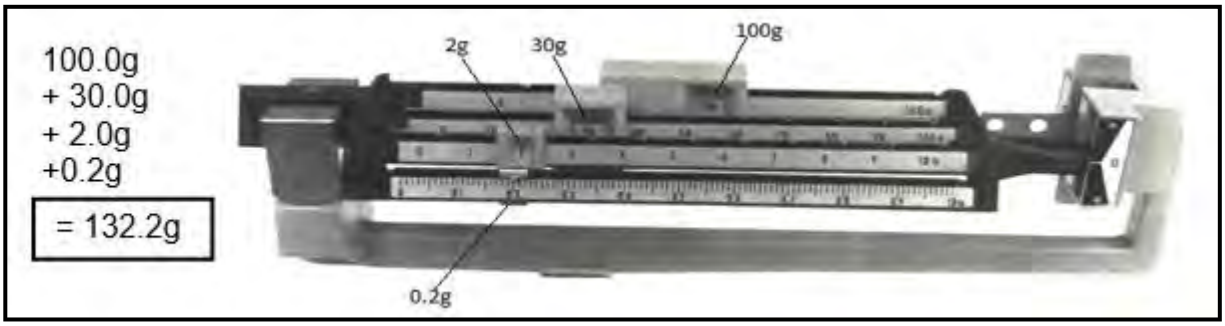
Spring balance comes in different sizes. Generally, small scales that measure Newton will have a less firm spring (one with a smaller spring constant) than larger ones that measure tens, hundreds or thousands of Newton.



The diagram above illustrates the different types of spring balances used to measure weight

Measuring Mass

When the sliding masses on the arms are balanced on balance arm as shown below on the triple beam balance the mass can be calculated as:



The diagram above illustrates scale reading on a triple beam balance

The same reading and calculation method can be applied for the suspended-pan balance and top-loading balance respectively.

Activity: Now test yourself by doing this activity.

Circle the letter of the correct answer from the alternatives listed.

1. Which of the following listed below is **not** used for measuring mass of objects?

   A. Thermometer
   B. Bathroom scale
   C. Electronic balance
   D. Triple-beam balance

---

2. Which of the list below is made of units of measurements for mass?

   A. Newtons, Grams, Kilojoules
   B. Grams, Kilograms, Milligrams
   C. Grams, Degree Celsius, Newtons
   D. Centimetres, Millimetres, Kilometres

---

3. Weight is the

   A. force of an object.
   B. mass of an object.
   C. upward force acting on the object.
   D. downward force acting on the object.

---

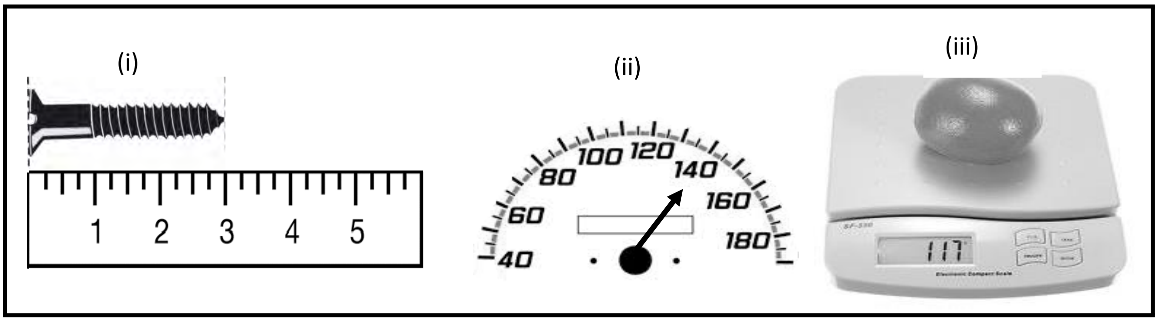
4. Which of the following planet or star has the greatest gravitational pull?

   A. Sun B. Moon

   C. Earth D. Jupiter

Refer to the pictures below to answer Question 5.

5. What is the scale reading on the following instruments?



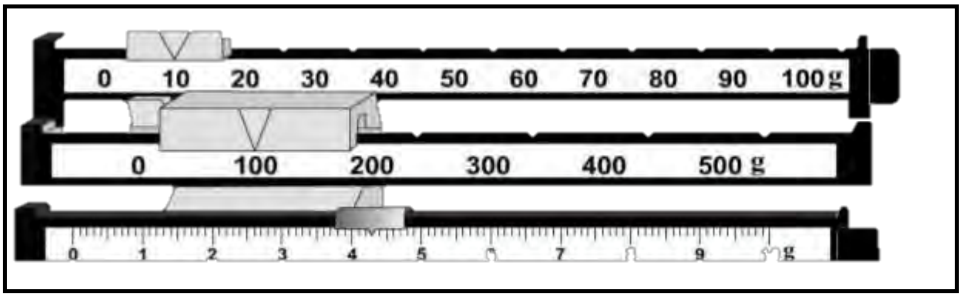
(i) __________

(ii) __________

(iii) __________

Refer to the diagram below to answer Question 6.

6. Calculate the mass reading on the balance arm of a triple beam balance. Show working.



Answer: ______________

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 5.

Summary

You have come to the end of lesson 5. In this lesson you have learnt that:

- weight is the gravitational force that is acting upon an object.
- the unit of weight is the Newton (N).
- the gravitational or downward pull force of the earth is about 10 newtons per kilogram.
- mass is the amount of material in an object.
- mass is measured in grams or kilograms using a balance. The results are usually given in grams where 1 kilogram is equal to 1000 grams.

- there are different types of balances used to measure the mass of an object. They range from an electronic balance, top-loading balance, suspended-pan balance, triple-beam balance and bathroom scale.
- A spring balance apparatus is simply a spring fixed at one end with a hook to attach an object to it. A spring balance is used to measure the weight of an object.

NOW DO PRACTICE EXERCISE 5 ON THE NEXT PAGE.

Practice Exercise 5

Answer the following questions.

1. What is the mass of an object?

   ____

---

2. What is the weight of an object?

   ____

---

3. List the names of the instruments used for measuring mass mentioned in the lesson.

   a. ____________________
   b. ____________________
   c. ____________________
   d. ____________________
   e. ____________________

---

4. Write the names and symbols of the unit of measurements for mass.

	Name	Symbol
a.	____________________	____________________
b.	____________________	____________________
c.	____________________	____________________

---

5. Write the name of the instrument used to measure the weight of an object.

   ____

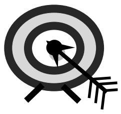
CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1

Answers to Activity

1. A
2. B
3. D
4. A
5. (i) 3
   (ii) 140
   (iii) 117
6. 10 + 100 + 4.3 = 114.3g

Lesson 6: Volume

Welcome to Lesson 6. In the previous lesson, you learnt about mass and weight. You defined weight as the gravitational force that is acting upon an object. The unit of weight is the Newton (N). The gravitational or downward pull force of the earth is about 10 newtons per kilogram. A spring balance apparatus is simply a spring fixed at one end with a hook to attach an object to it. A spring balance is used to measure the weight of an object. You then defined mass as the amount of material in an object. Mass is measured in grams or kilograms using a balance. The results are usually given in grams where 1 kilogram is equal to 1000 grams. There are different types of balances used to measure the mass of an object. They range from an electronic balance, top-loading balance, suspended-pan balance, triple-beam balance, and bathroom scale. You also learnt how to read different scales on some common science instruments and the triple beam balance.



Your Aims:

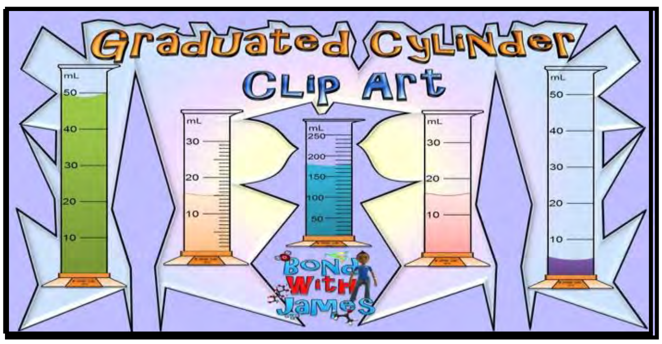
- define volume
- identify metric and imperial units used in measuring volume
- identify instruments used to measure volume
- measure volumes of regular and irregular-shaped solids
- analyse diagrams of volume measured and read scales correctly

What is Volume?

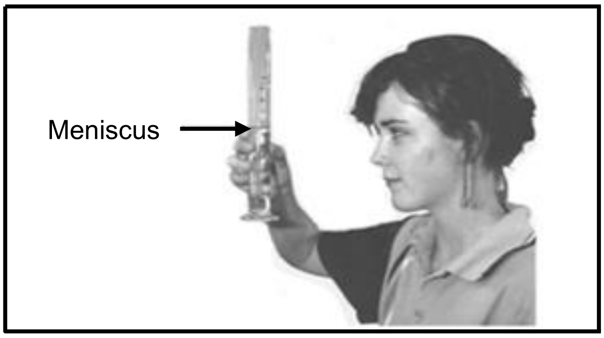
Volume is the amount of space taken up by a substance. It does not always have to be a container. It can also be a car, a bag or any object. The volume of a container is generally understood to be the capacity of the container that is the amount of fluid gas or liquid that the container could hold, rather than the amount of space the container itself displaces.

The **volume of a liquid substance** is the space occupied by the liquid substance in a container. The volumes can be measured using a measuring cylinder.

Volume is the amount of space an object occupies. The volume of a liquid substance can be measured using a measuring cylinder.



The photograph illustrates the proper reading of the meniscus on a measuring cylinder



The **volume of a solid substance** is the space the matter that makes up the solid shape occupies.

If a substance is a regular shaped solid, then the volume can be determined using mathematical formulas. Volumes of some simple shapes, such as regular, straight-edged, and circular shapes can be easily calculated using arithmetic formulas. The volumes of more complicated shapes can be calculated by integral calculus if a formula exists for the shape's boundary.

When an object is regular, you can figure out the amount of space it takes up easily. You measure a regular shaped object using cm rulers.

To find the volume, you measure the length, width, and height of the object, and multiple them together. (With an object that is fairly regular but has concave sections, you can figure out what it would be without the concave sections, figure out the area of the concave sections, subtract them and come up with the volume.)
The volume of a rectangular block is found by multiplying together the lengths of the sides. A cube 6.00 cm on each side, for example, has a volume of 6.00cm x 6.00cm x 6.00cm = 216cm^3. Notice that the unit of volume is length cubed. (L^3) (V= L x L x L

For a rectangle, length x width = area. The units of area are length squared, and volume = area x height.

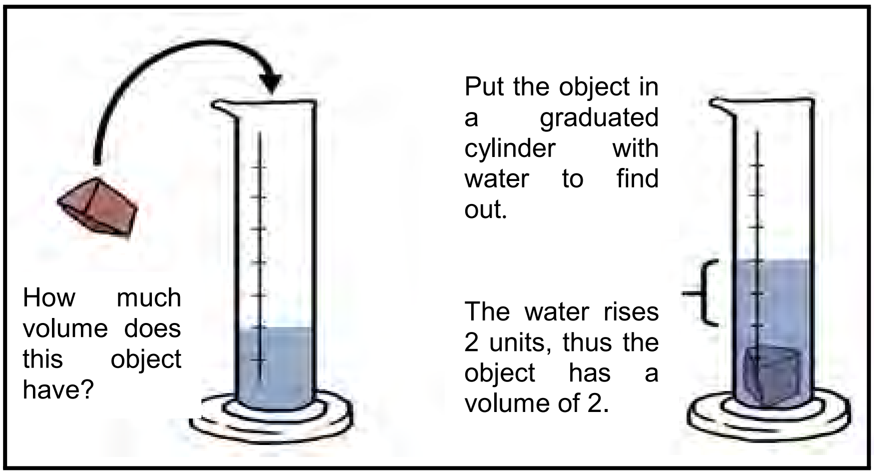
Water (fluid) displacement method
The volume of a solid whether regularly or irregularly shaped can be determined by fluid displacement.

To find the volume of an irregularly shaped object you can put it in a graduated cylinder or beaker, and note the change in the water level before and after the object is submerged.

To find out how many milliliters of water the object displaces, put the object in the beaker or cylinder. If it‟s a sinking object, drop it in, and then measure the amount of water the object displaces in an overflow container, or how many milliliters the water in a graduated cylinder rises. If the object floats, hold it just under the surface of the water and make the same measurements.

You can use the water displacement method to measure irregular objects such as a ring, a stone or a spoon. This process is a simple use of measurement and subtraction. You can do this by filling the beaker or measuring cylinder with enough water that allows the irregularly shaped object to fit inside it. Note the level of the water at this point and write the water level without the object.

Subtract the level without the object from the level including the object to reach the volume of the irregularly shaped object. The result may be in millimeters if you used a standard beaker or measuring cylinder.



The diagram above illustrates the fluid or water displacement method

The fluid displacement method can be used to measure the volumes of solid objects with irregular shapes

Volume is commonly measured in cubic centimetres (cm^3), cubic meter (m^3), litres (L) or millilitres (mL). The volume of a liquid may be measured by pouring it carefully into a measuring cylinder. The liquid surface usually curves downwards to form a meniscus. To measure the volume of a liquid accurately, read the scale at the eye level at the lowest part of the meniscus. Meniscus is the concave or convex curved upper surface of a liquid in a container or tube.

Volume is commonly measured in cubic centimetres (cm^3), cubic metre (m^3), litres (L) or millilitres (mL).

Activity: Now test yourself by doing this activity.

A. Circle the letter of the correct answer from the alternatives listed.

1. Which instrument listed below is used for measuring volume?

   A. Thermometer
   B. Tape Measure
   C. Bathroom scale
   D. Measuring cylinder

---

2. Which of the list below is made of units of measurements for volume?

   A. Newtons, Grams, Kilojoules
   B. Grams, Kilograms, Milligrams
   C. Grams, Degree Celsius, Newtons
   D. Litres, Cubic centimetres, Millilitres

---

3. Volume is the

   A. force of an object.
   B. mass of an object.
   C. upward force acting on the object.
   D. the amount of space something takes.

---

4. Which of the following methods is used to measure the volume of solids of irregular shape?

   A. Meniscus
   B. Water replacement
   C. Measuring cylinder
   D. Fluid displacement

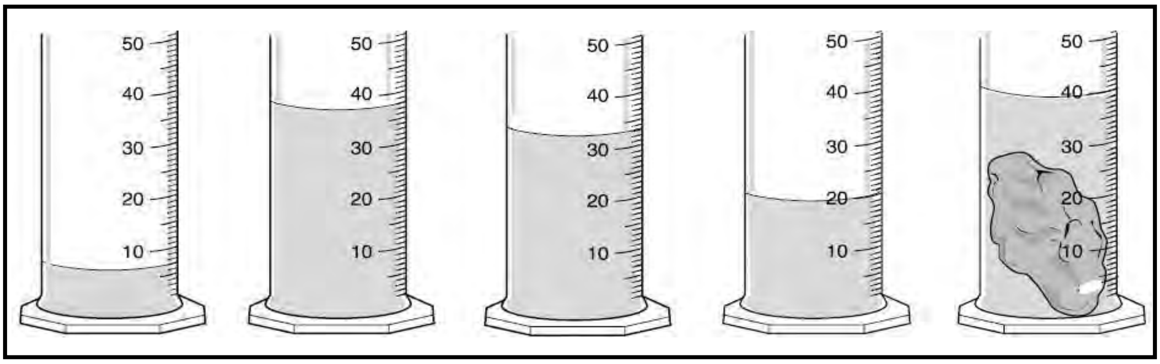
---

5. What is the volume of a solid object when the original volume is 10 mL and the final volume 15 mL after placed in the cylinder?

   A. 2 mL B. 3 mL

   C. 4 mL D. 5 mL

B. Refer to the diagram below. Write the correct scale readings on the following measuring cylinders.



(i)__________ (ii)__________ (iii)__________ (iv)__________ (v)__________

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 1.

Summary

You have come to the end of lesson 6. In this lesson you have learnt that:

- the amount of space something takes up is called its volume.
- the volume of a container is generally understood to be the capacity of the container, that is the amount of fluid (gas or liquid) that the container could hold, rather than the amount of space the container itself displace.
- the volume of a liquid substance is the space occupied by the liquid substance in a container. The volumes can be measured using a measuring cylinder.
- the volume of a solid substance is the space the matter that makes up the solid shape occupies. If a substance is a regular shaped solid, then the volume can be determined mathematically using arithmetic formulas.
- the volume of a solid (whether regularly or irregularly shaped) can be determined by fluid displacement.
- volume is commonly measured in cubic centimetres (cm^3), cubic meter (m^3), litres (L) or millilitres (mL).

NOW DO PRACTICE EXERCISE 6 ON THE NEXT PAGE.

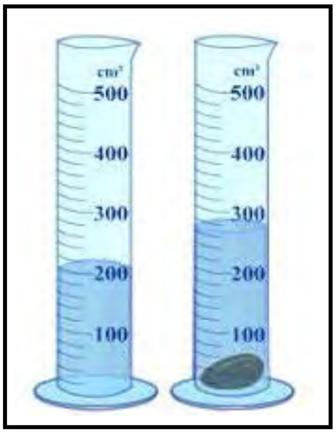
Practice Exercise 6

Answer the following questions:

1. What is the volume of an object?

____

2. Refer to the diagram below and answer the questions



a. What is the original volume of the liquid? __________

b. What is the new change in the volume after dropping the stone inside the container? __________

c. What is the name of the measuring instrument used? __________

d. Calculate the volume of the stone. Show working.

Working out:

3. What is the meniscus reading of a liquid volume measurement? __________

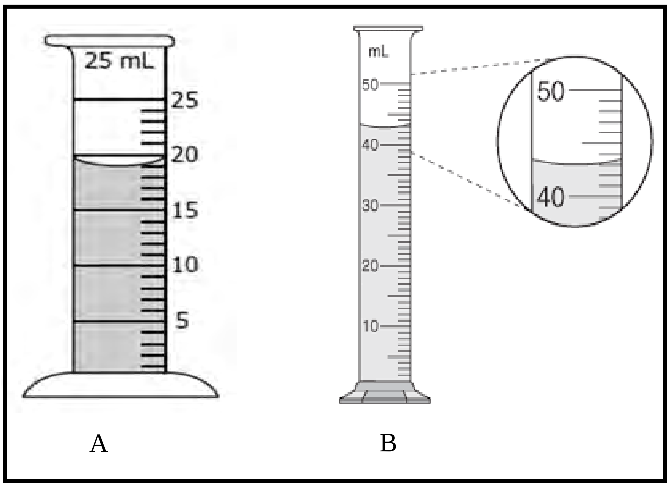
4. Write the names and symbols of the unit of measurements for liquid volume.

Name	Symbol
(i) ____________________	(i) ____________________
(ii) ____________________	(ii) ____________________

5. Write the name and symbol of the unit of measurement for solid objects.

Name	Symbol
(i) ____________________	(i) ____________________
(ii) ____________________	(ii) ____________________

6. Refer to the diagram below. Write the correct scale readings on the following measuring cylinders.



A. ______________________________ B. ______________________________

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1.

Answers to Activity

1. D
2. D
3. D
4. D
5. D
6. (i) 8mL
   (ii) 38mL
   (iii) 33mL
   (iv) 20mL
   (v) 40mL

Lesson 7: Density

Welcome to Lesson 7. Everyday experience tells us that some objects float in water while others sink. When you drop an inflated rubber tube into water it floats. Rocks and steel spanners, on the other hand, tend to sink. Whether the object floats or sinks depends on a property called density.

Your Aims:

- define density
- explain density using correct units
- identify instruments used to measure volume
- analyse diagrams of volume measured and reads scales correctly

What is Density?

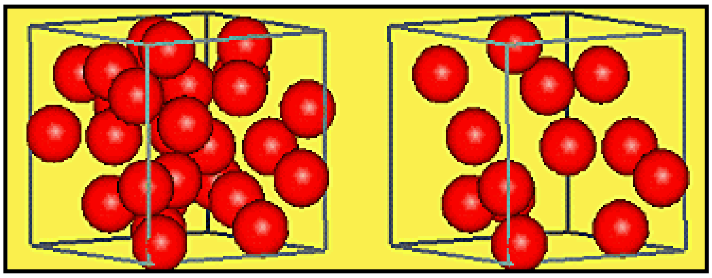
Density is defined as the measure of "heaviness" of an object with a constant volume. The density of a substance is a measure of how "heavy" it is.

For example: A rock is obviously denser than a crumpled piece of paper of the same size.

Density may also refer to how closely "packed" or "crowded" the material appears to be.

Take a look at the two boxes on the right. Each box has the same volume.

If each ball has the same mass, which box would weigh more? Why?



Comparing mass with the same volume

The box that has more balls has more mass per unit of volume. This property of matter is called density. The density of a material helps to distinguish it from other materials. Since mass is usually expressed in grams or kilograms and volume in cubic centimeters or meters, density is expressed in grams per cubic metre (g/m^3) or kilograms per cubic meter (kg/cm^3).

How to find the density of an object?

To find the density of an object, find its mass (in grams or kilograms) and then its volume (in cubic centimeters or cubic meters). You then divide the mass by the volume to find the density.

Measuring the density of solid, liquid and gas

1. Density of Solid

The measure of density of solids refers basically to mass per volume. So you need the mass of your solid object and the volume. Mass of the solid object can be accurately measured using a weigh balance. Volume is easy if your object is regular. You can use the standard equations available for most regular shapes, like cylinder, cube, and sphere. If it is irregular in shape the easiest technique to used is water displacement as discussed and learned from Lesson 6.

If a block of coal has a mass of 3200 kilograms (kg) and a volume of 2 cubic meters (m^3), its density is 3200 divided by 2, which is 1600 kg/m^3.

$$\textbf{Density} = \frac{\text{mass}}{\text{volume}}$$

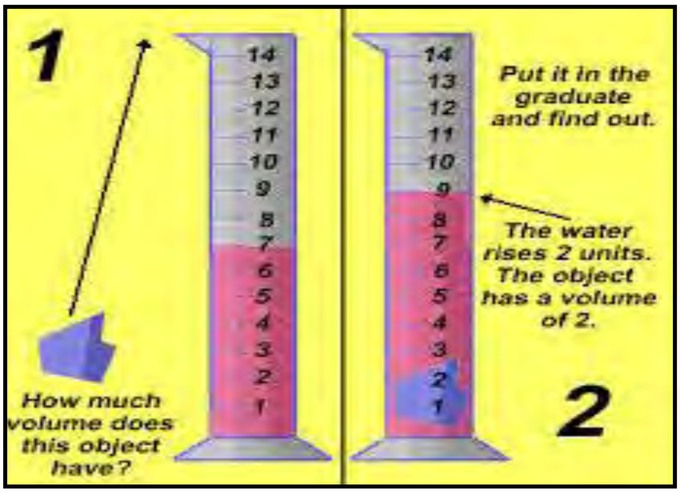
$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

$$= \frac{3200\text{kg}}{2\text{m}^3}$$

$$= 1600\ \text{kg/m}^3$$

2. Density of Liquid

It is fairly easy to measure both the mass and the volume. Measure the mass of the liquid and container, subtract the mass of the container and you have the mass of the liquid. Then measure the volume. Then calculate the density of the liquid.



For example, you have an empty container that weighs 8.668kg. Then if you fill it with $3m^3$ of a liquid, this will cause the mass to go up to 11.121kg. How do you determine the density of that liquid?

Density can be expressed as weight per volume. Subtract the empty mass from the full mass and then divide by the volume.

$$\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{11.121 - 8.668}{3\text{m}^3} = \frac{2.453\text{kg}}{3\text{m}^3} = 0.817666667\text{kg/m}^3$$

3. Density of Gas

There are several ways to measure the density of gas. One way is to take a certain amount of gas and weigh it. (Yes, you really can weigh a gas). One way to do this is by filling a container with the gas and weigh it, then using a vacuum pump to empty the container out completely and weigh it again.) If you know how much the gas weighs and how much space it takes up, you can figure out the density using the same formula of measuring density.

How to measure density and how is it derived?

There is no real instrument to measure density, but there is a way to find out.

1. First you need a triple beam balance, to measure the mass of the object.
2. After you find out the mass, you need to find the volume (height x width x length)
3. Then the divide mass, by the volume, to get the density.

Density is a mass of a volume unit. A unit of density is defined as a unit of mass divided by unit of volume. In its turn a unit of volume is a third degree of a unit of length. Mass and length units are main units. So density is a derived unit as derived from main units.

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

$$\text{Mass} = \text{density} \times \text{volume}$$

$$\text{Volume} = \frac{\text{mass}}{\text{density}}$$

Activity 7: Now test yourself by doing this activity.

Encircle the letter of the most correct answer from the alternatives listed.

1. A block of aluminium occupies a volume of 150 mL and weighs 40.5g. What is its density?

   A. 2.70g/mL B. 27g/mL

   C. 270g/mL D. 2700g/mL

2. What is the weight of the ethyl alcohol that exactly fills a 200.0mL container? The density of ethyl alcohol is 0.789g/mL.

   A. 1.58g B. 15.8g

   C. 158g D. 1580g

3. The density of an object is

A. The same as its weight
B. The same as the size of the object
C. The mass divided by the volume D = m/v
D. The volume divided by the mass D = v/m

---

4. If two objects have the same volume but one has a greater mass, the one with greater mass

A. will float.
B. will sink.
C. has a lower density.
D. has a higher density.

---

5. An object should float in a liquid if it is

A. shaped like a ball.
B. lighter than metal.
C. less dense than the liquid.
D. more dense than the liquid.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 2.

Summary

You have come to the end of lesson 7. In this lesson you have learnt that

- the density of a material is its mass per volume.
- different materials usually have different densities.
- less dense fluids float on more dense fluids if they do not mix. This concept can be extended, with some care, to less dense solids floating on more dense fluids. If the average density (including any air below the waterline) of an object is less than water it will float in water and if it is more than water's, it will sink in water.
- the density of the states of matter are measured in their respective way.

Answers to Activity

1. A
2. C
3. C
4. B
5. B

NOW DO PRACTICE EXERCISE 7 ON THE NEXT PAGE.

Practice Exercise 7

Answer the following questions by circling the correct letter.

1. The density of hot and cold water are different mainly because the molecules in

    A. hot water are larger.

    B. cold water move faster and are further.

    C. hot water move faster and are slightly further apart.

    D. hot water move slower and are slightly closer together.

2. Alcohol is less dense than water. If you measure the mass of the same volume of alcohol and water, the

    A. water would have a lower mass.

    B. water would have a greater mass.

    C. mass of the alcohol and water would be the same.

    D. mass of the alcohol and water would cancel each other out

3. An object should float in a liquid if it is

    A. lighter than metal.

    B. shaped like a ball.

    C. less dense than the liquid.

    D. more dense than the liquid.

4. 100 milliliters of water has a mass of 100 grams. If you measured the mass of 50 milliliters of water, the mass would be __________ grams.

    A. 25 B. 50

    C. 100 D. 200

5. If the density of water is 1gram/cm^3, this means that the mass of 100cm^3 of water should be __________ grams.

    A. 1 B. 50

    C. 100 D. 1000

6. Density is a characteristic property of a substance. This means that the density of water

   A. is less for a smaller mass of water.

   B. changes depending on the volume.

   C. is greater for a greater mass of water.

   D. stays the same regardless of the volume.

---

7. To find the mass of water in a graduated cylinder, you could

   A. add the mass of the water to the mass of the graduated cylinder.

   B. take the total mass of the water and graduated cylinder and divide the mass by two.

   C. take the total mass of the water and graduated cylinder and subtract the mass of the water.

   D. take the total mass of the water and graduated cylinder and subtract the mass of the graduated cylinder.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1

Answers to Practice Exercises 1 - 7

Practice Exercise 1

A. 1. (A)

2. (A)

3. (D)

4. (C)

5. (B)

B. 1. The main difference between imperial and metric systems of Measurement is that imperial systems are arbitrary, meaning they are not based on any scientific measurements while metric systems are based on scientific measurements.

2. The metric system uses only one base unit for each type of measurement.

Practice Exercise 2

A. 1. (B)

2. (D)

3. (D)

4. (C)

5. (C)

B. 1. Error in measurement is the difference between the result of the measurement and the true value of what you were measuring while accuracy describes how well a measuring instrument determines the variable it is measuring or how reliable and correct a particular measurement is.

2. Parallax error occurs when the line of sight or measure is not at right angles (perpendicular) to the objects being measured. Calibration error occurs when instrument is not calibrated correctly.

3. The calibration of an instrument is required to find its accuracy.

Practice Exercise 3

1. (D)

2. (B)

3. (C)

4. (C)

5. (C)

Practice Exercise 4

1. Time is the duration or how long it takes something to happen, from the start to the end.

2. Temperature is how fast molecules move (vibrate) as temperature, either, increases or decreases. The faster the atoms vibrate the hotter that something is and the less the movement in an atom is the colder that something is.

3.

	Name	Symbol
a.	Seconds	s
b.	Minutes	mins
c.	Hours	hrs

4.

	Name	Symbol
a.	Degrees Celsius	^oC
b.	Degrees Fahrenheit	^oF
c.	Kelvin	K

5. a. 100^oC
   b. 0^oC

Practice Exercise 5

1. Mass is the amount of material in an object.

2. Weight is the gravitational force that is acting upon an object.
3. a. electronic balance
   b. top-loading balance
   c. suspended-pan balance
   d. triple-beam balance
   e. bathroom scale

4.

	Name	Symbol
a.	Kilogram	kg
b.	Gram	g
c.	Milligram	mg

5. Spring balance

Practice Exercise 6

1. The space that a substance or shape occupies or contains.

2. a. 200mL
   b. 300mL
   c. Measuring cylinder
   d. Volume of solid = changed volume of liquid – original volume of liquid
   = 300mL – 200mL
   = 100 mL

3. Meniscus is the concave or convex curved upper surface of a liquid in a container or tube

4.

	Name	Symbol
a.	Litres	L
b.	Millilitres	mL

5.

	Name	Symbol
a.	Cubic meters	cm^3
b.	Cubic meters	m^3

6. A. 14mL
   B. 69mL

Practice Exercise 7

1. A
2. B
3. C
4. B
5. C
6. D
7. B

NOW REVISE WELL USING THE MAIN POINTS ON THE NEXT PAGE.

REVIEW OF TOPIC 1: MEASUREMENT

Now, revise all lessons in this Topic and then do **ASSIGNMENT 1**.
Here are the main points to help you revise.

Lesson 1: Unit System

- The main difference between imperial and metric systems of measurement is that imperial systems are arbitrary, meaning they are not based on any scientific measurement while metric systems are based on scientific measurement.
- To understand the world around us, it is necessary to know how items are measured, and what the units they are measured in represent.

Lesson 2: Reliability and Accuracy

- Errors in the measurement of physical quantity indicate the difference between the results of the measurement from its actual value.
- Accuracy and reliability play important roles in the measurement of any physical quantity. Calibration of instrument is done to find its accuracy.
- When experiment is performed and some data are obtained. Then it is required to analyse these data to find error, accuracy and general reliability of the experimental measurements.

Lesson 3: Length

- Length can be measured in metric units of millimetre, centimetre, metre, and kilometre in which millimetres is the smallest unit.
- Length can also be measured in imperial units of inch which is the smallest unit, foot, yard and miles.
- Length is the measurement of longer or smaller and vertical distance across.

Lesson 4: Time and Temperature

- Time is the duration at which takes something to occur, from the start to the end.
- Temperature is the amount of vibration that occurs within a molecule/atom. When there is more vibration the temperature increases. When there is less vibration the temperature decreases.
- Instruments that measure time are clocks, wrist watch, stop watch and hour glass.
- Instruments that measure temperatures are dial thermometer, hygrometer, digital temperature switch.
- The unit of temperature is Kelvin (K). However, most people use degrees Celcius (^{o}C).
- The unit of time is second.

Lesson 5: Mass and Weight

- Weight is the gravitational force that is acting upon an object.
- The unit of weight is the Newton (N).
- The gravitational or downward pull force of the earth is about 10 newtons per kilogram.
- Mass is the amount of material in an object.
- Mass is measured in grams or kilograms using a balance. The results are usually given in grams where 1 kilogram is equal to 1000 grams.
- There are different types of balances used to measure the mass of an object. They range from an electronic balance, top-loading balance, suspended-pan balance, triple-beam balance and bathroom scale.
- A spring balance apparatus is simply a spring fixed at one end with a hook to attach an object to it. A spring balance is used to measure the weight of an object.

Lesson 6: Volume

- The amount of space something takes up is called its volume.
- The volume of a container is generally understood to be the capacity of the container, that is the amount of fluid (gas or liquid) that the container could hold, rather than the amount of space the container itself displace.
- The volume of a liquid substance is the space occupied by the liquid substance in a container. The volumes can be measured using a measuring cylinder.
- The volume of a solid substance is the space the matter that makes up solid shape occupies. If a substance is a regular shaped solid, then the volume can be determined mathematically using arithmetic formulas.
- The volume of a solid (whether regularly or irregularly shaped) can be determined by fluid displacement.
- Volume is commonly measured in cubic centimetres (cm^3), cubic metre (m^3), litres (L) or millilitres (mL).

Lesson 7: Density

- The density of a material is its mass per volume.
- Different materials usually have different densities.
- Less dense fluids float on more dense fluids if they do not mix. This concept can be extended, with some care, to less dense solids floating on more dense fluids. If the average density (including any air below the waterline) of an object is less than water it will float in water and if it is more than water, it will sink in water.
- The density of the states of matter is measured in their respective way.

REVISE WELL AND THEN DO TOPIC TEST 1 IN YOUR ASSIGNMENT 1.

TOPIC 2

SCIENTIFIC APPROACH

In this topic you will learn about:

- **use of apparatus and instruments**
- **first aid**
- **prediction and inference**
- **how to present data**
- **control, variable and hypothesis**
- **parts of a science report**

INTRODUCTION TO TOPIC 2: SCIENTIFIC APPROACH

In this section we will take a look at the method you should use to design your research. This method is the most important part of science, it is called the **"Scientific Approach"**. The **Scientific Approach** is a way to make sure that your experiment can give a good answer to your specific question.

Observation is done first so that you know how you want to go about your research and called "research." It is the first stage in understanding the problem you have chosen.

Hypothesis is the answer you think you will find. It means "a possible solution to a problem, based on knowledge and research. The hypothesis is your general statement of how you think the scientific phenomenon in question works

> Using the example of the tomato experiment, here is an example of a hypothesis:
> Topic: "Does the amount of sunlight a tomato plant receives affect the size of the tomatoes?"
> Hypothesis: "I believe that the more sunlight a tomato plant receives, the larger the tomatoes will grow.

This hypothesis is based on:

(1) Tomato plants need sunshine to make food through photosynthesis, and logically, more sun means more food, and;

(2) Through informal, exploratory observations of plants in a garden, those with more sunlight appear to grow bigger.

Prediction is your specific belief about the scientific idea. An important thing to remember during this stage is that once you develop a hypothesis and a prediction, you should not change it, even if the results of your experiment show that you were wrong.
Continuing our tomato plant example, a good prediction would be: Increasing the amount of sunlight tomato plants in my experiment receive will cause an increase in their size compared to identical plants that received the same care but less light.

Experiment is the tool that you invent to answer the question, and the conclusion is the answer that the experiment gives. This is the part that tests your hypothesis.

Conclusion is the final step and a summary of the experiment's results, and how those results match up to your hypothesis.
You have two options for your conclusions: based on your results, either

(1) you can reject the hypothesis, or

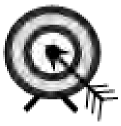
(2) you can not reject the hypothesis.

This is an important point. You cannot prove the hypothesis with a single experiment, because there is a chance that you made an error somewhere along the way. What you can say is that your results support the original hypothesis.

If your original hypothesis did not match up with the final results of your experiment, do not change the hypothesis. Instead, try to explain what might have been wrong with your original hypothesis. What information did you not have originally that caused you to be wrong in your prediction? What are the reasons that the hypothesis and experimental results did not match up?

Lesson 8: Use of Apparatus and Instruments

Welcome to Lesson 8. To discover answers to questions and have a better understanding of the world around us, scientists have developed a way of working known as **scientific approach** by way of performing experiments. An experiment is a technique to resolve problems and find an answer to questions. In this lesson, you will learn the different kinds of equipment and instruments to use in carrying out the experiment.



Your Aims:

- identify equipment used in science laboratory
- enumerate the correct and safe way to use different science equipment

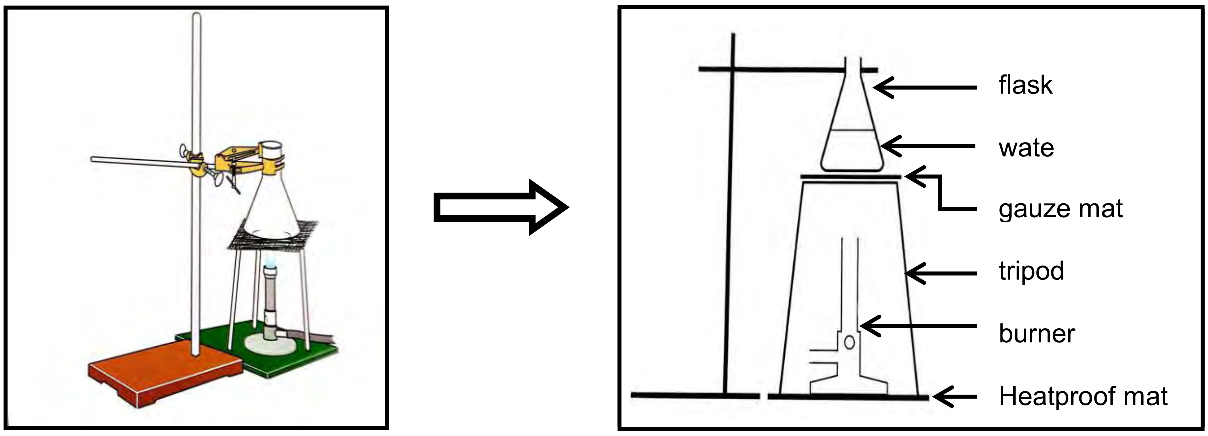
Use of Apparatus and Instruments

In most schools, scientific or experiments are done in the science classroom. This classroom has things that make it looks like a real laboratory. There will be special taps and sinks for washing. There may be fume cardboards to remove dangerous or unwanted smells. There will be gas taps placed around the room and gas burners that can be used for heating chemicals. There will be different pieces of glass wares of different shapes that you can use to perform experiments called equipment and instruments.

Equipment is the name given to all the items used in laboratory such as test tubes, beakers, dry cells and wires.

Instruments are pieces of equipment that are used to make measurements.

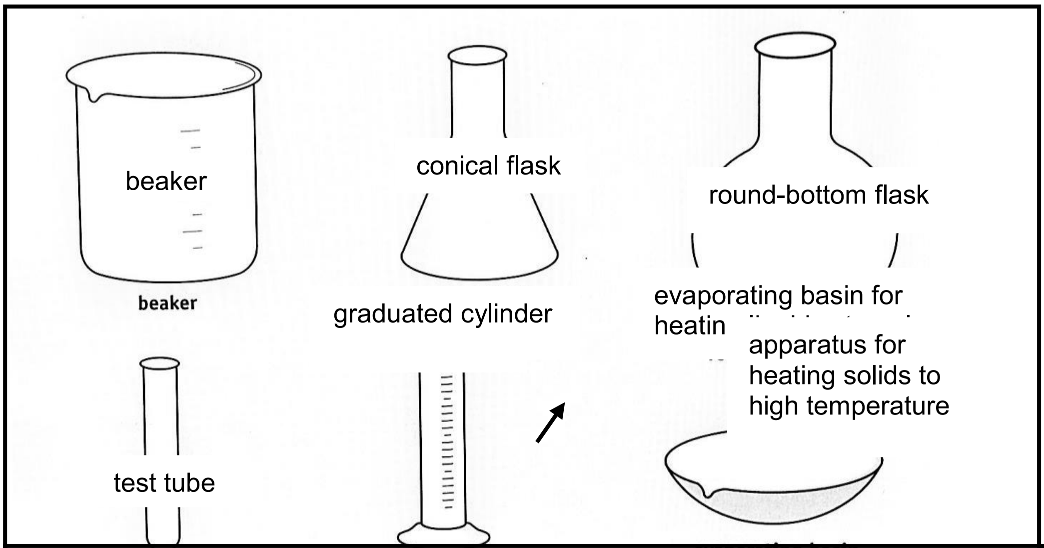
Apparatus is the name given to an equipment that has been put together for an experiment. For example, Fig 1 below shows the apparatus for heating a flask of water.

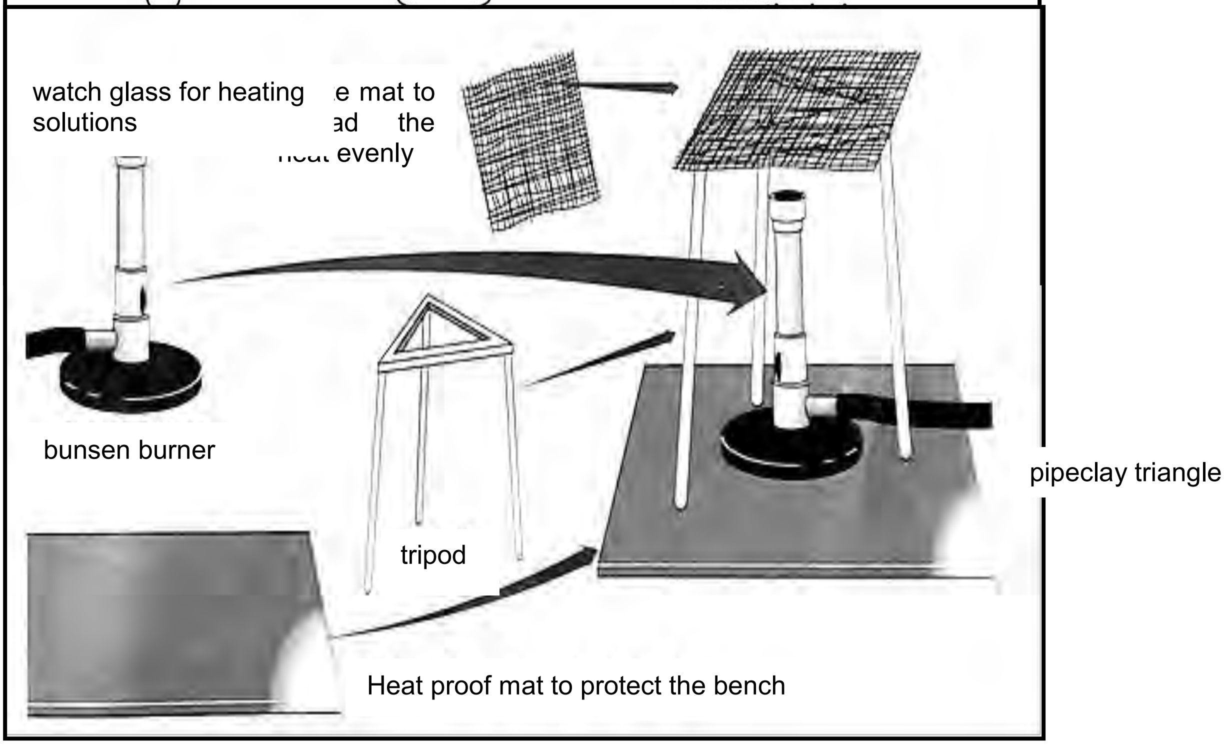


Apparatus for heating a flask of water

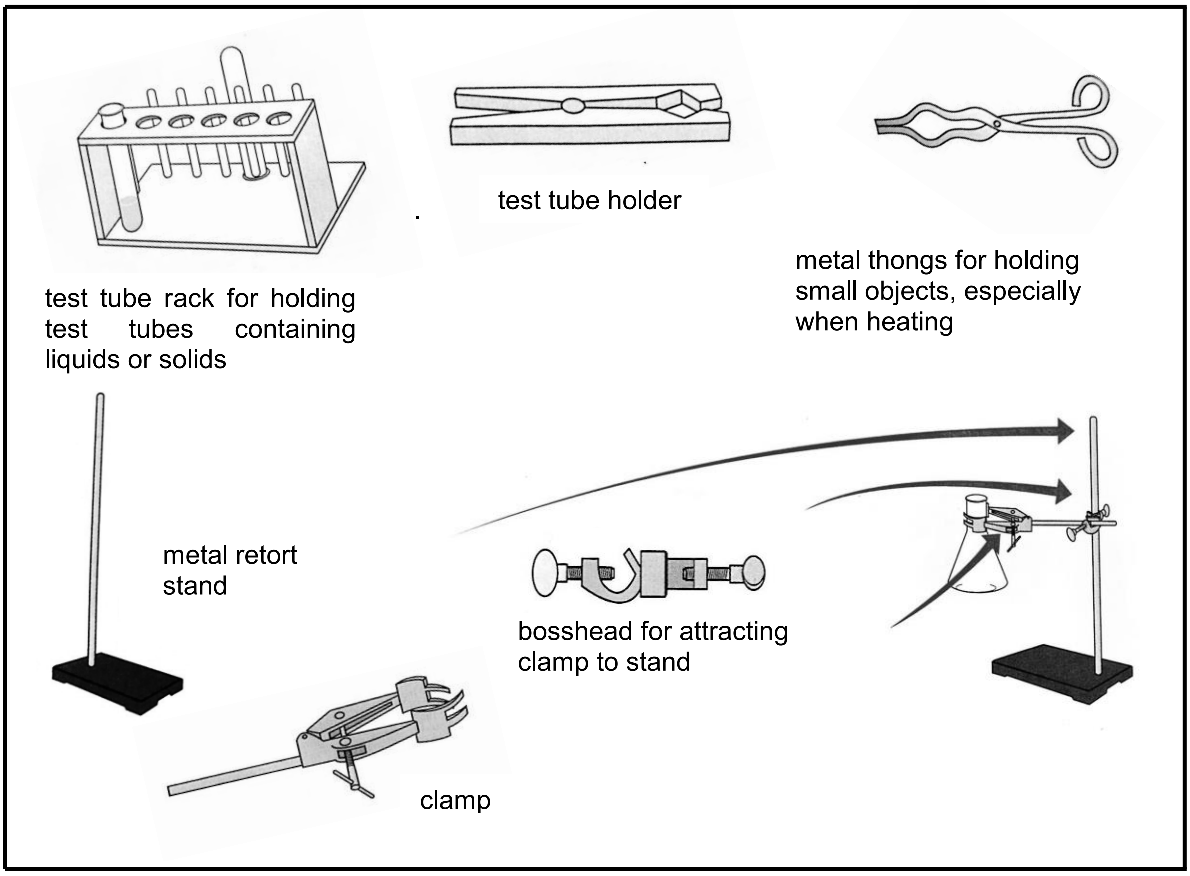
A science **laboratory** (la-BOR-a tory) is a specially designed room where you can carry out experiments safely.

Before you can begin experimenting you need to be able to identify these items and know what they are used for. The names of different pieces of equipment are shown below.

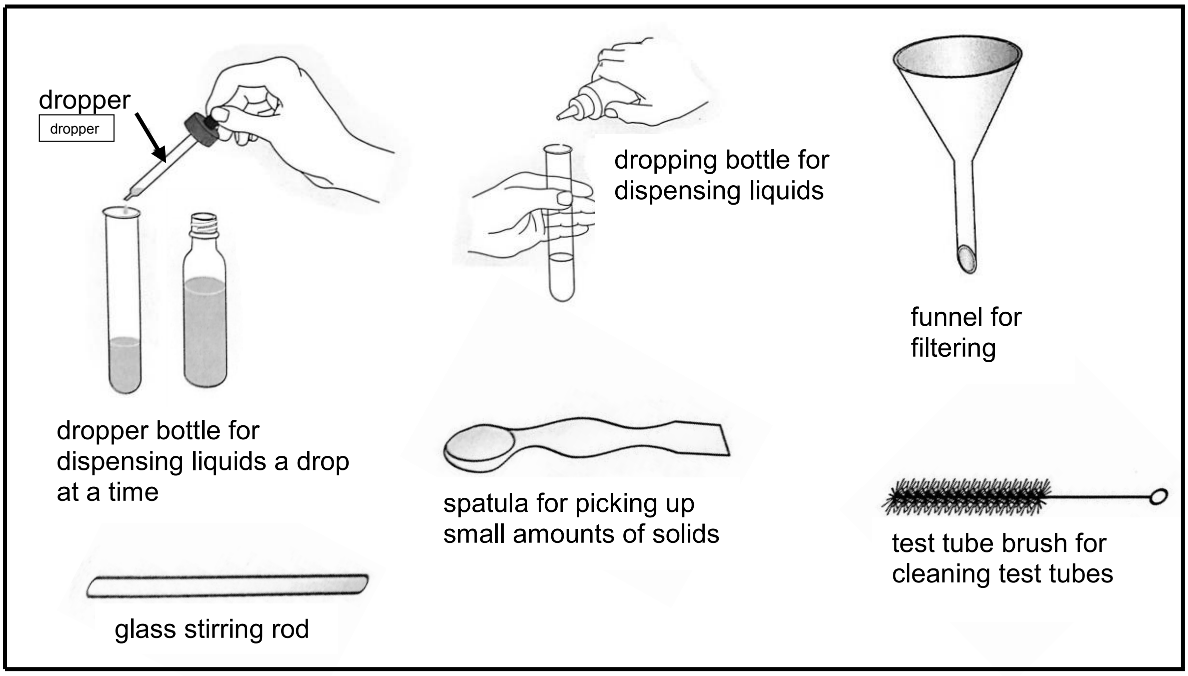




Heating



Equipment that hold items and other objects



Other useful items

The “Don‟ts “ in the Laboratory

1. *Do not run, push other people or behave in a rough way.*
2. *Do not eat food, snacks or lollies.*
3. *Do not drink from glassware or laboratory taps.*
4. *Do not play with gas taps or water taps.*
5. *Do not point the container towards people when heating a substance and do not directly look into the container.*
6. *Do not put your nose close to the container when you want to smell gases or chemicals.*
7. *Do not try experiments that have not been approved by the teacher.*
8. *Do not put any solid waste in the sink that might block the waste pipe.*
9. *Do not carry heavy objects or large bottles with one hand but support them by putting one hand under the base and the other hand on top.*
10. *Do not enter the preparation room without your teacher’s permission.*

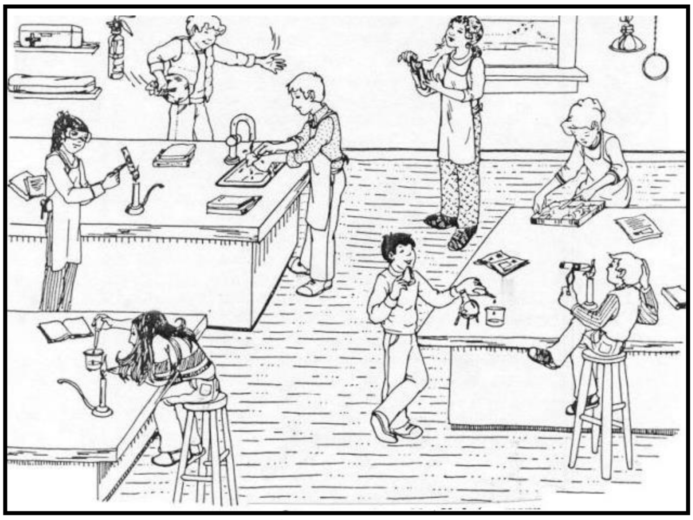
Follow these safety rules to avoid accidents.

Safety rules

1. You are not permitted in a science laboratory when your instructor is not with you.
2. Wear acceptable dress and protective covering. Splash proof covering (goggles) must be worn during activities in which eye hazard exists.
   Aprons or laboratory coats are required for students in laboratories.
   Do not wear easily flammable garments in the laboratory; wear shoes which cover the entire foot; hair which is long enough to hang down into a burner must be tied back while in the laboratory.
3. Learn the location and operation of laboratory emergency safety equipment.
   - Fire extinguishers, fire blankets, fire alarms, emergency exits, campus police.
   - Eye wash, overhead showers, first aid kits, glass disposal containers, sharp containers.
   - Never touch equipment in the laboratory unless you are told to use it.
4. Acts of carelessness and/or horseplay are prohibited in the laboratory. Behave in a professional manner and confine your conversation to the work at hand .Pay attention to what you are doing.
5. Always check the label on the bottle before using the contents.
6. Check with your teacher on how to dispose of waste liquids and solids. Broken glass should be placed in a special bin.
7. If you spill something on your skin or clothes, wash it immediately with lots of water.
8. Report all accidents and breakages to your teacher.
9. Clean your laboratory area before you leave the room.
10. Always wash hands before leaving the area.

Safety in the laboratory

A science laboratory is not a normal classroom because; the equipment and chemicals that are used for experiments are not also ordinary and common. For example, some chemicals can cause burning or poisoning. You might be cut when a piece of glassware breaks. For these reasons, safety rules have been developed to help you to make the laboratory a safe place to work.



Safety in the Science laboratory

There are **two main rules** to follow.

1. Know what you are doing in the laboratory and read instructions carefully before you start.
2. Always think of others and behave sensibly.

Read about the types of accidents that can occur and if an accident does occur, report it to your teacher.

Types of accidents that may occur in the laboratory

- **Burns** can be caused by touching hot equipment or by spilling hot liquid. Immediately treat these types of burns with cold water. More serious burns may occur when using the bunsen burner, if this happens report to your teacher immediately.

- **Fires** are always possible when using burners. Never use paper to light a burner and never place burning things in rubbish bins. It is essential to tie back long hair to prevent it from catching fire when using a bunsen burner.

- **Eye injuries** can be caused by liquids splashing into your eyes during experiments. You should always wear safety glasses and if you get a chemical in your eye, wash it immediately with lots of water, and tell your teacher.

- **Cuts** are caused mainly by broken glass, so make sure any broken glass goes immediately into the special bin.

- **Damage to clothing and skin** can occur when chemicals, especially corrosive liquids such as acids and alkalis are spilt. You should wear a laboratory coat or other protective clothing. If there is a spill, wash the area immediately with lots of water and ask someone to tell the teacher or when necessary use the safety shower.

- **Poisoning** can be caused by breathing in fumes, by tasting chemicals or by spilling them onto your skin. Never eat or drink in the laboratory. Check the labels on chemicals before you use them.

- **Damage to the laboratory** can occur when sinks become blocked by paper or solids, which can cause flooding if taps are left running. The benches can be scorched during heating, so use a heatproof mat. They can also be damaged by chemical spills, so wipe these up immediately.

Disposal of chemicals

Some chemicals are harmful to the skin or may irritate. Some chemicals are corrosive. Do not let chemicals touch your hand, body or clothes. Always follow your teacher‟s instructions in disposing chemicals properly to protect our environment. Some liquids can safely be poured down the sink, but others cannot, make sure you are familiar with toxic chemicals. Learn to recognise the safety label for corrosive substances and you should never put left over solid down the sink.

At home you must also be careful how you dispose chemicals. Councils usually provide places at the local dump where you can take liquids such as used oil and mineral turpentine. Industries must also follow laws enforced in the community to properly dispose chemicals that they use.

Safety symbols and warning signs
Safety symbols and warning signs are used to warn people about dangerous situations and chemical substances.

Safety symbols are usually in the shape of triangle or simple drawings to communicate the message rather than words and are found in many different situations, as road signs, at the entrance to buildings, in schools and on building sites.

Safety symbols

Warning Signs are special different colors of safety labels on chemical substances or situations used all over the world so that it is easier to understand.

Warning signs

Activity 8: Now test yourself by doing this activity.

Refer to the diagram below to answer Question 1.

1. Which of the pieces of equipment (identify the equipment number) in the figure above would you use to

   A. store a liquid in? ___________
   B. hold a test tube? ___________
   C. heat a substance? ___________
   D. pour a liquid into a narrow test tube? ___________

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2. Match each item of equipment listed below with its use. Write the correct pairs in your notebook in a table as shown.

Equipment	**Use**

a. tripod	a general purpose glass container for small amount of materials
b. gauze	for holding hot objects
c. spatula	stand equipment on this when heating things
d. test tube	for picking up small amount of solids
e. beaker	a general purpose glass container with a pouring lip
f. bunsen burner	used heating things
g. stand and clamp	for holding equipment in place
h. metal tongs	placed on top of a tripod to spread heat

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 8.

Summary

You have come to the end of lesson 8. In this lesson you have learnt that:

- scientists of different field use appropriate equipment to carry out their experiments.
- there are various apparatus used to carry out experiments in a science laboratory.
- when carrying out experiments, care must always be taken to avoid accidents.
- all equipment must be handled with care to avoid damages since they are very expensive.
- rules of a science laboratory must be followed closely to avoid any accidents.

NOW DO PRACTICE EXERCISE 8 ON THE NEXT PAGE

Practice Exercise 8

A. Copy and complete these statements. The missing words are written below.

beaker, bunsen, disposal, glasses, laboratory, safety, test

1. You must be able to correctly identify the equipment in a science__________.
2. You must obey the __________ rules for the science laboratory.
3. You need to know how to use a _________burner correctly.
4. It is important to wear safety __________ whenever there is a chance of liquid splashing into your eyes.
5. You must take special care in the handling and __________of chemicals.

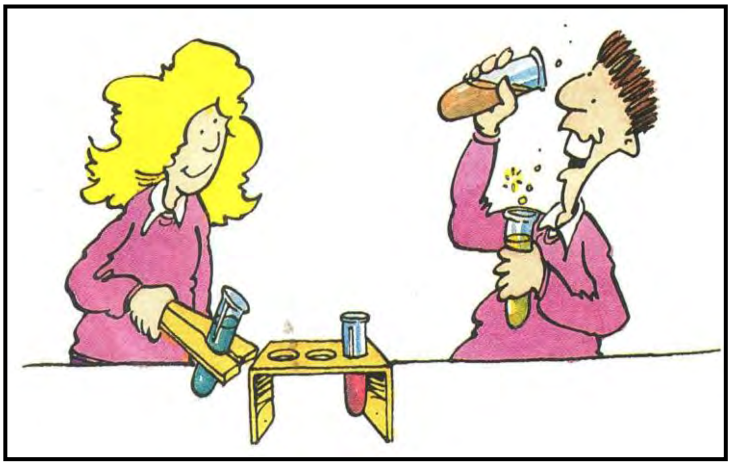
B. The following word maze contains 24 words used in this lesson. The words are mixed up. They may be written forwards, backwards, diagonally, up or down. Find each word and cross it off from the list below.

wash, beaker, bunsen, jar, clamp, funnel, tongs, tube, gauze, mat, flask, brush, stand, lab, lid, conical, rule, burner, water, heat, gas, wire, safe, aim.

B	E	A	K	E	R	I	W	S	F
U	O	I	C	L	A	M	P	A	U
N	A	M	E	A	J	A	O	F	N
S	G	N	O	T	E	T	D	E	N
E	F	G	A	U	Z	E	I	I	E
N	L	A	U	B	R	U	S	H	L
W	A	S	H	E	A	T	T	E	A
O	S	C	O	N	I	C	A	L	B
R	K	R	E	T	A	W	N	U	B
B	U	R	N	E	R	A	D	R	E

C. Which of the two people is working safe?

The girl or the boy?



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CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.

Answers to Activities

1. A. equipment # 6
   B. # 3
   C. # 2
   D. # 7

2.

Equipment	Use
a. tripod	stand equipment on this when heating things
b. gauze mat	place on top of a tripod to spread the heat
c. spatula	for picking up small amount of solids
d. test tube	a general purpose glass container for small amount of material
e. beaker	a general purpose glass container with a pouring lip
f. bunsen burner	used for heating things
g. stand and clamp	for holding equipment in place
h. metal tongs	for holding hot objects

Lesson 9: First Aid

Welcome to Lesson 9. Emergencies occur all around us, in all spheres of life. Someone may be injured at home, work or at school. When this happens, first aid basics will equip anyone around the injured person to reduce the danger posed by the accident, so it is useful to know what to do and perform the first aid, which is what you are going to learn in this lesson.

Your Aim:

- describe First Aid and its importance

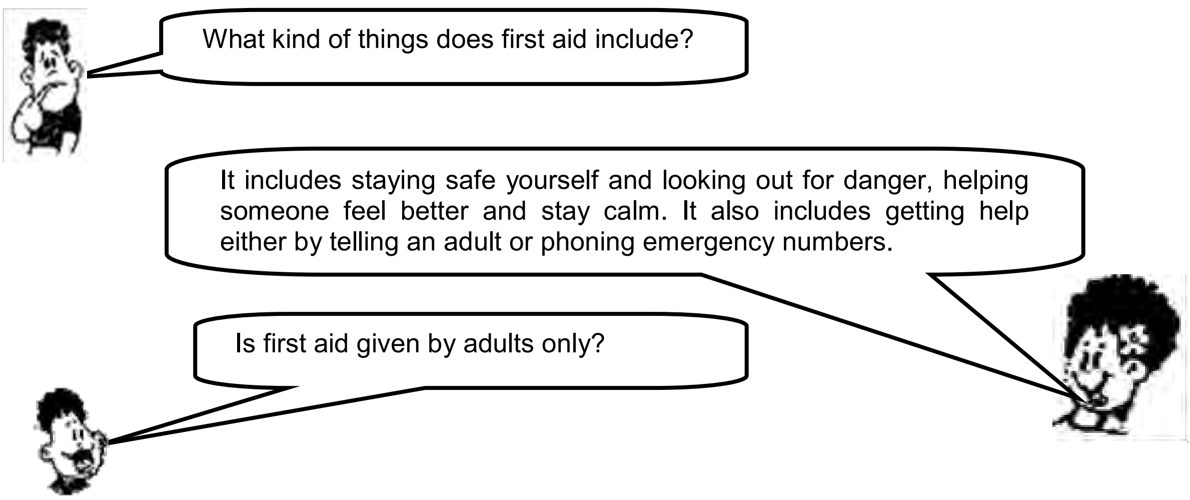
What is First Aid?

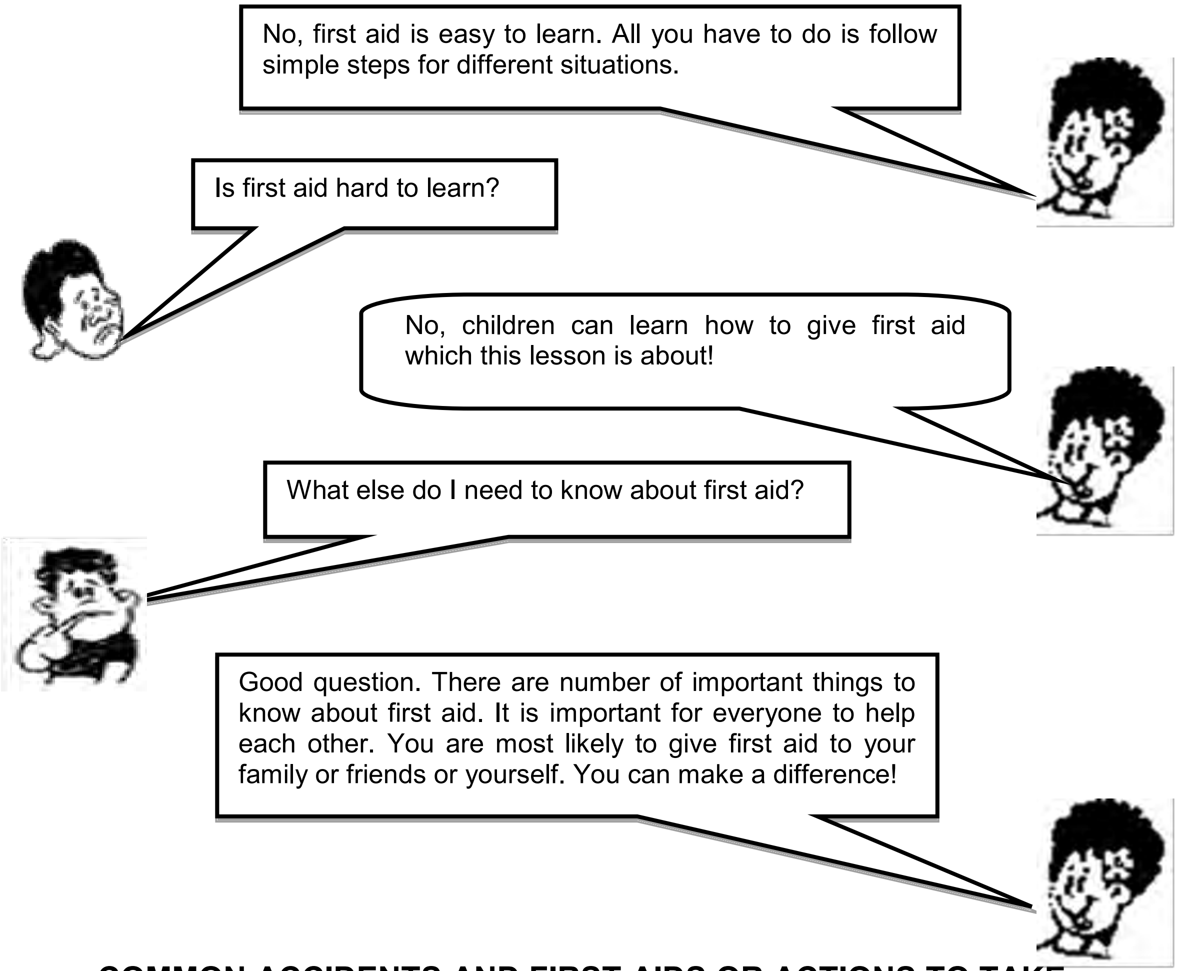
First aid is essential in emergency cases. Knowing what action needs to be taken to control an emergency. It can make the difference between life and death.

For example, if a child breaks a limb during play time at school, an attending teacher may perform first aid to help reset the bones and reduce any pain and discomfort the child may be experiencing. In cases where the injury causes profuse bleeding, first aid is necessary to reduce the chances of extensive blood loss. Ambulances hardly arrive immediately, and first aid makes all the difference in the time it takes the ambulance to arrive.

First aid is the initial provision for an illness or injury. It usually performed by non-expert, or a student like you to an injured person until proper medical treatment can be accessed. Certain self-limiting illnesses or minor injuries may not require further medical care after the first aid. Most of the accidents in school can be avoided using your common sense, which means you must pay attention and must be careful. If accident does happen you must report it quickly to your teacher so that first aid treatment can be applied to the injured person.

How first aid works?
The following questions and answers will tell you more about first aid:

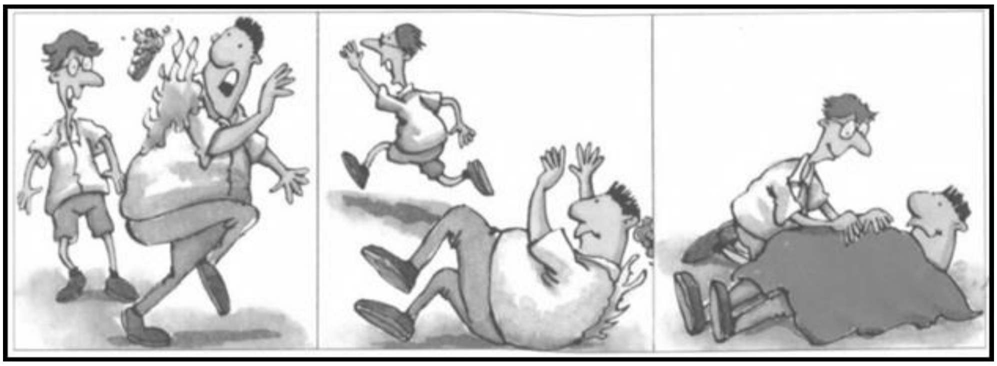




COMMON ACCIDENTS AND FIRST AIDS OR ACTIONS TO TAKE

Type of accident	**First aid or action to take until help arrives**
Chemical spills on surface or floor.	Keep clear of the area; cooperate with instructions for clean-up. All spills must be reported.
Chemical spill on skin, clothes, hands, eyes.	Wash with water **immediately**; continue washing until told to stop. Immediate washing is crucial in cases of spill the eyes and face.
Broken glass on work surface or floor.	Discard broken glass in designated containers.
Scalds	If you scald your hand with boiling water or steam put it under cold running water for at least 10 minutes. Let your teacher know immediately. Dry the scalded area carefully. If the scalded area is large, cover with a wet cloth and visit a health worker as soon as possible.
Thermal Burns	If you burn yourself hold the burnt skin under cold running water **immediately**, for at least 15 minutes. Do not use ice cold water from the fridge. Let your teacher know immediately. Remove any clothing close to the burn unless it is stuck to the burnt area.

	Try not to touch the burnt area. Use loose wet dressing to cover the area and visit a health worker as soon as possible. Do not put any cream or oil on the burn.
Cuts, punctures, gashes	Gloves, goggles and aprons must be used when blood is present. Control the flow of blood and apply first aid as necessary until help arrives. Item with blood and body fluids are to be treated as a hazardous waste and disposed of in properly labeled receptacle.
Asphyxiation or poisoning	Provide fresh air and/ or resuscitation. Use antidote if possible.
Electrical shock	Disconnect the power before touching the person, if they are still touching the electrical source.
Fire or explosion	Get out of the area. Assist person in trouble. If clothing is on fire use water source, fire blanket, overhead shower or fire extinguisher. If your hair or clothes catch fire, quickly drop to the floor and roll over to smother the flames. The blanket should be quickly wrapped around you to make sure air cannot get to the fire (see diagram below). Once the fire is out, call the emergency help and apply first aid. Treat burns quickly with cold running water or ice for 20 minutes. Stay calm until help arrives.



What to do when your clothes catch fire

First aid is help given to a person who has been hurt or is suddenly taken ill. It is the step you can take before a person gets expert medical help. Sometimes you can save a person's life, but more often it is help given in everyday accident or illness.

Activity 9: Now test yourself by doing this activity.

Answer the following questions by writing your answers on the space provided.

1. How can most accidents be avoided in the laboratory?

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2. What should you do if an accident happens?

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3. Read the following statements. Each one involves an important safety aspect.

   Write down the safety reason for each statement.

a) Alison ties back her long hair before she lights the bunsen burner.

b) Mary makes sure she is wearing leather shoes when she comes to class.

c) Peter puts on his safety goggles when he is heating something over the flame.

d) Tran points the test tube toward the window and away from other students.

e) Tom tells John not to run down the aisles of the laboratory.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 8.

Summary

You have come to the end of lesson 9. In this lesson you have learnt that:

- first aid is the initial help given to someone who has been injured.
- after first aid has been applied call emergency.
- accident must be avoided at all cost while using the laboratory.
- never leave your friend and run way if he or she is involved in an accident in the laboratory.
- first aid has been proven to save lives. Learning basic first aid will help anyone save a life in an emergency.

NOW DO PRACTICE EXERCISE 9 ON THE NEXT PAGE.

Answers to Activity

1. You must observe and follow the safety rules in the laboratory.
2. Call emergency and then apply first aid.
3. a) Hair should be tied back while using a bunsen burner because it might catch fire and burn Alison.
   b) Shoes should be worn at all times when you are in the laboratory. This is to avoid your feet from being in contact with harmful chemicals or other substances in the laboratory.
   c) Always remember to wear safety goggles. This is to avoid chemical spill into his (Peter"s) eyes.
   d) Never point test tube directly to the face or towards someone while heating it over a flame. The fumes from the experiment might be poisonous to inhale.
   e) Tom is telling John to stop because if he runs he might knock anything over the bench or stumble on something that might be placed on the floor.

Practice Exercise 9

Read the following statement. Each one describes a student doing something wrong

Write down the correct way of performing the task.

1. Anita uses her hand to scoop a small amount of solid chemical from a jar.

2. Gianni looks down the barrel of a test tube to see what is going on.

3. Charles leaves the beaker boiling on the tripod to go and talk to his friends.

4. Frances sticks her nose directly over the bottle to smell the chemical.

5. James sets up some glass ware at the edge of the bench.

6. Noah puts his hand over the end of the test tube and shakes it up and down trying to mix the content.

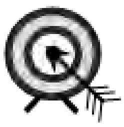
7. After boiling some liquid Andrew picks up the beaker with his hand to pour the contents down the sink.

8. Robert put some liquid and solid wastes in to the sink.

CHECK YOUR ANSWERS AT THE END OF TOPIC 2.

Lesson 10: Prediction and Inference

Welcome to Lesson 10. Scientific approach or investigative process by way of performing experiments does not only involve the use of equipment and observing safety rules in the science laboratory. As a science student should also develop the scientific skills to carry out your investigation. Find the answers to your questions. This lesson mainly talks about the skills making inference and predictions based on your observations. An observation is something you detect using one or more of your five senses.



Your Aims:

- define inferences and predictions
- make inferences in given situation
- make predictions in given situation

What is Observation and Inference?

An observation is an experience obtained through one or more senses

Observation is the act of seeing an object or an event and noting the physical characteristics or points in the event. It is an extension of our senses; when we observe, we record what is seen, smelled, tasted, heard and touched.

Observation gives the information about the world around us. From your observation you can be able to guess what might happen next or in the future.

An observation is an experience perceived through one or more senses while an **inference** is an explanation of an event. To infer means to construct a link between what is observed directly and what is known from past experience. An inference is not a guess since a guess is an opinion formed from little or no evidence.

In science, an inference refers to reasonable conclusions drawn from an experiment or collected information. Scientists make inferences all the time, which may prove similarities, but don"t prove what happened. In fact most "known" scientific facts, are inferences since it would be impossible to fully gather all results on a subject. The inference can take several forms.

A hypothesis or a theory about how something might work or not work, is the starting point. This may be an inference made when a person observes something in the known world, and sets out to test whether the hypothesis or inference agrees.

Steps in inferring

1. Make as many observations about the object or the event as possible.
2. Recall your experiences as much with relevant information about the object of the event and apply this information to what you observe.
3. State your observation in such a way that clearly distinguishes it from other kinds of statements.

Making inferences

1. You can usually make several different inferences from the same observation.
2. Observations are correct, provided the observer has been careful and honest in reporting the observations. However inferences made from these observations can be incorrect. They can be tested by further observations.
3. It is important not to confuse observations and inferences. Otherwise you may think something is a fact when it is only an educated guess.

For example, see figures 1 and 2 below.

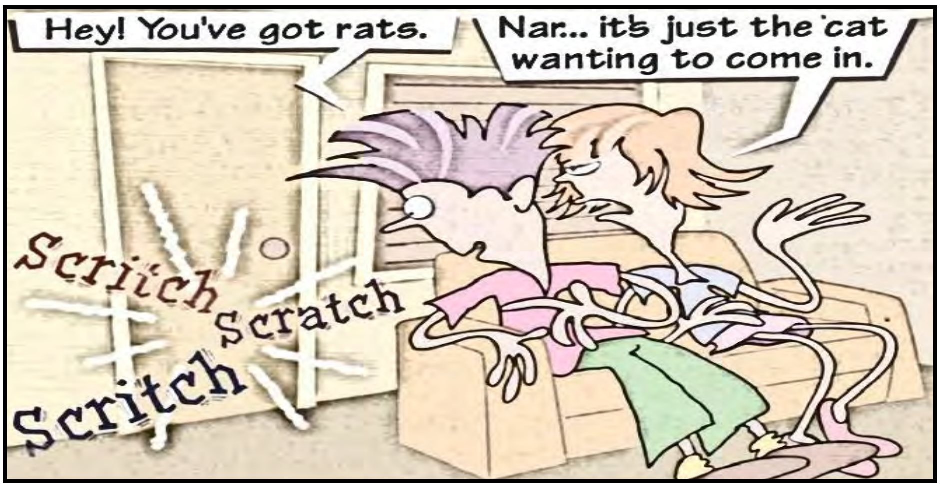


Fig. 1 Different inferences from the same observation

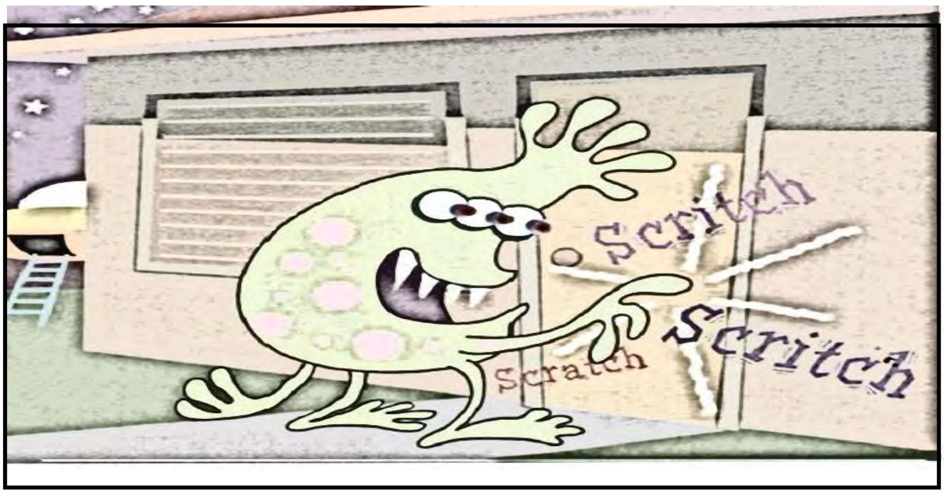
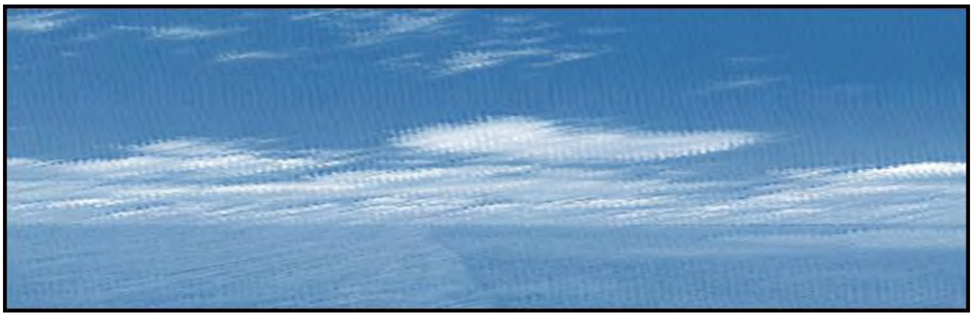
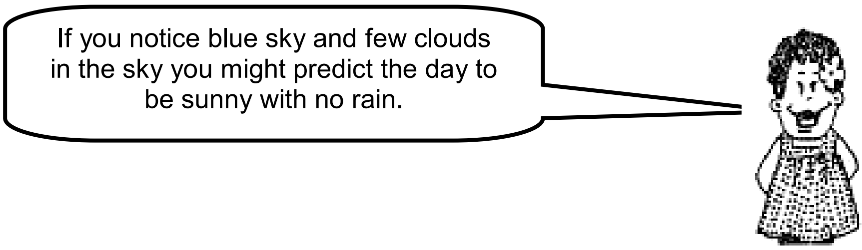


Fig. 2 Inferences can be wrong





Observation versus inference

1. Observation is what one sees, inference is an assumption of what one has seen.
2. Observation can be said to be factual description, inference is an explanation to the collected data.
3. Observation can be termed as a close watch of the world around you through the senses. Inference can be termed as an interpretation of facts that has been observed.
4. Inference is an assumption made from observation.
5. Without observation, there is no inference but after observations, there should be some inferences.
6. Observation can be called the process of gathering data and inference can be said as a process of making decisions about the gathered data.

Prediction and Hypothesis

A **prediction** is a statement about the way things will happen in the future, often but not always based on experience or knowledge. While there is much difference between prediction and forecast, a prediction may be a statement that some outcome is expected, while a forecast is more specific, and may cover a range of possible outcomes.

Accurate prediction and forecasting are very difficult in some areas, such as natural disasters, diseases, demography, population growth and weather.

For example, it is possible to predict the next wet season, but their exact timing and how long it last is much more difficult. Although exact information about the future is in many cases impossible, prediction is necessary to allow plans to be made about possible things happening.

The **hypothesis** is your general statement of how you think the scientific idea in question works. Your prediction lets you become more specific.

How will you demonstrate that your hypothesis is true? The experiment that you will design is done to test and prove the prediction.

An important point to remember during this stage of the scientific method is that once you develop a hypothesis and prediction, you should not change it, even if the results of your experiment show that you were wrong.
An incorrect prediction does not mean that you "failed." It just means that the experiment discovered some new facts that maybe you had not thought about before.

A prediction is a statement about the ways things will happen in the future. Hypothesis is your general statement of how you think the scientific phenomenon in question works.

Activity: Now test yourself by doing this activity.

A. Look at pictures A and B and make inferences by answering Questions 1 to 5 below.

1. Where do you think the pictures were taken from?

2. What makes you think so?

3. What can you notice from the surface of these pictures?

4. Why is there a shadow in picture **A**?

5. Which direction is the shadow falling in picture A and from what directions is the suns ray coming from?

____

B. You can ask anyone from your study area to answer the questions below

- Will it rain tomorrow?
- Will it be a full moon tonight?
- How fast can you run 100m?

1. Decide whether the answers they give are predictions based on observations and knowledge or just guesses.

____
____

2. What information would you need to turn the guesses into proper predictions?

____
____

Summary

You have come to the end of lesson 10. In this lesson you have learnt that

- prediction is a statement about how things will happen in the future.
- prediction is done only after an observation.
- an observation is what you experience through one or more of your senses.
- hypothesis is a general statement of how you think the scientific idea works.
- inference is a conclusion drawn from an experiment or observation.

NOW DO PRACTICE EXERCISE 10 ON THE NEXT PAGE.

Practice Exercise 10

Answer the following questions:

1. Cameron has a mouse in a cage. The mouse has an exercise wheel with a counter on it. Cameron wrote down the counter reading each morning, but the corner of his result sheets were torn off.

Days	Counter reading
1	49
2	100
3	152
4	

a. Predict what the counter reading for day 4 should be approximately.

____

____

b. Explain how you made this prediction.

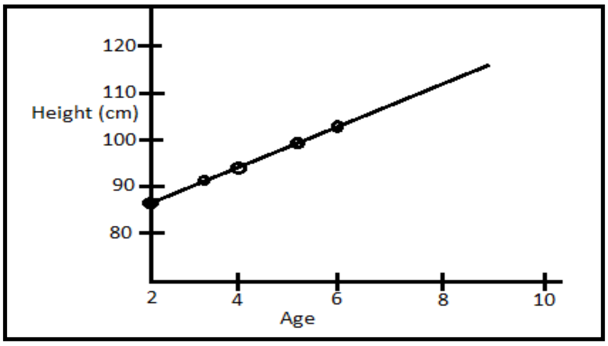
____

____

2. The table below shows the average height and mass of students aged 11 to 14. The following numbers have been left out, 38, 45,150 and 160. Copy the table and put in the missing numbers

Age	Average height		Average mass	
	Boys	Girls	Boys	Girls
11	144	145	35	36
12		152		40
13	156	158	42	
14	163		49	49

3. Paul‟s parents measured his height every year starting when he was two. They recorded his measurements on the graph on the right.



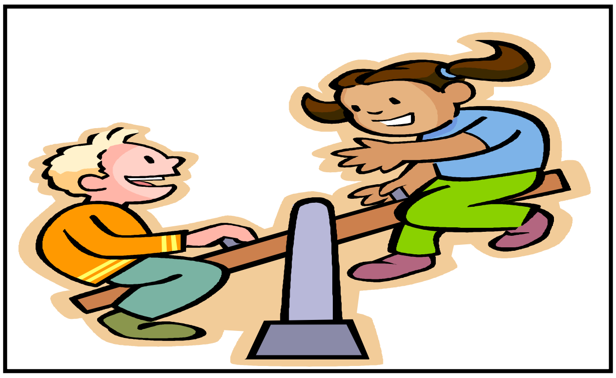
a. How old was Paul when he was 100 cm tall? ____________

b. Predict how tall he will be when he is eight. ____________

c. Can you predict how tall he will be when he is 20? ____________

4. Look at diagram below and find out whether statements a to c is an observation, inference or prediction. Write your answers on the space provided.

   a. The left hand of the see- saw is lower than the right hand.
   b. If John gets off Mary‟s end will fall.
   c. John is heavier than Mary.



John and Mary riding on the see-saw

CHECK YOUR WORK. ANSWERS AT THE END OF TOPIC 2

Answers to Activities

A. 1. The photo was taken on the surface of the moon.
   2. The astronaut is wearing space suit, there is a moon buggy in the background and also the surface of the moon has craters.
   3. The surface of the moon has little crates which were created by asteroids
   4. Shadow was created by the sunlight.
   5. The shadow towards the right and the sun‟s ray is coming from the left.

B. Answer is prediction based on observation and knowledge
   The last question may be just a guess.

(The guesses can be predictions if more observations are done.)

Lesson 11: How to Present Data

Welcome to Lesson 11. In the previous lessons, you have learnt how to make inference and prediction from observation. In this Lesson, you will learn another important part of an investigation.

Your aims:

- devise data tables and graphs for observations.
- draw conclusions from observations.

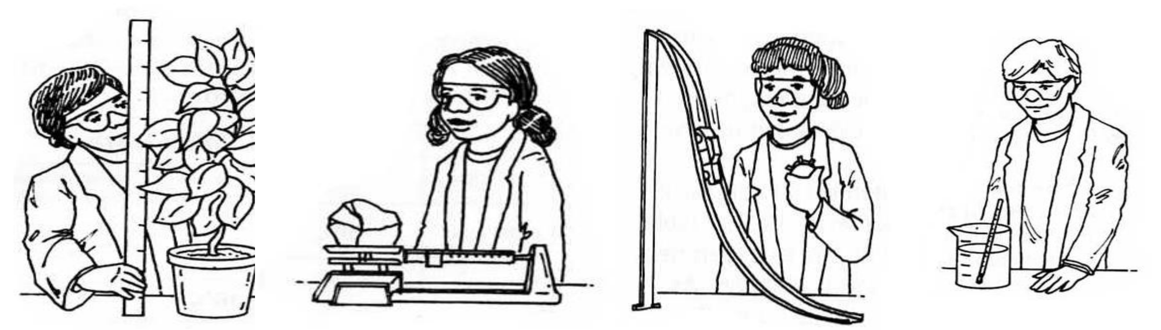
Making Observations

All scientists depend on observational skills to gather information. To make an observation is to notice something. An observation can be information gathered directly by means of our five senses or it can be detected with instruments. Good observations are complete and detailed. Observations are most reliable when they can be quantified or measured. For example the observation “the water is 50^0C” is better than the observation “the water is hot”.

Collecting data

How is data collected? **Data** refers to information you collect during an investigation. Data is a collection of facts, such as values or measurements. Data can be numbers, words, measurements, observations or even just descriptions of things. It can be collected in many ways. The simplest way is direct observation.

An **observation** is information gathered with your senses. **Measurements** are precise observations that include numbers and units. You make measurements using tools such as those shown in the diagram. During an investigation, you should record or write down your data. To keep your data accurate, record your observations when you make them. Also remember to include units with your measurements. Recording data accurately lets others repeat your experiment and to check and confirm your results. Repeating measurements allows you to check the accuracy of your data.



A metrestick measure length. | A balance measures mass. | A stopwatch measures time. | A thermometer measures temperature.

Data collecting through direct observation

Presenting observational data

When you record a set of measurements you end up with a list of numbers. These numbers can be presented in a table and such a table called a **table of data**.

Tables are good for organising data and presenting detailed information. A good table has:

- a **title** describing the subject of the table.
- **labelled columns** and **rows** that show what information is provided in the table.
- **units of measure** identified within the column and row labels.
- the central part of the table is the data field where you put your **data**.

You use tables when you want to present detailed information about a topic, communicate your findings to others or you want your data to be clearly organised into meaningful columns and rows.

Here is an example: Nelly observed five cats, measured their mass and recorded the information in a data table below.

A Cat Data Table

Cat Name	**Colour**	**Mass (grams)**
Cathy	White	8.3
Kitty	Brown	8.1
Misty	Gray	7.8
Tom	Light Brown	6.4
Tim	Black	5.9

Tables and graphs are visual ways to present data. Tables present data as rows and columns of information and graphs present data in a picture form. Both tables and graphs help people to understand what the data says, and to see the patterns resulting from the data.

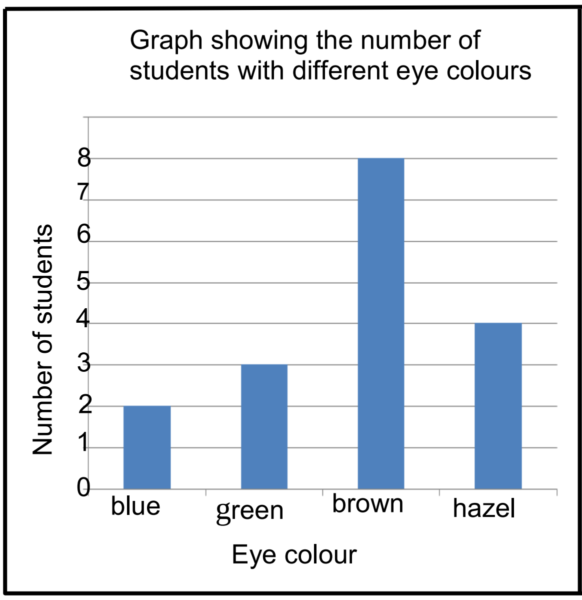
Graphs

It is usually very difficult to recognise patterns or trends in columns of raw numbers. As discussed earlier, data can be displayed in a **graph**, **diagram** or **chart**. Graphs are a way of presenting information as a „picture". There are different types of graphs. The two most common types of graphs are bar graphs and line graphs. Other types of graphs include pie charts and 3 –dimensional graphs. Each type is used to show particular forms of information.

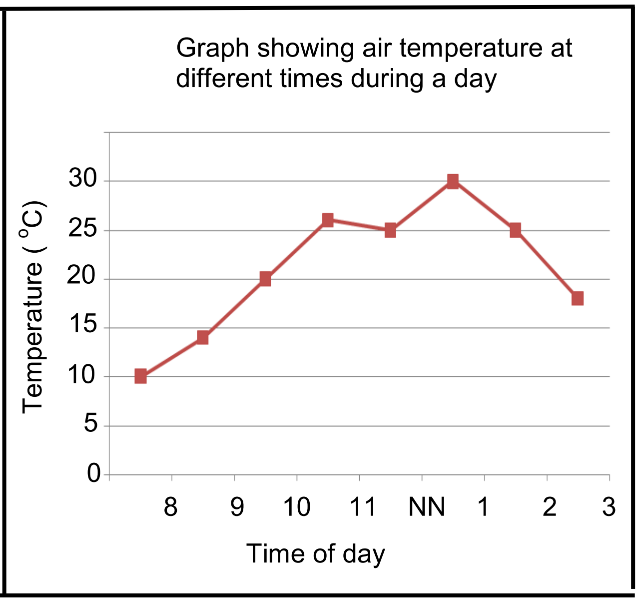
All types of graphs should contain the following information:

1) **Title** describing the subject of the graph.
2) An **X-axis** (horizontal line) and a **Y-axis** (vertical line).The **scale** of each axis must have an **appropriate range of units.** Each scale should be divided into **equal intervals**
3) **Axes labelled** with name of the changing factors and its appropriate units.

An example of a bar graph and a line graph is given below.



A bar graph



A line graph

A **bar graph** or **column graph** is used to compare data that has been counted or measured. The graph above shows how many students in a class have blue eyes, how many have green eyes and so on.

A **line graph** is used to show trends or changes over time. Such a graph shows two quantities that have been measured. The line graph above shows the air temperature (one quantity) at different times during a day. The temperature is plotted on the vertical axis of the graph, while the time is plotted on the horizontal axis.

Notice that the axes begin at zero, and a suitable scale has been chosen so that the graph fits neatly into the available space. The readings are recorded as dots which in this case are joined up by straight lines. Line graphs are probably the most common type of graph used in science.

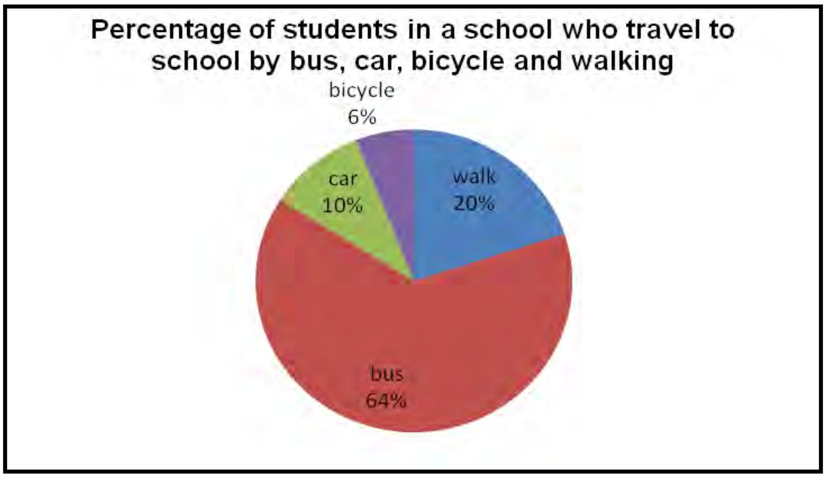
Suppose we want to compare the percentage of students in a school who travel to school by bus, car, bicycle and walk. One way would be to express them as percentages as in this table.

PERCENTAGE BY METHOD

Mode of travel	Percentage
Bicycle	6
Car	10
Bus	64
Walk	20

But it would be much better if it was shown as a diagram. One way of doing this is to represent the whole student population in the school as a circle, and the different methods of travel by sectors. We call this a pie chart. The pie chart on the next page shows this information.

A **pie chart** is used to compare the sizes, percentages or portions of things that make up a whole. Pie charts are circular.



A pie chart

After graphs are constructed, scientists look to see if one part of the data seems to have links to other parts. This is the pattern and from here they can be able to answer questions and make conclusions.

Now let us see if we can make observations and draw conclusions from our observations.

Suppose that 40 students in a class measure their heights, as shown in the table below.

Student	**Height (cm)**	**Student**	**Height (cm)**	**Student**	**Height (cm)**	**Student**	**Height (cm)**
Lois	121	Nigel	139	Grace	137	Doreen	134
David	130	Gabby	131	Irene	141	Luther	138
Bobby	144	Robert	140	Larry	129	Brian	127
Mary	138	Lloyd	123	Agnes	137	Salome	142
Linus	131	Betsy	135	Sheba	145	Sarah	148
Nancy	126	Adele	133	Robbie	131	Lydia	134
Ralph	135	Doris	139	Victor	146	Moses	143
Judith	140	Fiona	129	Ruben	136	Jean	130
Helen	132	Debra	136	Roland	149	Leo	138
Lucy	125	Susan	130	Wilson	125	Dale	127

We handle the data as follows:

We put it in order so that it is easier to use. From our data table, we have arranged the heights in groups and sorted the students into each group.
The table on the next page shows the measurements as a table. The heights are arranged in groups in the left hand column, and the numbers of students falling into each group are on the right.

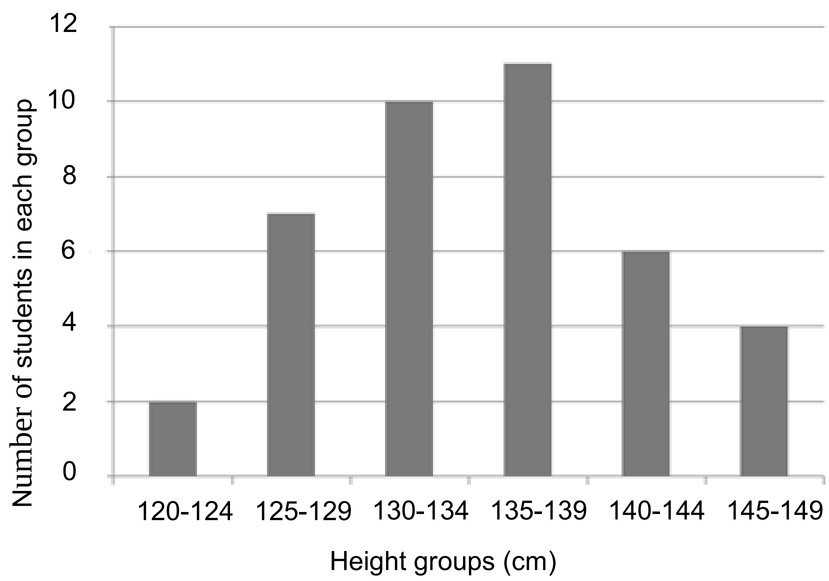
The Number Of Students In Each Group Of Height

Height groups (cm)	**Number of students in each group**
120-124	2
125-129	7
130-134	10
135-139	11
140-144	6
145-149	4

Results of this kind are best shown as a bar graph and that is what we will do.

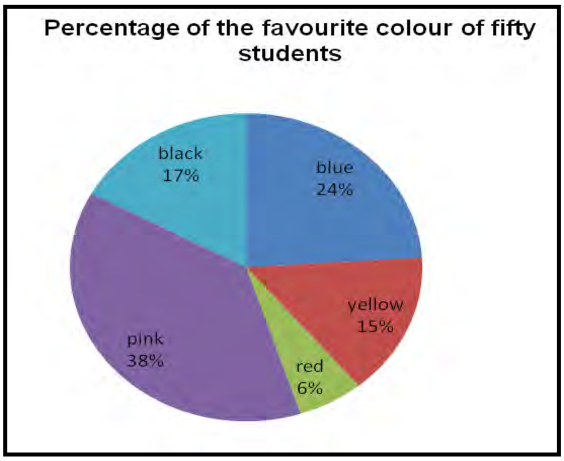
In the diagram below we have displayed in a **bar graph** the number of students in each group of height. Bar graphs are used when comparing data. The height groups are put on the horizontal axis, and the number of students on the vertical axis. The number of students in each height group is shown by the length of the bars.

Bar Group Of The Number Of Students In Each Group Of Height



Activity: **Now test yourself by doing this activity.**

1. Fifty students were asked about their favourite colour and the results were recorded on a pie chart.



a) Which colour is liked by most students?

____

b) Which colour is the least favoured?

____

---

2. Convert the pie chart to a bar graph showing how many students liked each colour?

Summary

You have come to the end of lesson 11. In this lesson you have learnt that:

- data is a collection of facts which can be numbers, words, measurements, observations or even just descriptions of things.
- an observation is most reliable when it can be quantified or measured.
- to make data more useful it needs to be sorted and displayed, for example in a bar graph.

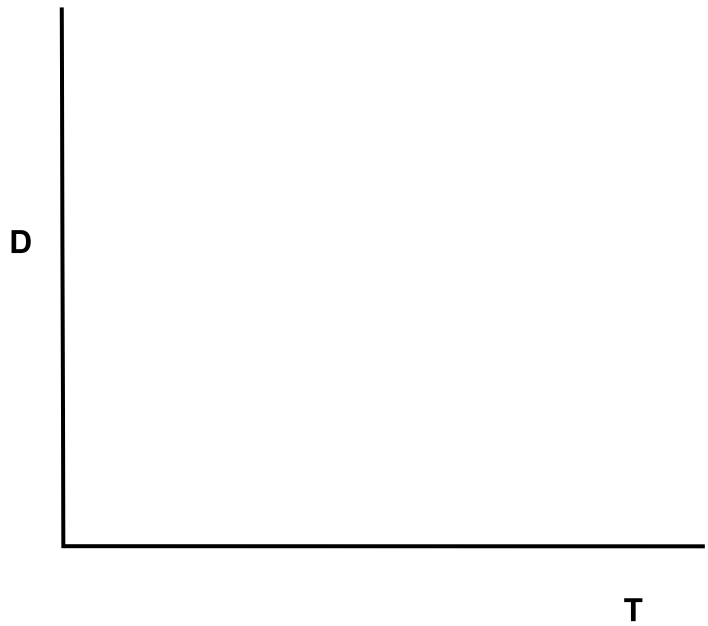
NOW DO PRACTICE EXERCISE 11 ON THE NEXT PAGE.

Practice Exercise 11

1. The following data shows the distance a fish swam away from its home after each hour has passed.

Distance (km)	0	80	160	240	320	400	480
Time (hr)	0	1	2	3	4	5	6

Plot a line graph of this data. Put the distance on the vertical axis and time on the horizontal axis. Use the graph to answer the questions below.



a) What does "km" stand for?

____

b) How far was the fish from its home after three and a half hours?

____

c) At what time was the fish 300 km from home?

____

d) If the fish kept travelling at the same speed, estimate the distance it would be from home after seven hours.

____

2. June and Eva observed the types of 1 kg rice bought by their dad in one week. They saw 12 roots, 8 jasmines, 16 trukais, 7 sunlongs, 10 ezy cooks and 4 kings.

a) Draw a bar graph of this information.

b) What was the most common type of rice eaten in that week?

____

c) What was the least common rice that was eaten?

____

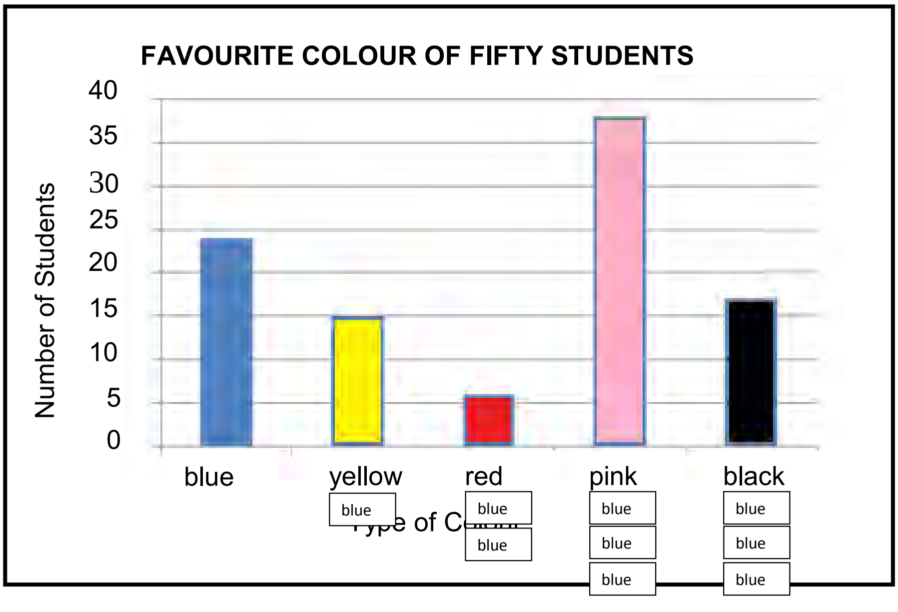
d) How many packets of 1 kg rice were eaten altogether?

____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2

Answers to Activity

1. a) pink
   b) red
2.



Lesson 12: Control, Variable and Hypothesis

Welcome to Lesson 12. Good science investigations begin with a question. This question often asks "what if", "how", or what effect something will have". The question should be one that can lead to an experiment, which will yield data. A question that is well written often identifies the variable and hypothesis which is a possible answer to a question. To find out if it is true or not, this is done by carrying out experiment. An experiment is the foundation of the scientific method, which is a systematic means of exploring the world around you.

Your Aims:

- define control, variables and hypothesis
- differentiate between a control and a variable

Designing Experiments

Scientists plan an experiment to test a hypothesis. You explore or find out about the world around you through experimenting. Experiment can take place in laboratories, but you can perform an experiment anywhere, at any time. One of the most important parts of doing a good, scientifically valuable experiment is to conduct a fair test.

Scientists often investigate things by first thinking of a hypothesis, and then testing it by doing experiments. This procedure is called **scientific method**.

For your experiment to be a fair test, you must change only one factor at a time while keeping all other conditions the same. Scientists call the changing factors in an experiment, **variables.**

Types of variables

Variables are anything that might change or be changed in an experiment. Some variables you will change yourself. Other variables are the ones you are interested in measuring. There are three main types, independent, dependent and control variables.

1. **Independent variable**

   An **independent variable** is something that you change when you do your experiment. To ensure a fair test, a good experiment has only one independent variable. As you change the independent variable you **observe** what happens.

2. **Dependent variable**

   As an effect of your experiment your results should show something changing. This is called the **dependent variable**. In other words, the dependent variable depends on the independent variable. Another way to say this is that the dependent variable responds to what you have changed (independent variable). This is often the main thing you will measure.

A scientist‟s observation is focused on the dependent variable to see how it responds to the change made to the independent variable. The new value of the dependent variable is caused by and depends on the value of the independent variable.

For example, if you open a tap (the independent variable), the quantity of water flowing (dependent variable) changes, and in response you observe that the water flow increases. The number of dependent variables in an experiment varies, but there is often more than one.

3. **Controlled variable**
   Experiments also have controlled variables. **Controlled variables** are quantities that a scientist wants to remain constant, and he must observe them as carefully as the dependent variables. The controlled variables refers to the fact that only one thing should change in an experiment and that you should be in full control over that one thing.

For example, if we want to measure how much water flow increases when we open a tap, it is important to make sure that the water pressure (the controlled variable) is held constant. That is because both the water pressure and the opening of a faucet have an impact on how much water flows. If we change both of them at the same time, we cannot be sure how much of the change in water flow is because of the faucet opening and how much because of the water pressure. In other words, it would not be a fair test.

Most experiments have more than one controlled variable. You will have trouble drawing reliable conclusions from an experiments without good control.

For example, we want to test the hypothesis that light is needed for the leaves of a young plant to become green.

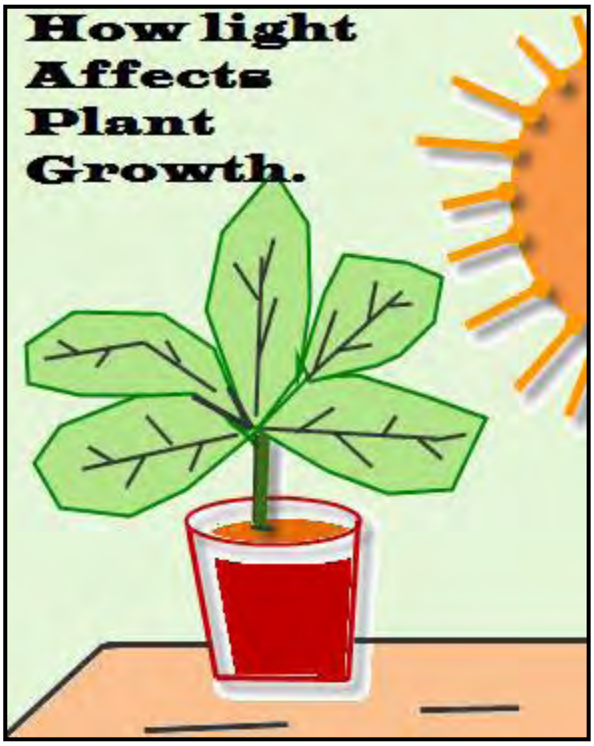
We get a plant and put it in the dark. If the green colour fails to develop, we will conclude that light is needed for it. However, we are not finished. There is something more that we must do: we must get a second plant and put it in the light. We need this second plant in order to provide a standard or something like a mark to compare the first plant. The second plant is called the **control**.

In carrying out this experiment it is essential that the two plants should be kept in exactly the same conditions, except for the light they receive.

An experiment of this kind, in which an experimenter controls the conditions, is called a **controlled experiment**.

A controlled or constant variable is a variable that does not change during an experiment. To put in a general way: we must keep all the variables constant except for the one whose effect we want to investigate.

Let us look at a science fair project and try to identify the variables.



An experiment on how plants grow in response to light

We have learnt that, a "fair test" is one where you only change one thing (**variable**).

A **variable** is part of an experiment that can change such as amount of light, temperature, humidity, time changes, or plant growth.

In an experiment, an **independent variable** is a variable that either changes on its own or you purposely change it.

For example: If the purpose of an experiment is to determine how changes in the amount of light on a plant affect the plant"s growth.

The **Independent Variable** is the amount of light the plant received.

You can change the amount of light by using sunlight which changes during the day as well as from one day to the next or you can also use direct and indirect sunlight.

If you use artificial light you can determine when and for how long the plant will receive this light. You also have the option to control the power rating of light used and its color type (fluorescent, UV, incandescent). Just use the same type of light for each test plant.

Remember you should only change one thing in your experiments. This is called the independent variable.

As a consequent or effect of your experiment your results should show something changing. (How the plant grows might change). This is called a **dependent** variable.

Dependent variable

The purpose of changing an independent variable is to determine how the change affects something else, which is called the **dependent variable.** In other words, changes in the independent variable may **cause** the dependent variable to change.

In an experiment, a dependent variable may change due to the changes made in the independent variable.

In the previous plant experiment, "How Plants Grow in Response to Light," the growth of the plant is the **dependent variable** being observed. The plant growth is in response to changes in the amount of light the plant receives, this is the **independent variable.**

Controlled variables

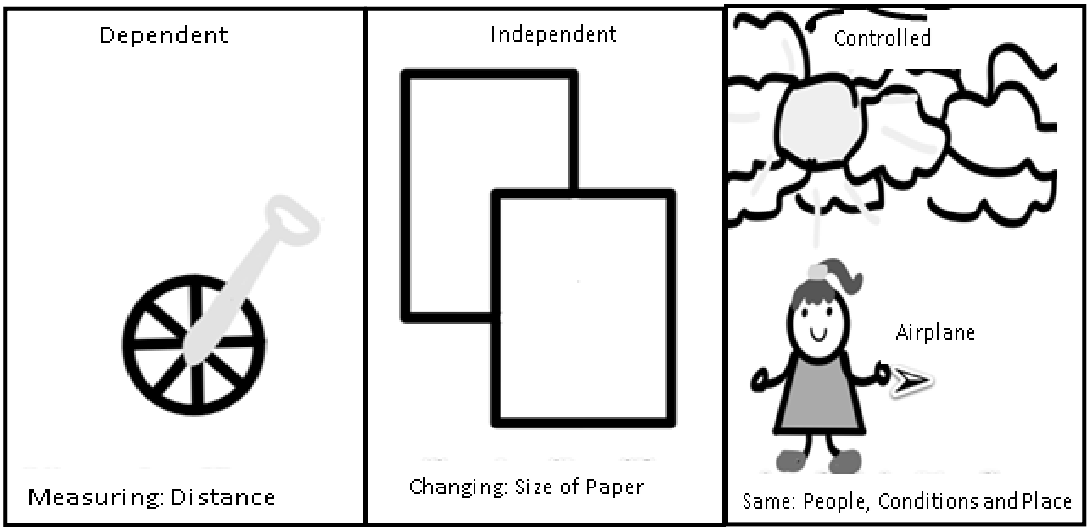
Just remember that variables are things that can change. This means that they can be controlled and prevented from being changed.

It is important when you devise an experiment that you have only two variables that change.

1. The independent variable that you want to change, you can measure how it changes.
2. The dependent variable that you are measuring, you can see how much it changes in response to the independent variable.

Changes in any other variable could affect your results. So, you must try to control any other variable, meaning you want to eliminate them or control them so that the things being tested are not affected.

Variables



For example, in the previous experiment, "How Plants Grow in Response to Light," the variables that must be controlled include, the type of plant tested, container, type of soil, temperature, amount of water, humidity, type of light, and others need to be the same for every plant tested. Some variable are difficult to control, but you should try to make every effort to keep them under the same conditions during the testing.

In the experiment, "How Plants Grow in Response to Light," the

- Independent Variable is the Amount of Light.
- Dependent Variable is the Plant Growth.
- Controlled Variables are the temperature, humidity, container and soil

Activity 12: Now test yourself by doing this activity.

---

1. Identify the control group, independent variable and dependent variable in this experiment.

Tang Mow thinks that a special juice will increase the productivity of workers. He creates two groups of 50 workers each and assigns each group the same task (in this case, they are supposed to staple a set of papers). Group A is given the special juice to drink while they work. Group B is not given the special juice. After an hour, Tang Mow counts how many stacks of papers each group has made. Group A made 1, 743 stacks, Group B made 2,207.

(a) Control Group ____________________
(b) Independent variable ____________________
(c) Dependent variable ____________________

2. Identify the independent variable and dependent variable in this scenario.

A teacher wishes to compare the number of tardy students to school wearing red with the number of tardy students wearing yellow.

(a) Independent variable ____________________
(b) Dependent variable ____________________

Summary

You have come to the end of lesson 12. In this lesson you have learnt that:

- scientists often investigate things by first thinking of a hypothesis, and then testing it by doing experiments. This procedure is called scientific method.
- a hypothesis is a possible answer to a question made from observation.
- one of the most important factors in doing genuine and scientifically valuable or worthy experiment is to conduct a fair test.
- scientists call the changing factors in an experiment the variables. There are three types of variables and they are independent, dependent and controlled.

NOW DO PRACTICE EXERCISE 12 ON THE NEXT PAGE.

Practice Exercise 12

Read the experiment below and answer the questions that follow.

Nigel believes that fish that eat food exposed to microwaves will become smarter and would be able to swim through a maze faster. He decides to perform an experiment by placing fish food in a microwave for 20 seconds. He has the fish swim through a maze and records the time it takes for each one to make it to the end. He feeds the special food to 10 fish and gives regular food to 10 others. After 1 week, he has the fish swim through the maze again and records the time for each.

Here are his results.

Special Food Group
(Time in minutes/seconds)

Fish	Before	After
1	1:06	1:00
2	1:54	1:20
3	2:04	1:57
4	2:15	2:20
5	1:27	1:20
6	1:45	1:40
7	1:00	1:15
8	1:28	1:26
9	1:09	1:00
10	2:00	1:43

Regular Food Group
(Time in minutes/seconds)

Fish	Before	After
1	1:09	1:08
2	1:45	1:30
3	2:00	2:05
4	1:30	1:23
5	1:28	1:24
6	2:09	2:00
7	1:25	1:19
8	1:00	1:15
9	2:04	1:57
10	1:34	1:30

a. What was Nigel‟s hypothesis?

b. Which fish are in the control group?

c. What is the independent variable?

d. What is the dependent variable?

e. Look at the results in the charts. What should Nigel"s conclusion be?

____

____

____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.

Answers to Activities

1. a. Control Group — Group B
   b. Independent variable — The special juice
   c. Dependent variable — Productivity of Workers

2. a. Independent variable — Clothing Colour
   b. Dependent variable — Difference in the number of students, categorized by clothing colour

Lesson 13: Parts of a Science Report

Welcome to Lesson 13. You have learned from the previous lessons that scientists have a way of discovering and finding answers to questions about things around us through experiments using the scientific method. They have a way of presenting these data gathered from the experiments called **practical** or **scientific report.** A science report is written in a clear way that allows other people to understand how the experiment was conducted and the result of the said experiment.

Your Aims:

- list the parts of writing a report
- read a sample of a science report
- describe the different parts of a science report

What is a Scientific Report and its Characteristics?

A **scientific report** is an important document for those who need to use it to understand what a scientist or a science student has investigated. Its success depends on careful planning and writing to meet every possible requirement of the report.

The aim should be to cut down the reader‟s attention, to save all possible confusion, and to enable him to get the help he needs quickly and easily. It is essential, therefore, that a scientific report has certain characteristics: It should:

- have the general aim or objective which can be readily grasped.
- present all materials which are relevant.
- reach and state, valid conclusion based on the data.
- be written in a style that is simple, brief, and free from the possibility of misinterpretation.
- be readily understood by all persons concerned even though they may not be well versed in the technical details.

An example of a science report is shown below.

Experiment to investigate the black ink used in pens.

What colours are in black ink?

Aim: To find out if different brands of black inks are made up of the same colour or different colours.

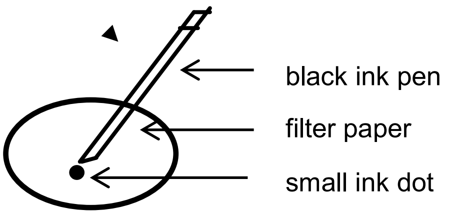
Hypothesis: If different black inks are tested, they will all be made up of the same black colour.

Materials:

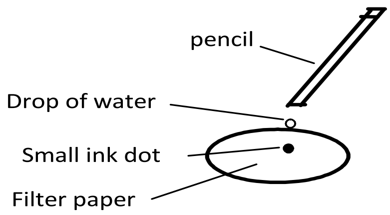
- Sheets of filter paper
- Different brands of water-soluble ink pens
- Pencil
- Water

Method:

1. Draw a small dot of ink in the centre of a sheet of filter paper with an ink pen.



2. Dip a pencil in water, then add drops of water onto the ink dot one at a time to allow the ink to spread.



3. Repeat steps 1 and 2 for all the black pens.

Results:

Brand	Colours
Ink	Black, green, blue, pink
Flower	Black, purple, green, yellow
Writeze	Black, blue, green
Nibit	Black, blue, yellow

Discussion:
I was surprised to find that all the black inks I tried were made up of other colours as well. I thought that black ink was just black. Sometimes it was difficult to describe the exact shade of colour that I could see on the filter paper. I wonder whether any black inks are made up of only one colour. What are other ink colours made up of? What would happen if I used permanent ink that is not water soluble! Could I use something else to spread the inks instead of water?

Conclusion:
Black inks seem to be made up of different colours and different brands of ink are made up of different combination of colours.

Parts of a science report and their importance.

1. **Title**
This is the face of a report. Properly designed, it does not only allow the reader to grab the main topic of the experiment or project quickly, but also gives the report a professional look. It should show what is being investigated.

2. **Aims**
Is a summary of the main concept that you will learn in carrying out the experiment. State the objectives of the laboratory experiment, summarise the work and findings and explain the significance of the finding. The purpose is to give the reader an overall idea about the report before reading the details.

3. **Hypothesis**
It is stated as possible, answer to the problem. It introduces to the readers the issues or problems to be addressed. It discusses the current status of the problem and possible answer to the problem being investigated.

4. **Materials**
These are equipment or chemicals used in the experiment which need to be listed in specific amounts and sizes. (Example- three five – gram weights).This allows other people to replicate which means to repeat, the experiment exactly to see if they get the same results. This process is called verification.

5. **Procedures/Experimental Methods**
This is an outline of what was done during the experiment. Diagrams may be used to show how the experiment was set up and step–by step instructions for performing the experiment may be listed. The procedural section describes the equipment and apparatus used for the laboratory and the procedures followed. The descriptions should be in detail that a person with similar interest, can replicate the results. In a classroom environment, the procedures are generally given or described to the students by the instructor. In a research environment, developing a proper procedure may be part of the research and must be documented very carefully.

6. **Results/Data**
Careful observations are made and recorded as results that can be presented in the form of graphs or table. This section presents the data and results obtained from the experiment. The results can be summarised in table forms, plotted in to graphs or described in narrative forms. When tables and figures are used, they should be numbered, have figure captions and referenced in the text. A common problem with laboratory report is that students produce numerous tables and graphs in the report without mentioning them in the text.

7. **Discussion**
The discussion outlines what the results of the experiment show and should explain to the reader the significance of the results.

8. **Conclusion**
Is a brief summary of what was done. This should be clear and short and should relate to the aim. This section discusses the results and compares them with the theoretical predictions or expectations. Analyses should be conducted and conclusion drawn. Problems encountered in the experiment should be reported and inconsistencies should be explained. For long report, it may be appropriate to separate Discussion and Conclusion into two sections.

Summary

You have come to the end of lesson 13. In this lesson you have learnt that:

- scientists write up experimental reports so that information is organised in a clear way.
- a good experimental report usually has the following parts: A title, an aim, a hypothesis, a list of materials used, an outline of the method used, the results of the experiments, a discussion of the results and a conclusion.

NOW DO PRACTICE EXERCISE 12 ON THE NEXT PAGE.

Practice Exercise 13

A. Circle the correct answer.

1. The possible answer to the problem investigated which can be written as a brief statement is a/an __________.

A. aim B. data
C. hypothesis D. conclusion

---

2. The purpose of the experiment or why you did the experiment is called the __________.

A. aim B. data
C. title D. hypothesis

---

3. This outlines what the results of the experiment shows __________.

A. results B. conclusion
C. discussion D. hypothesis

---

4. These section records the data that were collected.

A. Aim B. Title
C. Methods D. Results

---

5. This is an outline of what was done during the experiment.

A. Results B. Methods
C. Materials D. Conclusion

---

6. An answer to the problem being investigated can be stated in the __________.

A. aim B. title
C. hypothesis D. conclusion

B. Answer the following:

7. In which part of an experimental or science report would you find information on

   a. What was observed? ______________________

   b. What was done? ______________________

   c. What question was asked? ______________________

   d. What was found out? ______________________

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.

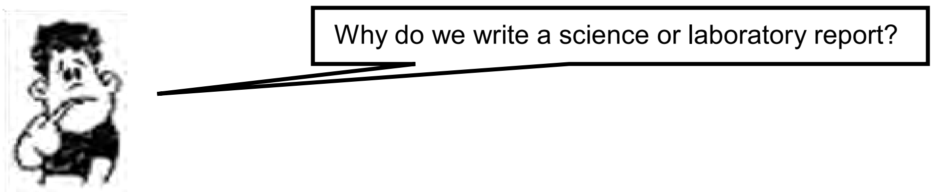
Lesson 14: Writing a Science Report

Welcome to Lesson 14. In our previous lesson, we have discussed the parts of a science report. We have learned that a well organised report uses the following headings, title, aim, hypothesis, materials, method, results, discussion and conclusion. In this lesson, we will discuss and learn the general guide to writing reports about scientific research you have performed. In addition to describing the conventional rules about the format and content of a laboratory report, we will also attempt to convey why these rules exist, so you will get a clearer, more helpful idea of how to write the report.

Your Aims:

- plan and perform an experiment from a given topic.
- write up the experiment in the correct scientific format
- draw conclusions on the aim of the experiment

Writing a Report



You did an experiment or study for your science class, and now you have to write it up for your teacher to review. You feel that you understood the background sufficiently, designed and completed the study effectively, obtained useful data, and can use those data to draw conclusions about a scientific process or principle. But how exactly do you write all that? What is your teacher expecting to see in your report?

To help you to answer these questions, try to think beyond the classroom setting. In fact, you and your teacher are both part of a scientific community, and the people who participate in this community tend to share the same values. As long as you understand and respect these values, your writing will likely meet the expectations of your readers including your teacher.

So why are you writing this science report? The practical answer is “Because the teacher assigned it,” but that is classroom thinking. Generally speaking, people investigating some scientific hypothesis have a responsibility to the rest of the scientific world to report their findings, particularly if these findings add to or contradict previous ideas. Interestingly, people reading such reports have two primary goals:

1. They want to gather the information presented.
2. They want to know that the findings are legitimate.

Your job as a writer, then, is to fulfil these two goals.

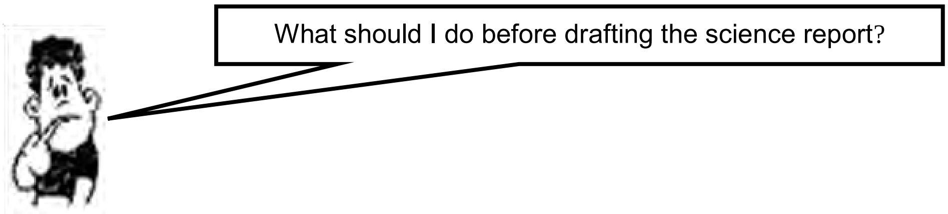
How do you do that?

Good question. You are probably now familiar with the basic format scientists have designed for science reports as you have learned in the previous lesson.

How to write science report?

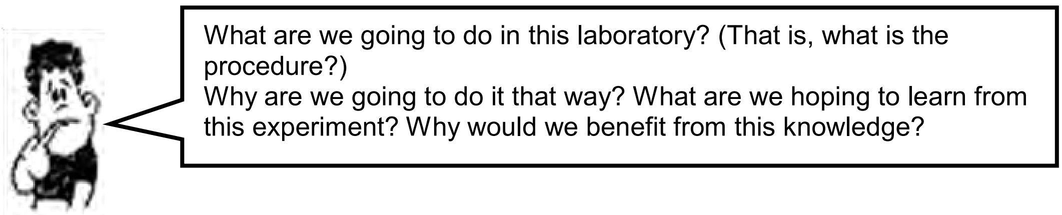
The ability to report technical information in a clear and concise manner is one of the most important practical skills that a research trained person can develop. This is true because, the results and conclusions drawn from experimental methods are of little value unless they can be communicated to others in a meaningful way.

Writing laboratory reports that describe experimental methods, results, discussions, and conclusions that can be drawn from those results is an excellent way to gain the practice and experience needed to become an effective technical writer. It is only by writing and being corrected that one can learn to write. A beginner will find it helpful to follow a certain format for his or her reports. This will help ensure that the report is complete and well written.



The best way to prepare to write the laboratory report is to make sure that you fully understand everything you need to know about the experiment. Obviously, if you do not quite know what went on during the laboratory, you‟re going to find it difficult to explain the laboratory satisfactorily to someone else. To make sure you know enough to write the report, complete the following steps:

1. **Read your laboratory manual thoroughly,** well before you start to carry out the experiment. Ask yourself the following questions:



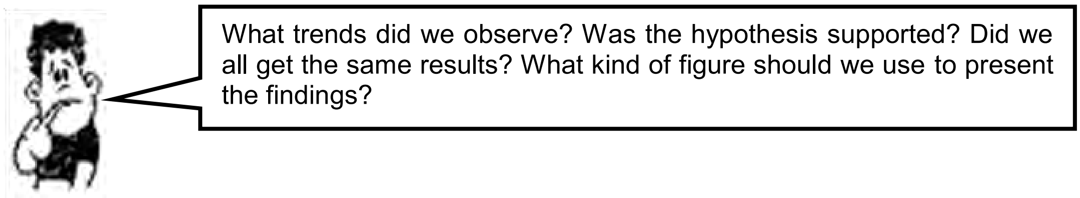
Answering these questions will lead you to a more complete understanding of the experiment, and this “big picture” will in turn help you write a successful science report.

2. **Make use of your laboratory supervisor** as you perform the experiment. If you do not know how to answer one of the questions above for example, your laboratory supervisor will explain it to you (or, at least, help you out).

3. **Plan the steps of the experiment carefully** with your laboratory partners. The less running around you do, the more likely that you will perform the experiment correctly and record your findings accurately. Also take some time to think about the best way to organise the data before you have to start putting numbers down. If you can design a table to account for the data that will tend to work much better than jotting down results hurriedly on a scrap piece of paper.

4. **Record the data carefully** so you get them right. You will not to trust your conclusions if you have the wrong data, and your readers will know you messed it up if the other three people in your group have for example recorded 97 degrees and you recorded 87 degrees.

5. **Consult with your laboratory partners** about everything you do. Laboratory groups often make one or two mistakes. Two people do all the work while two have a nice chat, or everybody works together until the group finishes gathering the raw data. Collaborate with your partners, even when the experiment is over. The whole group can work together to answer the following questions.



6. **Consider your audience.** You may believe that audience is non-issue; it is your laboratory teacher, right? Well, yes – but again, think beyond the classroom. If you write with only your laboratory instructor in mind, you may omit material that is crucial to a complete understanding of your experiment, because you assume the instructor knows all the stuff already. As a result, you may receive a lower grade, since your teacher will not know much about your experiment particularly. Alternatively, you could envision yourself five years from now after the reading and lectures for this course have faded a bit. What would you remember, and what would you need to explain clearly (as a refresher)?

Once you have completed these steps as you perform the experiment, you will be in a good position to draft an effective science report.

Writing science reports that describe experimental methods, results, discussions, and conclusions that can be drawn from those results is an excellent way to gain the practice and experience needed to become an effective research writer. It is only by writing and being corrected that one can learn to write. A beginner will find it helpful to follow a certain format for his or her reports. This will help ensure that the report is complete and well organised.

Written science reports should consist of the following parts:

1. **Title**

   The title must be long enough to specifically indicate what the report is about and to generate interest for the reader. In addition, titles that are too short are not acceptable.

2. **Aim/Objective**
   The inclusion of the aim (sometimes called the objective) of the experiment often confuses writers. The biggest misconception is that the aim is the same as the hypothesis. Not quite, but basically they provide some indication of what you expect the experiment to show. The aim is broader, and deals more with what you expect to gain through the experiment. In a solubility experiment, for example, your hypothesis might talk about the relationship between temperature and the rate of solubility, but the aim is probably to learn more about some specific scientific principle underlying the process of solubility. The aim should explain the significance of the findings and to give the reader an overall idea before reading the details.

3. **Hypothesis**
   For starters, most people say that you should write out your working hypothesis before you perform the experiment or study. Many beginning science students neglect to do so and find themselves struggling to remember precisely which variables were involved in the process or in what way the researchers felt that they were related.

   Write your hypothesis down as you develop it, you will be glad you did. As for the form a hypothesis should take, it is best not to be too fancy or complicated; an inventive style is not nearly as important as clarity here. Be as specific as you can about the relationship between the different objects of your study.

   Not a hypothesis: "It was hypothesised that there is a significant relationship between the temperature of a solvent and the rate at which a solute dissolves."

   Hypothesis: "It was hypothesised that as the temperature of a solvent increases, the rate at which a solute will dissolve in that solvent increases."
   In a more technical sense, most hypotheses contain both an independent and a dependent variable. The independent variable is what you manipulate to test the reaction; the dependent variable is what changes as a result of your manipulation. In the example above, the independent variable is the temperature of the solvent, and the dependent variable is the rate of solubility. Be sure that your hypothesis includes both variables.

4. **Materials and Measures**
   This section describes all non-human materials or organisms used in your study. This is a broad category and includes any substances, instruments, or apparatus used in the experiment. The presentation of this section should be chronological. Depending on the complexity of the tools you use to measure the results of your study, you may also need to include a special subsection on "Measures." This is especially true if your study hinges on the quality of specific measures used. If your study focuses on plants or animals, you would probably describe them in the materials section; however your instructor may wish to see any live materials set apart in a sample section.

5. **Methods**
   The methods section should describe what materials you used and what you did with them (Lobban, 1992). You should include the type of equipment, technology, and amounts of different compounds used, and so on. Although you should not describe every detail of your process, you need to explain how you set up the study in enough detail for a reader to repeat or replicate it. You

should also include any details that will affect the outcome of the study. Include a description of any anomalies that you found in the study. Be exact and specific in your descriptions.

For example, if the study took place in an environment at room temperature, do not simply write, “the experiment was undertaken at room temperature.” Instead, note the exact temperature of the room you or your laboratory partner(s) made during the study. Keep in mind that this section is very important. In order for your work to be of scientific merit, you must provide enough information for your reader to be able to reproduce your methods and repeat your study. Never use ambiguous words like “maybe” or “often” or “sometimes.” Be explicit and accurate. Try to quantify the information that you present as much as possible. This ensures that the reader will be able to replicate the experiment. Usually the method section is written in past tense.

Here is a paradox for you. The next section of your report which is the **RESULT** is often both the **shortest** and **most important part** of your report. **Materials** and **methods** section show how you obtained the results, and your **discussion** section explores the significance of the results, so clearly the results section forms the backbone of the science report.

6. **Results/Data**

This section provides the most critical information about your experiment: **the data** that allow you to discuss how your hypothesis was or was not supported. But it does not provide anything else, which explains why this section is generally shorter than the others. Before you write this section, look at all the data you collected to figure out what relates significantly to your hypothesis. You will want to highlight this material in your results section. Resist the urge to include every bit of data you collected, since perhaps not all are relevant. Also, do not try to draw conclusions about the results, save them for the discussion section.

In this section, you are reporting facts. Nothing your readers can dispute should appear in the Results section**.** The results can be summarised in the table forms, plotted in to graphs or described in narrative forms. When tables and figures are used, they should be numbered, have figure captions and be referenced to the text. These formats allow the reader to clearly understand the relationships between different kinds of data. You should use proper units of measurement and be clear and concise to avoid misinterpretation. Include all of your calculations and formulas. Make sure your calculations are organised and sequential, use proper units, that are clearly labelled. Define new symbols and other pertinent information.

7. **Discussion**

It is important that what is found out is clearly communicated with others so that knowledge is shared. For this reason, it is important to write a scientific report so that information is organised in a clear way

Practice report writing

You can plan and carry out an experiment yourself and then write a report on it. You can also carry out and write a report on an experiment that was planned by someone else. In the book "Science World" by Peter Stannard and Ken Williamson, an investigation or experiment was planned and students were asked to write a report on it. Read how the experiment was planned and carried out. Find a piece of paper and write a full report of the experiment using the headings from the previous lesson. Then compare your report with the one written on the next page, but do not look at it until you have written your own.

In this case the **title** and **aim** have been written for you, but when you design your own experiment you will need to write an aim.
Sometimes a **hypothesis** may also be stated. In this case we do not have one.
Under the **method** you should write, in your own words, what was done. Include diagrams to help your description.
Under **results** record your observations of what happened during the investigation.
In the **discussion** try to explain your results and list any improvements you would make to the method.

In the **conclusion,** write down an answer to the question in the aim.

Please! Do not cheat. You can look at the report below after you have written your own. In this way, you will help yourself to write your own reports.

Experiment 3: Making Milk Glue

Aim

Can glue be made from milk?

Materials

- about 100mL of skim milk
- about 25 mL of white vinegar
- baking soda (about 5g)
- two 250mL beakers
- spatula
- stirring rod
- filter funnel and paper
- stand and clamp (or filter stand)
- bunsen burner
- tripod, gauze mat and heatproof mat
- matches

Planning And Safety Check

- Carefully read through the method and list safety precautions you will have to take.
- Discuss this with your teacher before you start.
- Why should you wear safety glasses during this investigation.

Method

1. About one-third fill a 250mL beaker with skim milk
2. Add 25mL of vinegar to the milk.
3. Set up a tripod, gauze mat, Bunsen burner and heatproof mat.
4. Heat the mixture slowly, stirring all the time with the stirring rod. When you see small white clumps (called curds) forming, turn off the burner. The curds will fall to the bottom of the beaker. You have made cottage cheese!
5. While the mixture settles and cools, set up the filtering apparatus.
6. Decant the clear liquid (called the whey) into another beaker, and try not to lose any of the curds. Pour the liquid down the sink.
7. Fold the piece of filter paper and put it in the funnel.
8. Pour the curds into the filter paper. When all the liquid has filtered through, gently scrape the curds into a beaker.
9. Add 20mL water and one spatula of baking soda to the curds.
10. Stir to make a paste. This is the milk glue.
11. Test your glue by sticking paper or ice-cream sticks together

Record your observations when the glue dries.

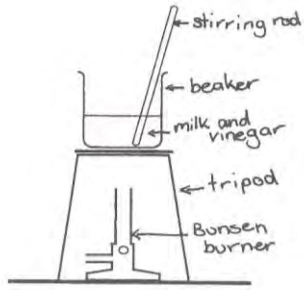
Your report should look like this. Compare your report with this report and see how your report is similar to this one and how it is different.

Investigation 2 — Making Milk Glue — 8 March

Aim:
To find out if glue can be made from milk.

Materials:
100 mL skim milk, 25 mL white vinegar, 5g baking soda, spatula, stirring rod, filter funnel and paper, stand and clamp, Bunsen burner, tripod, gauze mat, heatproof mat and matches.

Method:
1. About 100 mL of milk was added to a 250 mL beaker, then about 25 mL of vinegar was added.
2. The mixture was heated slowly with a burner while stirring.
3. When white curds were noticed, the burner was turned off.
4. The mixture was set aside to cool, while the filtering apparatus was set up.
5. The liquid was decanted from the mixture, and the curds were filtered.
6. The curds were scraped into a beaker.
7. About 20 mL of water and a spatula of baking soda were added to the curds.
8. The mixture was stirred to make a paste.



Results:
The glue paste was tested with paper and with wooden ice-cream sticks. We found that the glue stuck paper together really well. But the wooden ice-cream sticks came apart with a little force.

Discussion:
We think milk glue works really well with paper. However, we found out on the internet that the curds are actually made from casein which is a protein in milk. This casein glue was used by the Egyptians as a wood glue.
We don't know why our glue didn't work well on wood. But we think we should have dried the curds better before we added the baking soda.

Conclusion:
A glue can be made from milk.

Was your report nearly the same as this report? Write it again if it was not. You have written a scientific report and you can now practice writing your own reports.

Summary

You have come to the end of lesson 14. In this lesson you have learnt that:

- a scientist designs and carries out an experiment to solve a problem or to answer a question.
- as well as planning investigations or experiments carefully, scientists also plan how they are going to record their observations and write how they conducted their experiments. They do this in a report.

NOW DO PRACTICE EXERCISE 14 ON THE NEXT PAGE

Practice Exercise 14

1. Read the notes of a student‟s experiment below taken from “Science Moves” by Anne Garton (1996). Write down the student‟s aim, apparatus, method, results, discussion and conclusion.

- My glass bottle of soft drink explodes when I put it in the freezer with the top on. Why does this happen? Why doesn‟t it happen when I put the bottle in the fridge?
- Water expands when it is frozen and this causes the bottle to break.
- If I place two bottles in the freezer, one with a lid and one without, the bottle with the lid will break because the water will expand as it freezes.
- Take two glass of soft drink bottles. Fill both bottles with water. Leave the lid off one bottle and put the lid on the other bottle. Put both bottles in the freezer.
- The following things will make a difference to this experiment:
  - the amount of water in the bottle
  - the time in the freezer
  - the temperature of the freezer
  - the type of water
  - the size of the bottle
- I left the lid off one bottle to compare it with the bottle with the lid on.
- The bottle with the lid on did explode. The ice in the bottle without the lid had pushed out the top of the bottle. My hypothesis was supported.
- I could investigate whether all liquids behave in this way.
- Danger: Do not try this yourself. It could be dangerous.

Aim:

Apparatus:

Method:

Results:

Discussion:

____

Conclusion:

2. State what a standard scientific report must contain.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.

Answers to Practice Exercise 8 - 14

Practice Exercise 8

A. 1. laboratory
2. safety
3. bunsen
4. glasses
5. disposal

B.

B	E	A	K	E	R	I	W	S	F
U	O	I	C	L	A	M	P	A	U
N	A	M	E	A	J	A	O	F	N
S	G	N	O	T	E	T	D	E	N
E	F	G	A	U	Z	E	I	I	E
N	L	A	U	B	R	U	S	H	L
W	A	S	H	E	A	T	T	E	A
O	S	C	O	N	I	C	A	L	B
R	K	R	E	T	A	W	N	U	B
B	U	R	N	E	R	A	D	R	E

C. Girl

Practice Exercise 9

1) Anita should not have used her bare hand to pick up the substance from the jar. She should have used a forcep or spatula to pick up the substance.

2) She should never look down the barrel of the tube directly. The tube should be directed away from her face.

3) Charles should have left to talk to his friends especially when using flames. He must always supervise the experiment.

4) Frances should never put her nose directly over the bottle to smell the content. She should gently fan a little vapour towards her.

5) James put the glass ware at the end of the bench and can easily fall if knocked over. He should have placed it in the centre.
6) Noah put his hand over the test tube. Noah should have shaken it gently without using his hands to block the end of the test tube. Some chemicals are corrosive.
7) He used his bare hands to pick up hot objects. Never use your bare hands to pick up hot objects.
8) Robert should never put solid waste and liquid into the sink. The solid waste might block the sewerage pipes.

Practice Exercise 10

1. a) Between 190 and 200

   b) Because the increase is by 50 each time

2.

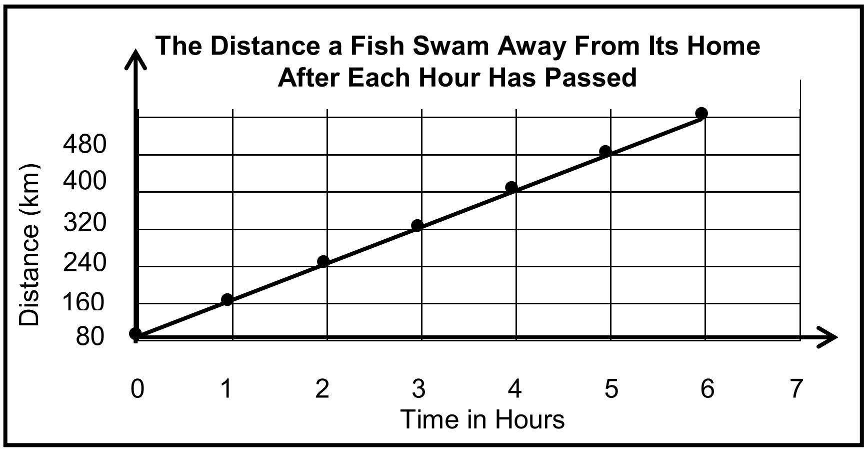
Age	Average height		Average mass	
	Boys	Girls	Boys	Girls
11	144	145	35	36
12	150	152	38	40
13	156	158	42	45
14	163	160	49	49

3. a) About five years old
   b) He will be 110 cm tall if he is 8 years old
   c) He will be 180 cm tall when he is 20 years old

4. The left hand of the see- saw is lower than the right hand -observation .
   If John gets off Mary‟s end will fall-prediction.
   John is heavier than Mary– inference.

Practice Exercise 11

1.



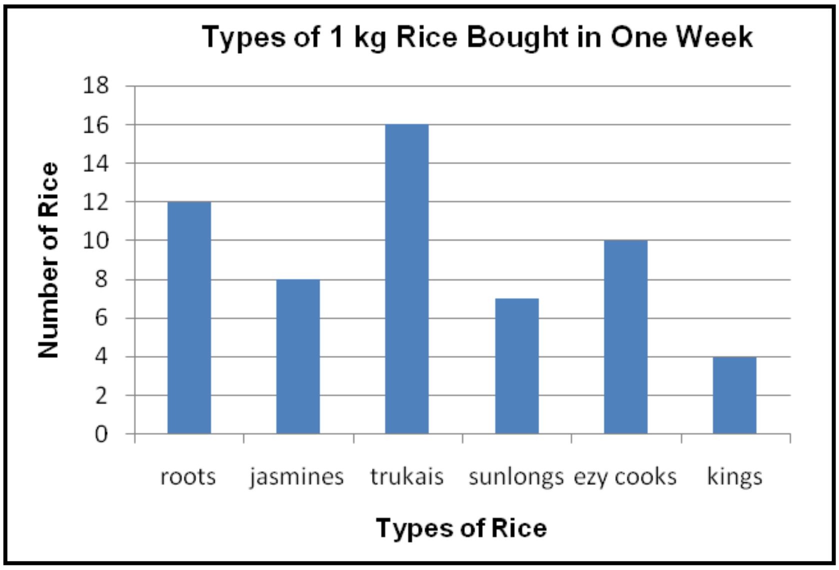
a) Kilometres

b) 280 kilometres

c) At 3 hours 45 minutes

d) 560 kilometres

2. a)



b) Trukai rice

c) King rice

d) 57 packets

Practice Exercise 12

a) He hypothesised that feeding fish microwaved food would make them become smarter.

b) The fish that eats regular food.

c) Microwaved food

d) Time required to complete the maze or how fast it travels through a maze.

e) According to the data, all but two fish in each group decreased their time through the maze. The special food does not appear to be a big factor in helping fish become smarter.

Practice Exercise 13

1. C. conclusion

2. A. aim

3. C. discussion

4. D. results

5. B. methods

6. D. conclusion

7. a. Results

   b. Methods

   c. Aim

   d. Conclusion

Practice Exercise 14

1.

Aim:	To find out why a glass bottle of soft drink explodes when it is put in the freezer with the top on.
Apparatus:	Two glass soft drink bottles, one with a lid and one without, water, freezer
Method:	I took two glass soft drink bottles and filled them with water. I left the lid off one bottle and put the lid on the other bottle and placed both bottles in the freezer.
Results:	The bottle with the lid on exploded. The ice in the bottle without the lid pushed itself out the top of the bottle.
Discussion:	When the two glass bottles were placed in the freezer, the water in them froze. The freezing caused the water to expand. When the water expanded the glass bottle with the lid on cannot contain it any more so this caused the bottle to break. The water in the glass bottle without the lid also expanded. This expansion did not cause the bottle to break because there was no lid, but instead the water pushed itself out the top of the bottle. Maybe next time if I want to put water in the freezer I will fill it only halfway so that when the water expands it will fill the remaining space and I will also put it in the freezer without the lid.
Conclusion:	Water expands when it is frozen.

2. A standard report must have a title, an aim, hypothesis, list of apparatus, methods, results, discussion and conclusion.

NOW YOU MUST COMPLETE ASSIGNMENT 1. RETURN IT TO YOUR PROVINCIAL COORDINATOR.

GLOSSARY

Apparatus	is the name given to equipment that has been put together, usually for a particular purpose or experiment.
Arbitrary unit	means that you cannot adjust your equipment and therefore you cannot tell us how your data compares to other data.
Controlled variables	are quantities that a scientist wants them to remain constant, and he must observe them as carefully as the dependent variables.
Data	are pieces of information you collect during an investigation.
Density	is defined in a qualitative manner as the measure of the relative "heaviness" of objects with a constant volume.
Dependent variable	is the result of your experiment, your results should show something changing.
Equipment	is the name given to all the things used in laboratory such as test tubes, beakers, dry cells and wires.
First aid	is the initial provision for an illness or injury.
Hypothesis	is your general statement of how you think the scientific idea in question works.
Inference	is an explanation of an event.
Instruments	are pieces of equipment that are used to make measurements.
Independent variable	is something that you change when you do your experiment.
Laboratory	(la-BOR-a tory) is a specially designed room where you can carry out experiments.
Length	is the distance from end to end. It also means the longer distance across.
Mass	is the amount of material in an object.
Measurement	is a collection of quantitative data.
Miles	are long distances and are mostly used to measure the distance between places which are far away from each other.

Observation is the act of seeing an object or an event and noting the physical characteristics or points in the event.

Parallax error is the inaccuracy of measurement which is caused by reading a scale from an incorrect position.

Precision is the smallest unit to which measurement is possible with a particular tool.

Prediction is a statement about the way things will happen in the future, often but not always based on experience or knowledge.

Scientific report is an important document for those who need to use it and a recap of what a scientist or a science student has investigated.

Time is the ongoing string of events taking place in the past, present and future.

Unit is any measurement that 1 of a physical quantity.

Volume is the amount of space taken up by a substance. It does not always have to be a container.

Weight is the gravitational force that is acting upon an object.

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FODE PROVINCIAL CENTRES CONTACTS

PC NO.	FODE PROVINCIAL CENTRE	ADDRESS	PHONE/FAX	CUG PHONE (COORDINATOR)	CUG PHONE (SENIOR CLERK)
1	ALOTAU	P. O. Box 822, Alotau	6411343/6419195	72228130	72229051
2	BUKA	P. O. Box 154, Buka	9739838	72228108	72229073
3	CENTRAL	C/- FODE HQ	3419228	72228110	72229050
4	DARU	P. O. Box 68, Daru	6459033	72228146	72229047
5	GOROKA	P. O. Box 990, Goroka	5322085/5322321	72228116	72229054
6	HELA	P. O. Box 63, Tari	73197115	72228141	72229083
7	JIWAKA	c/- FODE Hagen		72228143	72229085
8	KAVIENG	P. O. Box 284, Kavieng	9842183	72228136	72229069
9	KEREMA	P. O. Box 86, Kerema	6481303	72228124	72229049
10	KIMBE	P. O. Box 328, Kimbe	9835110	72228150	72229065
11	KUNDIAWA	P. O. Box 95, Kundiawa	5351612	72228144	72229056
12	LAE	P. O. Box 4969, Lae	4725508/4721162	72228132	72229064
13	MADANG	P. O. Box 2071, Madang	4222418	72228126	72229063
14	MANUS	P. O. Box 41, Lorengau	9709251	72228128	72229080
15	MENDI	P. O. Box 237, Mendi	5491264/72895095	72228142	72229053
16	MT HAGEN	P. O. Box 418, Mt. Hagen	5421194/5423332	72228148	72229057
17	NCD	C/- FODE HQ	3230299 ext 26	72228134	72229081
18	POPONDETTA	P. O. Box 71, Popondetta	6297160/6297678	72228138	72229052
19	RABAUL	P. O. Box 83, Kokopo	9400314	72228118	72229067
20	VANIMO	P. O. Box 38, Vanimo	4571175/4571438	72228140	72229060
21	WABAG	P. O. Box 259, Wabag	5471114	72228120	72229082
22	WEWAK	P. O. Box 583, Wewak	4562231/4561114	72228122	72229062

FODE SUBJECTS AND COURSE PROGRAMMES

GRADE LEVELS	SUBJECTS/COURSES
Grades 7 and 8	1. English
	2. Mathematics
	3. Personal Development
	4. Social Science
	5. Science
	6. Making a Living
Grades 9 and 10	1. English
	2. Mathematics
	3. Personal Development
	4. Science
	5. Social Science
	6. Business Studies
	7. Design and Technology- Computing
Grades 11 and 12	1. English – Applied English/Language& Literature
	2. Mathematics - Mathematics A / Mathematics B
	3. Science – Biology/Chemistry/Physics
	4. Social Science – History/Geography/Economics
	5. Personal Development
	6. Business Studies
	7. Information & Communication Technology

REMEMBER:

- For Grades 7 and 8, you are required to do all six (6) subjects.
- For Grades 9 and 10, you must complete five (5) subjects and one (1) optional to be certified. Business Studies and Design & Technology – Computing are optional.
- For Grades 11 and 12, you are required to complete seven (7) out of thirteen (13) subjects to be certified.

Your Provincial Coordinator or Supervisor will give you more information regarding each subject and course.

Notes: You must seek advice from your Provincial Coordinator regarding the recommended courses in each stream. Options should be discussed carefully before choosing the stream when enrolling into Grade 11. FODE will certify for the successful completion of seven subjects in Grade 12.

GRADES 11 & 12 COURSE PROGRAMMES			
No	**Science**	**Humanities**	**Business**
1	Applied English	Language & Literature	Language & Literature/Applied English
2	Mathematics A/B	Mathematics A/B	Mathematics A/B
3	Personal Development	Personal Development	Personal Development
4	Biology	Biology/Physics/Chemistry	Biology/Physics/Chemistry
5	Chemistry/ Physics	Geography	Economics/Geography/History
6	Geography/History/Economics	History / Economics	Business Studies
7	ICT	ICT	ICT

CERTIFICATE IN MATRICULATION STUDIES		
No	**Compulsory Courses**	**Optional Courses**
1	English 1	**Science Stream:** Biology, Chemistry and Physics
2	English 2	**Social Science Stream:** Geography, Intro to Economics and Asia and the Modern World
3	Mathematics 1	
4	Mathematics 2	
5	History of Science & Technology	

REMEMBER:

You must successfully complete 8 courses: 5 compulsory and 3 optional.