Physics: SS1 First Term

WEEK 3: Dimensions and Measurement of Physical Quantities

Measurement of Length/Distance

Length is measured using the following instruments.

(a) **Metre Rule:** A metre rule is a measuring device calibrated in centimetres (cm) with a range of 0 – 100cm. In using the metre rule, the eye must be fixed vertically on the calibration to avoid parallax errors. The smallest reading that can be obtained on a metre rule is 0.1cm (0.01cm).

(b) **Callipers:** These are used in conjunction with metre rule for measuring diameter of tubes, thickness of sheet, etc. The callipers are of two types –

(i) The external calliper and

(ii) The internal calliper.

The external calliper is used to measure the external diameters of solid objects; while the internal calliper is used to measure the internal diameters of solid objects.

(c) **Vernier calliper**

The vernier calliper can be used for measuring smalllinear length and diameters of objects within the range of 0-12cm at least. It is calibrated in centimetres (cm). It has a reading accuracy of 0.1mm (0.01cm)

(d) **The micrometer screw gauge:** It is used to measure the thickness of a round objects E.g, the diameter of a wire. The micrometer screw guage gives a more accurate reading than the vernier calliper. It is calibrated in millimetre (mm). It has a reading accuracy of 0.01mm (0.001cm)

Other instruments for measuring length include: measuring tape, ruler, etc. The S.I. unit of length is metre (m).

EVALUATION

1. Mention any three instrument used in measuring length.
2. Which of the above instrument could give the highest degree of accuracy?

Measurement of Mass/Weight

Mass is defined as the quantity of matter a body contains; while Weight is the amount of gravitational force acting on a body or the force with which a body is attracted towards the centre of the earth. The weight of a substance varies from place to place due to variation in acceleration due to gravity,'g' over places but mass remains constant from place to place.

Mass and weight of objects are measured using instrument such as spring balance, beam balance, chemical balance, scale balance, etc.

However, the **differences between mass and weight** are shown below.

	S/N	MASS	WEIGHT
	1	Mass is a scalar quantity.	Weight is a vector quantity.
	2	Mass is the amount of stuff or quantity of matter contained in a body.	Weight is the amount of gravitational force acting on a body.
	3	Mass is measured using a beam balance, chemical balance	Weight is measured using spring balance.
	4	The S.I. unit of mass is kilogramme (kg)	The S.I. unit of weight is Newton (N).

EVALUATION

1. State three instruments used in measuring mass and weight.
2. Differentiate between mass and weight in four ways.
3. Why is weight a vector quantity?

Measurement of Volume

Volume of liquid objects is measured using instruments such as cylinder, burette, pipette, eureka can, etc. For regular solid objects, their volume could be determined using their mathematical formula.

S/N	Solid Object	Formula for Volume
1	Cube	$l \times l \times l$
2	Cuboid	$l \times b \times h$
3	Cylinder	$\pi r2h$
4	Cone	$13\pi r2h$
5	Sphere	$43\pi r2$

The S.I. unit of volume is metre cube m3

Measurement of Area

The area of a solid object could be determined using mathematical formulae after determining the two dimensions of the object.

S/N	Solid Object	Formula for Area
1	Triangle	12bh
2	Rectangle	lb
3	Square	l2
4	Parallelogram	bh

	5	Trapezium	12(a+b)h

The S.I. unit of volume is metre square m2

WORKED EXAMPLES

1. **Find the volume of a cylinder of diameter 12cm and height 15cm.**

SOLUTION

d =12cm

∴ r =12cm2=6cm

h =15cm,π=227

Now, v =πr2h

∴ v =227×62×15

∴ v =22×36×157=118807

∴ v =1697.14cm3

2. **What is the area of a triangular card board of base 6cm and height 4cm?**

SOLUTION

b =6cm and h =4cm

Now, A =12bh

∴ A =6×42=242

∴ A =12cm2

EVALUATION

1. Calculate the volume of a rectangular prism of dimension 7cm by 3.5cm by 1.5cm.
2. A cube has an edge of 0.8cm. Find its volume.

Measurement of Time

The Concept of Time

You must have heard the following statements made about time:

1. “Time and tide waits for no man”
2. “Time is business”
3. “There is time for everything: time to sow and time to reap, time to laugh and time to cry, time to go to bed and time to wake up” and so on

Time is very important in our daily activities. Many people have failed in one area or the other because of mismanagement of time. In Physics time is very important. Wrong timing can lead to wrong observations, results and wrong conclusions.

What then is time? Time may be considered as the interval between two successive events. It is a fundamental quantity. Its S.I unit is *seconds*.

Ways of Measuring Time

Time as mentioned earlier is very important. That is why early men developed various means of measuring time. They used the sun to tell time. Even today people still use the position of the sun to determine time. Other devices they developed and used are:

1. The water clock or hourglass
2. The sand clock
3. The primitive Sundials

Today, we have better time-measuring devices that measure time more accurately than the above mentioned devices. Some of them are:

1. The stop watch which is the standard instrument for measuring time in the laboratory

2. The wrist watch
3. The modern pendulum clock
4. The wall clock

It is worthy of note that:

1. 60 seconds makes one minute
2. 60 minutes makes one hour
3. 24 hours makes one day
4. 365 ¼days makes one year
5. 10 years makes a decade
6. 100 years makes a century/centenary
7. 1000 years makes a millennium

Calculations on Time

Example 1: How many seconds are there in 2 hours 15 minutes?

Since ***60 seconds*** makes ***1 minute*** and ***60 minutes*** makes ***1 hour***, ***1 hour*** will have ***60 x 60*** seconds. ***2*** hours will have ***60 x 60 x 2 seconds = 7200 seconds.***

15 minutes will have ***60 x 15 seconds*** = ***900 seconds***

Therefore 2 hours 15 minutes will have ***(7200 + 900) seconds = 8100 seconds***

Example 2: If it takes a pendulum bob 32 seconds to complete 20 oscillations, what is the period of oscillation of the bob?

Period (T) is time (t) taken for the bob to complete an oscillation.

i.e. T =timenumber of oscillations

=3220=1.6seconds

EVALUATION

1. What are the standard instruments for measuring time in the laboratory?
2. Mention 2 examples each of modern and olden days time-measuring devices you know.

Units of Measurement in Industries

Measurement of Length

Length was considered earlier as a fundamental quantity whose S.I unit is metre. We also learnt that other units of length are centimeter, millimitre,, and kilometer.

Units of Length

	Multiples of other units	Other units	Conversion to S.I unit
	_____	1 inch	= 2.54cm = 0.0254m
	12 inches make	1 foot	= 0.3048m
	3 feet make	1 yard	= 0.9144m
	22 yards make	1 chain	= 20.12m
	10 chains make	1 furlong	= 201.2m
	8 furlongs make	1 mile	= 1.609 km

Class Activity

1. Mention the unit for measuring the following quantitiesby the following person
2. Classify these units under S.I units and other units.

S/N	Persons	Physical quantity	Unit
1	Bricklayers	Distance	_____
2	Tailors	Length	_____

	3	Science teachers	Length	_____
	4	Petroleum engineers	Volume	_____
	5	Butcher	Mass of meat	_____
	6	Electrical engineers	Electrical energy	_____

Example 1

1. Convert 3550km to miles
2. The length of an iron rod is given as 66 inches. What is its length in metres?

Solution

1. 1 mile = 1.609km

Hence, 3550km = (3550 x 1.609) miles = 5,712 miles

2. 1 inch = 2.54cm

Therefore 66 inches = (66 x 2.54) cm = 167.64cm.

But 100cm = 1m,

Thus 167.64cm = =167.64100m = 1.6764m

Therefore the length of the iron rod in metres is 1.676.4m

EVALUATION

1. The height of a girl is 7.5 feet. Estimate her height in metres
2. Convert 30km to miles

Measurement of Volume

Volume is a measure of the space contained in an object. A barrel of oil is equivalent to 158.987 litres.

Example 2

The table below is a statistics of oil exportation to the United States for three years by NNPC

	Year	Price per barrel (₦)	Volume exported (barrels)
	1993	140	1.05 million
	1994	135	1.5 million
	1995	162	0.9 million

(i) What volume of oil in litres was exported in 1994?

(ii) What is the highest amount gotten and in what year was it gotten?

Solution

(i) In 1994, 1.5 million barrels of oil was exported.

Since 1 barrel = 158.987 litres

1.05 million barrels = (1.5million x 158.987) litres = 238.4805million litres

(ii) In 1993, volume of oil exported = 1.05 million barrels. Price per barrel = N140

Amount realized = 1.05million × 140 = N147,000000

In 1994, volume of oil exported = 1.5million, price per barrel = N135

Amount realized = 1.5million × N135 = N202.5 million

In 1995, volume of oil exported = 0.9 million barrels. Price per barrel = N162

Amount realized = 0.9 million × N162 = N145.8 million

Therefore, the highest amount of money gotten is N202.5 million and it was gotten in 1994

Measurement of Temperature

The S.I unit of temperature is Kelvin. Other units for temperature include degree Celsius and degree Fahrenheit. In the U.S.A, degree Fahrenheit is still in use. On the Celsius scale, the freezing point and the boiling point of water are measured as 0^0C and 100^0C respectively. But on the Fahrenhiet scale, the freezing point and the boiling point of water are measured as 32^0F and 212^0F respectively.

The Celsius Scale is related to the Fahrenheit scale by the equation:

F is temperature in Fahrenheit scale, C is temperature in Celsius scale

F–329=C100orC5=F–329

Example: (a) Convert 77 degrees Fahrenheit to Celsius scale **(b)** Convert 105 degrees Celsius to degrees Fahrenheit

Solution

(a) Considering the equation:

C5=F–329C=5(F–32)9=5(77–32)9=5×459=25

(b) C5=F–329F=9C5+32=9×1055+32=9×21+32=189+32=221oF