Physical Quantities and Scientific Methods of Measurement

Worksheet One

In our day to day life, we measure many things such as the mass of vegetables, the volume of liquids, the speed of a car, the temperature of the day etc. Such quantities which could be measured are called **physical quantities.** A physical quantity is a property of an object that can be measured or calculated from other physical quantity. Examples of physical quantities are: length, mass, time, temperature, area, volume, density, force etc. Generally, physical quantities are classified into two types, namely: fundamental quantities and derived quantities

1.Fundamental Physical quantities and their units

Fundamental quantities, also known as base quantities, are quantities which cannot be expressed in terms of any other quantity. They are the bases for other quantities. There are seven fundamental (basic) physical quantities: length, mass, time, temperature, electric current, luminous intensity and amount of a substance.

In this section we will discuss only about the first four commonly measured fundamental quantities: length, mass, time and temperature. The names and symbols of the units of the fundamental quantities in the International System of units (SI) are shown in table 1.1.The International System of Units (SI, abbreviated from the French Système international (d'unités)) is a system of measurement based on base units. An International System of units (SI) is currently used all over the world.

Measurement is the comparison of an unknown quantity with some known quantity. This known fixed quantity is called a unit. Thus, the result of a measurement is expressed in two parts. One part is a number and the other part is the unit of the measurement. For example, if a student has a mass of 32 kg:

the quantity being measured is mass, the value of the measurement is 32 and the unit of measure is kilograms (kg). This tells us that any measurement consists of two parts. The first is the number which indicates the magnitude of the quantity and the second indicates the unit (standard) of that quantity. Units can be classified into two

groups: fundamental units and derived units. The units used to measure fundamental quantities are called fundamental units. It does not depend on any other unit.

Table 1. 1 Fundamental quantities and their SI units

Quantity	Name of Unit	Symbol of the unit
Length	Meter	m
Mass	kilogram	kg
Time	Second	S
Temperature	Kelvin	K

2.Derived Physical Quantities and their Units

Physical quantities which depend on one or more fundamental quantities for their measurements are called derived quantities. Speed, area, volume, density and force are examples of derived quantities. The units used to measure derived quantities are called derived units. It depends on fundamental units for their measurement. SI derived units are described by mathematically combining (dividing, multiplying or powering) the base units. Some of the derived quantities and their units are given in table 1.2.

Table 1. 2 Derived quantities and their SI units

No.	Derived quantity	Symbol	Unit
1	Area	A	$m \times m = m^2$
2	Volume	V	$m \times m \times m = m^3$
3	Speed	V	m/s
4	Density	ρ	Kg/m^3

Example 1.1: Show how the unit of (a) area and (b) speed is derived from the fundamental units.

Solution:

(a) The equation for the area of rectangular surface is

Area = length x width.

Both length and width are length measurements. Hence they are measured in meter.

Unit of area = unit of length x unit of width

Unit of area = m x m = m^2

(b) The equation for speed is

Speed = distance/time

Thus the unit of speed is the unit of distance (m) over the unit of time (s) = m/s

Choose the correct answer for the following questions

1. Which of the following is a physical quantity?

   a) Happiness b) Length

   c) Anger d) Beauty

2. A physical quantity is defined as:

   a) A property that cannot be measured

   b) A property that can only be observed

c) A property of an object that can be measured or calculated

d) A property without any unit

3. Which of the following is NOT a physical quantity?

a) Mass b) Force

c) Temperature d) Intelligence

4. How many fundamental (base) physical quantities exist in SI system?

a) 4 b) 5 c) 7 d) 9

5. Which of the following is a **fundamental quantity**?

a) Speed b) Volume

c) Mass d) Force

6. Which of the following is a **derived quantity**?

a) Length b) Time

c) Temperature d) Speed

7. The SI unit of length is:

a) Gram b) Metre c) Second d) Kelvin

8. The SI unit of mass is:

a) Kilogram b) Metre c) Newton d) Pascal

9. The SI unit of time is:

a) Hour b) Minute c) Second d) Day

10. The SI unit of temperature is:

a) Celsius b) Fahrenheit

c) Kelvin d) Joule

11. Which of the following is a derived unit?

a) Kilogram b) Metre c) Joule d) Kelvin

12. The unit of **density** is:

a) kg/m^3 b) m/s c) N d) J

13.The SI unit of force is:

a) Pascal b) Newton c) Joule d) Watt

14. The unit of area can be expressed as:

a) m b) m^2 c) m^3 d) m/s

15.Which of the following is the unit of speed?

a) m^2 b) m/s c) m^3 d) kg/m^3

16.The SI system of units is abbreviated from which language?

a) German b) English

c) French d) Latin

17. A student has a mass of 32 kg. Here "32" represents:

a) Unit b) Number only

c) Quantity d) Magnitude of the measurement

18. In a measurement, the part which shows "what is being measured" is:

a) The number

b) The unit

c) The instrument

d) The value

19. Which of the following correctly matches quantity and unit?

a) Length – Kelvin

b) Mass – Metre

c) Time – Second

d) Temperature – Gram

20. Derived units are obtained by:

a) Observing natural quantities

b) Multiplying or dividing fundamental units

c) Using instruments only

d) Guessing based on experiment

Answer the following questions as True/False

1. Length, mass, time, and temperature are all fundamental quantities.

2. Force is a fundamental quantity.

3. The SI unit of mass is gram (g).

4. The SI unit of time is second.

5. Density is a fundamental quantity.

6. Every measurement has two parts: a number and a unit.

7. The SI unit of temperature is Celsius (°C).

8. Area is a derived quantity with SI unit m^2.

9. The International System of Units (SI) originated from English measurement system.

10. Volume is a derived quantity and its SI unit is cubic metre (m^3)..