UNIVERSITY OF RWANDA

COLLEGE OF SCIENCE AND TECHNOLOGY

PHYSICS FOR ENGINEERS I (PHY1163)

STUDY GROUP: EPE & CEGE, Level 1

TUTORIAL N^{O}1: Unit 1- Introduction to Physics & Measurements

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Question No 1:

i) What are the ***size*** and ***speed*** of objects studied by the classical mechanics?
ii) What is the meaning of "***to measure***" for any exact science like Physics?
iii) Give the ***fundamental quantities*** which are subjected to measurement in Mechanics.
iv) Express the following quantities using the prefixes:
   a) $3\times10^{-4}m$
   b) $5\times10^{-5}s$
   c) $72\times10^{2}g$
v) What do these prefixes stand for: ***Giga***, ***micro*** and ***femto***?
vi) What do you mean by "***dimension***" of a physical quantity?
vii) What is the important use of the **dimensional consistency** of a physical law?

Question No 2:

The **Newton's law of universal gravitation** states that any two bodies in the universe attract each other with a ***force*** that is ***directly proportional*** to the product of their masses and ***inversely proportional*** to the square of the distance between them: $F = G\frac{m_1 m_2}{r^2}$. Determine the dimension and give the SI unit of the constant G.

Question No 3:

Verify that the following equations are dimensionally consistent knowing that v is the speed expressed in $m\cdot s^{-1}$, a the acceleration in $m\cdot s^{-2}$, x the position in m, and t the time in s:

a) $x = \frac{v^2}{2a}$ b) $x = \frac{1}{2}at$ c) $t = \sqrt{\frac{2x}{a}}$

Question No4:

With help of dimension analysis, find a formula for the rate of flow (Q) of a fluid through a pipe in terms of the liquid viscosity η, the pressure gradient in the pipe per unit length $\left(\frac{\Delta P}{l}\right)$ and the

radius (r) of the pipe. (Hints: $Q = k\eta^x r^y \left(\frac{\Delta P}{l}\right)^z$). The viscosity of the liquid η, the force F, the surface area A and the velocity gradient $\frac{\Delta v}{\Delta x}$ are related by $F = \eta A \frac{\Delta v}{\Delta x}$

Question No 5:

The speed of a particle changes with time according to the formula $v = At - Bt^3$. What are the dimensions and the SI units of the constants A and B?

Question No 6:

Suppose that two quantities A and B have different dimensions. Determine which of the following arithmetic operations could be physically meaningful:

a) $A+B$ b) $B-A$ c) AB d) A/B

Question No7:

Round this measurement 0.00350681kg to:

a) 1 significant figure b) 3 significant figures c) 5 significant figures

Question No8:

A particular reading in an experiment shows L = 5.2 ± 0.1 m when t = 0.32 ± 0.05 s.

a) What are the maximum and minimum values for L and t?
b) Show this range in a sketch of L versus t.

Question No9:

For the following set of measurements: 5.8 cm, 5.6 cm, 5.7 cm, 5.4 cm, 5.4 cm, 5.6 cm, Determine:

a) the absolute uncertainty
b) the relative uncertainty
c) the percentage uncertainty

Question No10:

A student measures the width of an object several times and records the following data: 2.3 cm, 2.4 cm, 2.2 cm, 2.3 cm, 2.3 cm, 2.2 cm, and 2.8 cm. He decides to represent his data the following way:

- 2.3 + 2.4 + 2.2 + 2.3 + 2.3 + 2.2 + 2.8 = 16.5
- 16.5 ÷ 7 = 2.357 cm
- (2.8 – 2.2) ÷ 2 = 0.3 cm

Therefore, the average value is 2.4 ± 0.3 cm. A teacher tells the student that his report should read 2.3 ± 0.1 cm.

How did the teacher get this result and what type of error did the student commit?

Question No11:

Write down, just in SI units, the order of magnitude of the following (you may need to do some research).

a) the length of a human foot
b) the mass of human brain
c) the charge on a proton
d) your age
e) the speed of electromagnetic waves in a vacuum

Question No12:

The volume V of a cylinder of height h and radius r is given by the expression $V = \pi r^2 h$. In a particular experiment, r is to be determined from measurements of V and h. The percentage uncertainty in V is ±5% and that in h is ±2%. Calculate the percentage uncertainty in r.