THE COPPERBELT UNIVERSITY
KAPASA MAKASA UNIVERSITY CAMPUS
ICT DEPARTMENT

PH 110, TUTORIAL SHEET 1, 2019: UNITS AND DIMENSIONS

1. Using scientific notation, write the following masses in grams:

(a)0.66 μ g (b) 32.55 ng (c) 231 picograms

2. Carry out the following conversions:

(a) 300 inches to kilometres. (b) 60,000 micrograms to tones. (c) 60 mi/h to m/s.

(d) 1 week to microseconds (in scientific notation).

3.

(a) What does it mean by dimensions of a physical quantity?

(b) Mention two applications/uses of dimensional analysis.

4. In the gas equation $\left(P + \frac{a}{V^2}\right)(V - b) = RT$, where p is the pressure, v is the volume R is the universal gas constant and T the temperature, what are the dimensions of a and b?

5. Prove that the following equations are dimensionally consistent

a) Potential energy = mgh
b) Kinetic energy = $\frac{1}{2}mv^2$
c) Pressure = ρgh
d) The period of the pendulum $(T) = 2\pi\sqrt{\frac{L}{g}}$

6. The velocity of a particle varies with time according to the relation

$V = at^2 + bt + c$.

Find the dimensions of, a, b and c

7. Stoke's formula gives an expression for the viscous force acting on a small sphere moving through a homogenous viscous fluid. The viscous force (F) acting on the sphere depends on the viscosity of the fluid (η), the radius of the sphere (r), and the velocity of the sphere (v). Derive Stoke's formula using dimensional analysis.

8.

(a) What are the limitations of dimensional analysis?

(b) Show that the equation for the gravitational potential energy

$E = \frac{GMm}{R}$ is dimensionally correct given that the units for the gravitational constant G are $N.m^2.kg^{-2}$, M and m are masses of interacting objects and R is their separation distance.

(c) Newtons law of Universal gravity states that: $F = \frac{GMm}{R^2}$ were F is the gravitational force, G is the Universal gravitational constant, M and m are masses of interacting objects and R is their separation distance. What the units of the Universal gravitation constant G.

9.After an experiment was conducted using an electric spectrometer, the wavelength of red light was found to be approximately 6.50×10^{-7} m. Express this wavelength in micrometers (μ).

10. Explain using an experiment, how the data of an experiment can be precise but not accurate.

11. A gas bubble from an explosion under water oscillates with a period ***T*** which is directly proportional to $P^a d^b E^c$ where P is the static pressure, d is the density of water and ***E*** is the total energy of the explosion. Determine the values of ***a, b*** and ***c***.

12. A famous relation in in Physics which relates to 'moving mass' ***m*** to the rest mass $\boldsymbol{m_0}$ of a particle in terms of its speed ***v*** and the speed of light ***c*** is as shown below.

$$m = \frac{m_0}{(1 - v^2)^{\frac{1}{2}}}$$

This relation first arose as a consequence of special theory of relativity due to the Great Albert Einstein. A student recalls the relation almost correctly but forgets where to place the dimensional constant c. Determine where the dimensions of c must be placed in order for the equation to be dimensionally consistent. Show your working.

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