BTU 1113 Physics

Chapter 1: Physics and Measurement

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Chapter Description

- Aims
  - Understand the unit of measurement and its applications
  - Learn on how to use the prefixes
  - Solve the problems regarding the unit conversion

- Expected Outcomes
  - Students should be able to understand the unit of measurement and its applications
  - Students should be able to learn on how to use the prefixes
  - Students should be able to solve the problems regarding the unit conversion

- Other related Information

- References

  - Giancoli, D.C., 2008. Physics for Scientists & Engineers. 4th edition. Prentice Hall, USA.
  - Jones, E., 2002. Contemporary College Physics. 3rd Ed, McGraw-Hill, Singapore.
  - Young, H. D. and Freedman, R. A., 2012. University Physics with Modern Physics. 13th edition, Pearson, San Francisco

1st aim:
Understand the unit of measurement and its applications including standard of length, mass and time.

Basic Quantities

There are a few basic quantities in physics that are used for measurement. In 1960, it was standardize and is known as **SI system** units.

Quantities	SI Unit	Symbol
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Temperature	Kelvin	K
Electric Current	Ampere	A
Luminous Intensity	Candela	Cd
Amount of substance	Mole	mol

Basic Quantities Derivatives

Quantities	SI Unit	Symbol
Volume	cubic meter	m^3
Density	kilograms per cubic meter	kg/m^3
Speed	meter per second	m/s
Newton	kg m/ s^2	N
Energy	Joule (kg m^2/s^2)	J
Pressure	Pascal ($kg/(ms^2)$	Pa

SI Unit Prefixes

Name	Symbol	Factor
tera-	T	10^{12}
giga-	G	10^{9}
mega-	M	10^{6}
kilo-	k	10^{3}
hecto-	h	10^{2}
deka-	da	10^{1}

SI Unit Prefixes

Name	Symbol	Factor
deci-	d	10^{-1}
centi-	c	10^{-2}
milli-	m	10^{-3}
micro-	μ	10^{-6}
nano-	n	10^{-9}
pico-	p	10^{-12}
femto-	f	10^{-15}

Prefixes and Applications

Name	Symbol	Application	Example
giga	G	PC memory	80 GB
mega	M	Electric power	200 MW
kilo	k	Distance	8 km
deci	d	Length	
centi	c	Length	
milli	m	Medicine	5 ml
micro	μ	Biology	Microb size -2 μm
nano	n	Astronomy	wv - 400 nm

2nd aim:
Learn on how to use the prefixes.

Scientific Notation

$M \times 10^n$

M is the coefficient $1<M<10$

10 is the base

n is the exponent or power of 10

3rd aim:
Solve the problems regarding the unit conversion.

Unit-cancellation procedure

1. Solve the equation algebraically for the desired term.
2. Decide on the proper units for the result.
3. Substitute known values, including units.
4. Cancel units that appear in both the numerator and the denominator of any term.
5. Use conversion factors to eliminate unwanted units and obtain the proper units as decided in Step 2.
6. Perform the calculation.

Method of Unit Conversion

Example 1: Convert 86 km to m:
Multiply the original measurement by a conversion factor.

$$86\ \text{km} \times \frac{1{,}000\ \text{m}}{1\text{km}} = 86{,}000\ \text{m}$$

Method of Unit Conversion

Example 2: Convert 75.00 km/h to m/s

$$75.00\ \frac{\text{km}}{\text{h}} \times \frac{1000\ \text{m}}{1\ \text{km}} \times \frac{1\ \text{h}}{3600\ \text{s}} = \mathbf{20.83\ m/s}$$

Limits of Measurement

Accuracy: A measure of how close a measurement is to the true value of the quantity being measured.

Who is more accurate when measuring a book that has a true length of 17.0 cm?

Susan:

17.0 cm, 16.0 cm, 18.0 cm, 15.0 cm

Amy:

15.5 cm, 15.0 cm, 15.2 cm, 15.3 cm

Precision: A measure of how close a series of measurements are to one another. A measure of how exact a measurement is.

Who is more precise and accurate when measuring the same book?

Susan:

17.0cm, 16.0cm, 18.0cm, 15.0cm accurate

Amy:

15.5cm, 15.0cm, 15.2cm, 15.3cm precise

Significant Figures

The significant figures in a measurement include all of the digits that are known, plus one last digit that is estimated.

Rounding to Significant Numbers

To round to n significant figures:

If the first non-significant figure is a 5 followed by other non-zero digits, round up the last significant figure (away from zero).

For example, 1.2459 as the result of a calculation or measurement that only allows for 3 significant figures should be written 1.25.

If the first non-significant figure is a 5 not followed by any other digits or followed only by zeros, rounding requires a tie-breaking rule.

For example, to round 1.25 to 2 significant figures, Round half up rounds up to 1.3, while Round half to even rounds to the nearest even number 1.2.

Replace any non-significant figures by zeros.

Conclusion of The Chapter

This chapter introduces a fundamental of physics and covers unit and measurements, prefixes and unit conversion. It summarizes the basic knowledge of physics and the importance of understanding the standard measurement system that has been widely used in this world.

Reference

Giancoli, D.C., 2008. Physics for Scientists & Engineers. 4th edition. Prentice Hall, USA.