Phys 103

Chapter 1

Physics and Measurement

By

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LECTURE OUTLINE

- 1.1 Standards of Length, Mass, and Time
- 1.4 Dimensional Analysis
- 1.5 Conversion of Units

1.1 Standards of Length, Mass, and Time

In mechanics, there are three basic quantities: length, mass, and time

- All other quantities in mechanics can be expressed in terms of these three.
- In1960, an international committee established a set of standards for the fundamental quantities of science. It is called the SI (Système International)
- In the SI:

➢ Units of length: **meter**

➢ Units of mass : **kilogram**

➢ Units of time : **second**

1.1 Standards of Length, Mass, and Time

- **Length**: SI Unit of length is: meter (m).
- **Mass**: SI Unit of mass is: kilogram (kg)
- **Time**: SI Unit of time is: second (s)
- In many situations, you may have to derive or check a specific equation. A useful and powerful procedure called dimensional analysis can be used to assist in the derivation or to check your final expression.
- As a simple method:

Left Hand Side must = Right Hand Side

1.4 Dimensional Analysis

- **Dimension:** it denotes the physical nature of a quantity
- **Example:** distance: could be in meters, yards, or micrometers. But over all it is: a **length**
- **Symbols we are going to use are:**
- dimension of length: **[L]**
- dimension of mass: **[M]**
- dimension of time: **[T]**

Units of Area, Volume, Velocity, Speed, and Acceleration

System	Area (L^2)	Volume (L^3)	Speed (L/T)	Acceleration (L/T^2)
SI	m^2	m^3	m/s	m/s^2
U.S. customary	ft^2	ft^3	ft/s	ft/s^2

1.4 Dimensional Analysis

Example: Use dimensional analysis to check the equation:

$$x = 1/2at^2$$

- ***Solution:***

$$L = \frac{L}{T^2}.T^2 = L$$

Example: *Show that* $v = at$ *is dimensionally correct.*

- ***Solution:***

L.H.S.:$[v] = \frac{L}{T}$ $and\ L.H.S\ [at] = \frac{L}{T^2}.T\ = \frac{L}{T}$

L.H.S=R.H.S

So the equation is dimensionally correct

1.5 Conversion of Units

Some times it is necessary to convert units from one measurement system to another, or to convert within a system, for example, from kilometers to meters.

Examples: 1 mile = 1 609 m = 1.609 km

- 1 ft = 0.304 8 m = 30.48 cm
- 1 m = 39.37 in. = 3.281 ft
- 1 in. = 0.025 4 m = 2.54 cm (exactly)

PROBLEMS

- **Section 1.4 Dimensional Analysis**

13. The position of a particle moving under uniform acceleration is some function of time and the acceleration. Suppose we write this position

$$S = ka^m t^n$$

where *k* is a dimensionless constant. Show by dimensional analysis that this expression is satisfied if $m = 1$ and $n = 2$. Can this analysis give the value of *k*?

PROBLEMS

- **Section 1.4 Dimensional Analysis**

15. The position of a particle moving under uniform

Which of the following equations are dimensionally correct?

a) $v_f = v_i + ax$

b) $y = (2m)\cos(kx)\,, where\ k = 2m^{-1}$

PROBLEMS

- **Section 1.5 Conversion of Units**

21. A rectangular building lot is 100 ft by 150 ft. Determine the area of this lot in m^2.

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25. A solid piece of lead has a mass of 23.94 g and a volume of 2.10 cm^3. From these data, calculate the density of lead in SI units (kg/m^3).

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31. One gallon of paint (volume=3.78×10^{-3} m^3) covers an area of 25.0 m^2. What is the thickness of the paint on the wall?

Lecture Summary

- The three fundamental physical quantities of mechanics are length, mass, and time, which in the SI system have the units meters(m), kilograms(kg), and seconds(s), respectively.
- The method of dimensional analysis is very powerful in solving physics problems.
- Dimensions can be treated as algebraic quantities. By making estimates and performing order-of-magnitude calculations, you should be able to approximate the answer to a problem when there is not enough information available to completely specify an exact solution.

Thank You


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