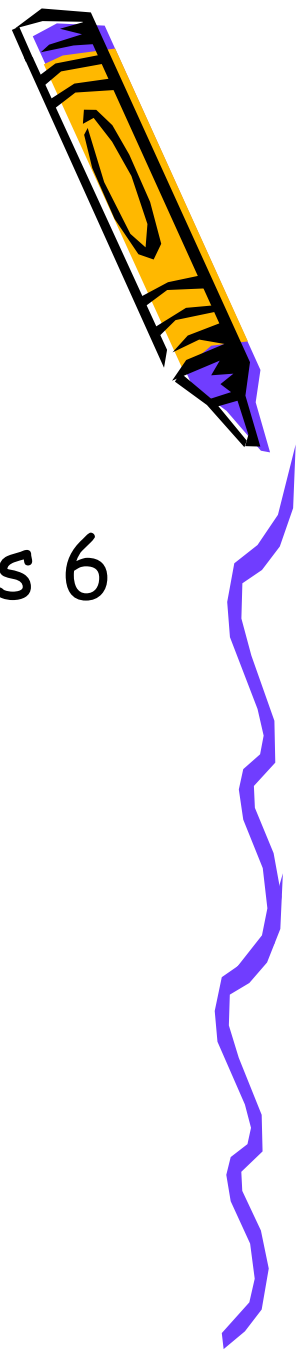




Phys 103
General Physics(1)
(Mechanics)

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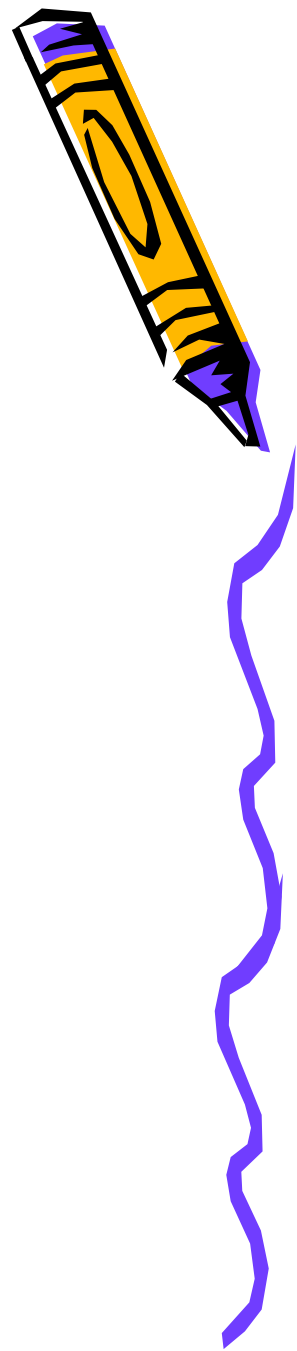




- Text book:

Physics for Scientists and Engineers 6
th Edition Raymond A. Serway



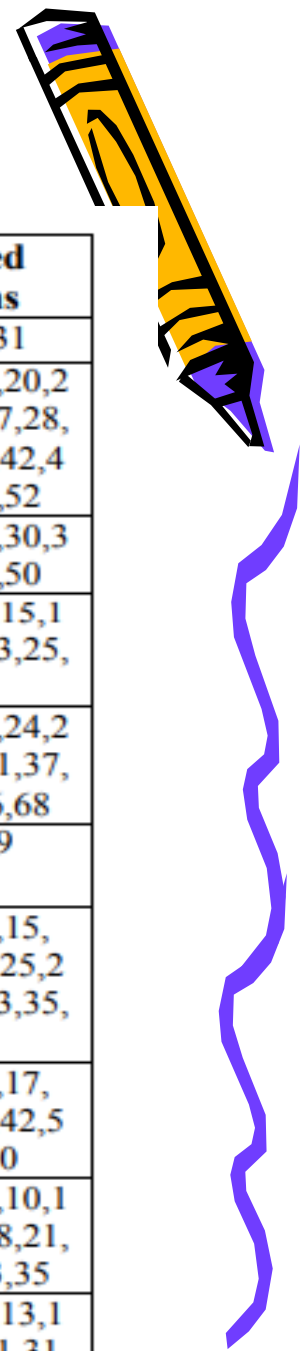


- Marks distribution:
 - 1) One midterm exam 30 marks
 - 2) Practical work (Lab.) 30 marks
 - 3) Final exam 40 marks

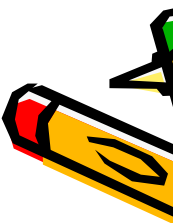
Total 100 marks



Course outline



Chapter	Title	Section	Hours	Suggested problems
1	Physics and measurement	1.1, 1.4, 1.5	2	13,15,21,25,31
2	Motion in One Dimension	2.1, 2.2, 2.3, 2.5, 2.6	4	4,5,11,15,16,20,21,22,23,25,27,28,29,32,33,40,42,43,46,48,51,52
3	Vectors	3.1--to--3.4	4	1,4,19,21,27,30,31,33,39,49,50
4	Motion in Two Dimensions	4.1--to--4.5	4	1,3,5,6,8,14,15,17,19,20,22,23,25,29
5	The Laws of Motion	5.1--to--5.8	6	3,7,11,16,18,24,25,26,28,30,31,37,41,44,45,46,68
6	Circular Motion and Other Applications of Newton's Laws	6.1	2	1,2,5,7,59
7	Energy and Energy Transfer	7.2--to--7.8	4	1,4,7,13,14,15,16,19,21,24,25,26,28,31,32,33,35,37,40
8	Potential Energy	8.1--to--8.5	4	2,5,6,11,13,17,31,33,36,38,42,55,57,59,60
9	Linear Momentum and Collisions	9.1--to--9.4	5	1,2,4,5,7,8,9,10,13,15,16,17,18,21,25,27,32,33,35
10	Rotation of a Rigid Object About a Fixed Axis	10.1--to--10.8	6	1,3,5,6,8,12,13,16,17,18,20,21,31,35,37,46,70,71



Chapter 1

Physics and Measurement



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

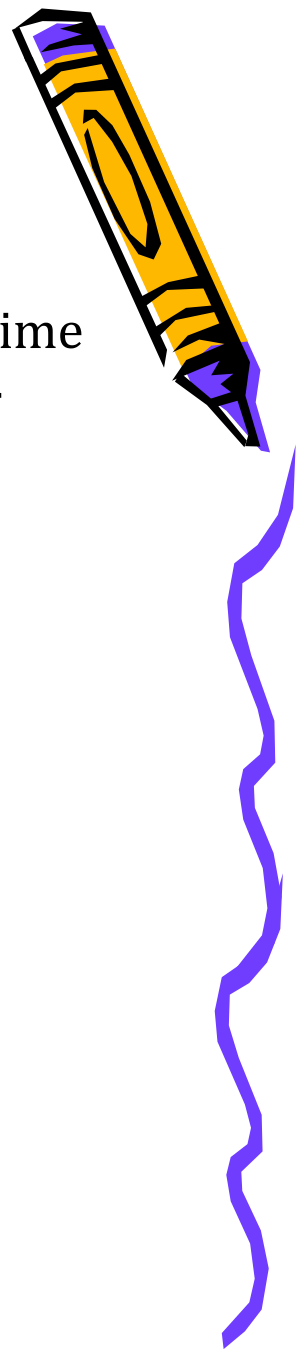


- In 1960, an international committee established a set of standards for the fundamental quantities of science. It is called the **Système International (SI)** **Système International (SI)**, which are Length, Mass, and Time and its fundamental units are the meter (m), kilogram (kg), and second (s).
- Other standards for SI fundamental units are: Temperature (Kelvin), Electric current (Ampere), Luminous intensity (candela), and the Amount of substance (mole).



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

- All other quantities in mechanics can be expressed in terms of these three.
- **Length:** SI Unit of length is: meter (m).
- **Mass:** SI Unit of mass is: kilogram (kg)
- **Time:** SI Unit of time is: second (s)



Derived Quantities

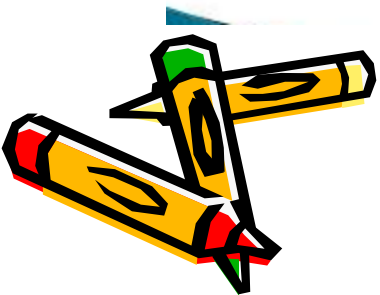


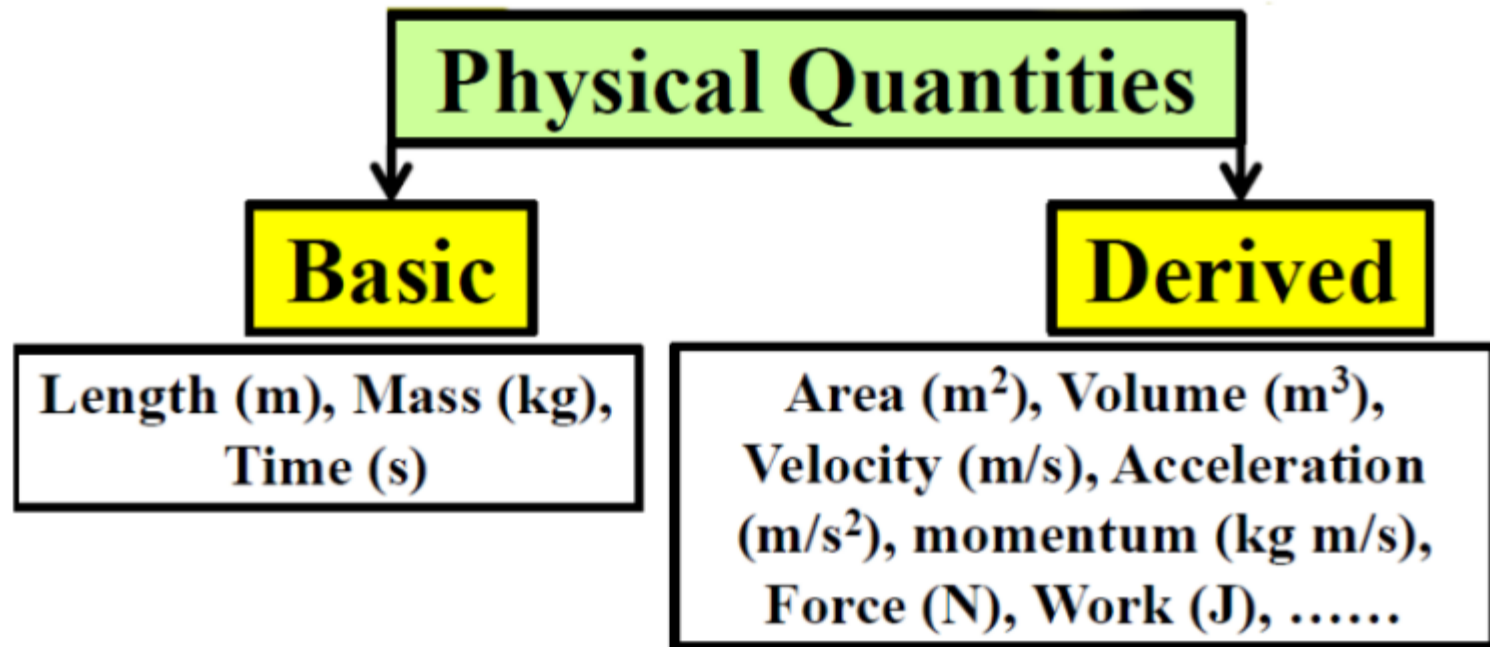
- When a quantity involves the measurement of 2 or more fundamental quantities it is called a **Derived Quantity**
- The units of these are called **Derived Units**



Example **derived quantities & units:**

Quantity	Law	Unit
Area	$A = l \times w$	m^2
Volume	$V = l \times w \times h$	m^3
Speed or velocity	$v = \text{distance}/\text{time}$	m/s or ms^{-1}
Acceleration	$a = \text{velocity}/\text{time}$	m/s^2 or ms^{-2}
Momentum	$p = \text{mass} \times \text{velocity}$	Kgm/s or $kgms^{-1}$
Density (mass/volume)	$\rho \equiv \frac{m}{V}$	kg/m^3 or kgm^{-3}







- 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]**



Basic Quantity



Quantity	Symbol	Unit	Dimension
Length	l	meter (m)	L
Mass	m	kilogram (kg)	M
Time	t	second (s)	T

Derived Quantity

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



Dimensional Analysis

- Dimensional Analysis is a technique to check the correctness of an equation or to assist in deriving an equation.
- Dimensions (length, mass, time, combinations) can be treated as algebraic quantities add (+), subtract (-), multiply (x), divide (:)
- Both sides of equation must have the same dimensions.

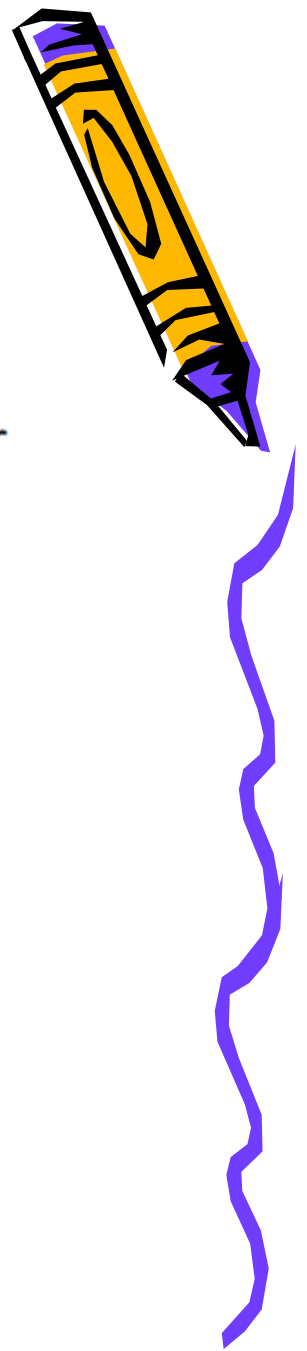


EXAMPLE:

- Given the equation: $x = \frac{1}{2} at^2$
 - Let say, x is distance traveled by a car in a time (t) if the car starts from rest and moves with constant acceleration (a).
- Check dimensions on each side:

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

- The T^2 cancel, leaving L for the dimensions of each side
 - Left hand side (LHS) = Right hand side (RHS)
 - The equation is dimensionally correct





Example 1.1

Analysis of an Equation

Show that the expression $v = at$, where v represents speed, a acceleration, and t an instant of time, is dimensionally correct.

SOLUTION

Identify the dimensions of v from Table 1.5:

$$[v] = \frac{\text{L}}{\text{T}}$$

Identify the dimensions of a from Table 1.5 and multiply by the dimensions of t :

$$[at] = \frac{\text{L}}{\text{T}^2} \times \text{T} = \frac{\text{L}}{\text{T}}$$

Therefore, $v = at$ is dimensionally correct because we have the same dimensions on both sides. (If the expression were given as $v = at^2$, it would be dimensionally *incorrect*. Try it and see!)



Example 1.2

Analysis of a Power Law

Suppose we are told that the acceleration a of a particle moving with uniform speed v in a circle of radius r is proportional to some power of r , say r^n , and some power of v , say v^m . Determine the values of n and m and write the simplest form of an equation for the acceleration.

Solution:

$$a \propto r^n v^m \Rightarrow a = k r^n v^m$$

$$\text{Dim. of L.H.S} = \text{Dim. of R.H.S}$$

$$[a] = [k r^n v^m]$$

$$L T^{-2} = L^n (L T^{-1})^m$$

$$L T^{-2} = L^n L^m T^{-m}$$

$$L T^{-2} = L^{n+m} T^{-m}$$

$$\text{from } L \Rightarrow 1 = n + m \quad \& \quad \text{from } T \Rightarrow -2 = -m \quad \therefore m = 2$$

$$1 = n + 2$$

$$\therefore n = -1$$

$$a = k r^n v^m \quad \therefore a = k r^{-1} v^2 \quad \therefore a = k \frac{v^2}{r}$$

$$L^1 T^{-2} = L^{n+m} T^{-m}$$

So,

$$L^1 = L^{n+m}$$

$$T^{-2} = T^{-m}$$



- ▶ An example is a kinematic equation for the velocity v of a uniformly accelerated body,

$$v = v_0 + at$$

where v_0 is the initial velocity, a the acceleration and t the time interval. In terms for dimensions of the equation, we can expand that: $[v] = [v_0] + [at]$

Then, $LT^{-1} = LT^{-1} + LT^{-2} \cdot T$

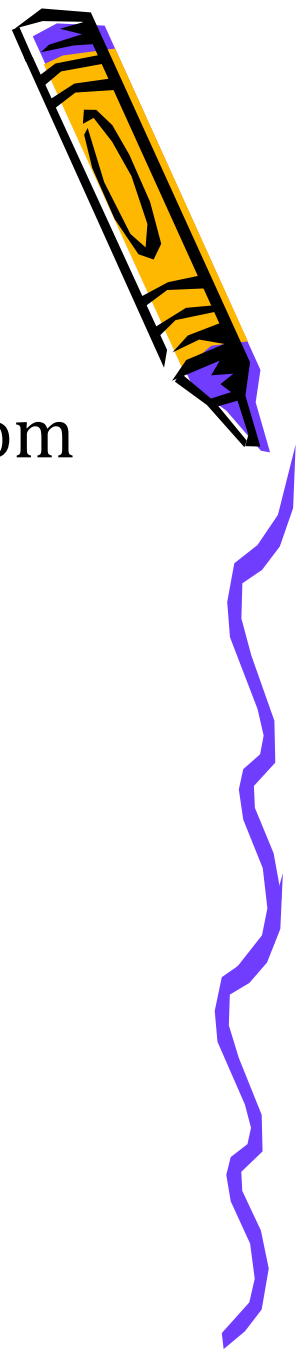
$$LT^{-1} = LT^{-1} + LT^{-1} \rightarrow$$

$$LT^{-1} = LT^{-1}$$

LHS = RHS, equation is 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)





Converting TIME units

1 hour = 60 minutes

1 minute = 60 seconds

Then,

$$1 \text{ h} = 60 \text{ min} = (60)(60) \text{ s} \\ = 3600 \text{ s}$$

Example:

Speed of a car is **60 km/h**, what is its speed in **m/s**?

Answer:

$$60 \text{ km/h} = (60)(1000) \text{ m} / (60)(60) \text{ s} \\ = (60000 \text{ m}) / (3600 \text{ s}) \\ = \underline{16.67 \text{ m/s}}$$

Then, **60 km/h = 16.67 m/s**



Table 1.4

Prefixes for Powers of Ten

Power	Prefix	Abbreviation
10^{-24}	yocto	y
10^{-21}	zepto	z
10^{-18}	atto	a
10^{-15}	femto	f
10^{-12}	pico	p
10^{-9}	nano	n
10^{-6}	micro	μ
10^{-3}	milli	m
10^{-2}	centi	c
10^{-1}	deci	d
10^3	kilo	k
10^6	mega	M
10^9	giga	G
10^{12}	tera	T
10^{15}	peta	P
10^{18}	exa	E
10^{21}	zetta	Z

Proplem 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 .

.....

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).

.....

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

