PHYS1050 Mechanics

Dr. Peter Blunden

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Consulting hours: MF 2:30-3:30

Lab/Tutorial

Starts this week!

B01	Friday	2:30-5:30 p.m.
B02	Thursday	2:30-5:30 p.m.
B03	Friday	8:30-11:30 a.m.

Lab exemptions

- you have taken the course within the last 2 years
- you got more than 80%
- go to 301 Allen (Physics office) by Tuesday, January 12!
- you still need to come to the tutorials in your assigned slot

Still trying to register?

- keep trying, as lab slots may still open up

Course website

www.physics.umanitoba.ca/~blunden/phys1050

- Watch for announcements!
- Homework section will have solutions posted as we complete chapters.

Secured areas (solutions, marks, etc.)

User Name: student
Password: fizzix (write it down NOW)

Midterm Test: Thursday, February 11, 7:00-9:00 p.m.
No makeup test!

Chapter 1

Measurement

In mechanics we deal mainly with 3 fundamental quantities:

Length, Time, and Mass

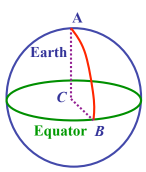
They are known as **base quantities.**

We use the **International System of Units (SI)**.

In this system the units for the base quantities are:

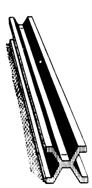
Physical Quantity	Dimensional Symbol	SI unit name	Symbol
Length	[L]	metre	m
Mass	[M]	kilogram	kg
Time	[T]	second	s

The Meter



In 1792 the meter was defined to be one ten-millionth of the distance from the north pole to the equator.

$$1\text{ m} \equiv \frac{AB}{10^7}$$



For practical reasons the meter was later defined as the distance between two fine lines on a **standard meter bar** made of platinum-iridium.

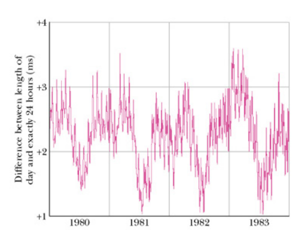
Since 1983 the meter is defined as **the length traveled by light in vacuum during the time interval of 1/299792458 of a second.** The reason why this definition was adapted was that the measurement of the speed of light had become extremely precise.

The Second

Initially the second was defined as follows:

$$1\text{ second} \equiv \frac{1}{24\times 60\times 60}$$

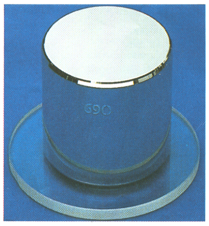
of the time it takes the Earth to complete a full rotation about its axis.



The problem with this definition is that the length of the day is not constant as is shown in the figure. For this reason, since 1967 the second is defined as **the time taken by 9192631770 light oscillations of a particular wavelength emitted by a cesium-133 atom**. This definition is so precise that it would take two cesium clocks 6000 years before their readings would differ by more than 1 second.

The Kilogram

The SI standard of mass is a platinum-iridium cylinder shown in the figure. The cylinder is kept at the International Bureau of Weights and Measures near Paris and assigned a mass of 1 kilogram. Accurate copies have been sent to other countries.



Measuring Things, Including Lengths

- SI has many derived units, which are written in terms of base units
  - density (mass per unit volume): $\rho = \frac{m}{V}$ (units kg/m^3)
  - Joules (energy): 1 J = 1 kg m^2/s^2
  - Watts (power): 1 W = 1 J/s = 1 kg m^2/s^3

Scientific notation employs powers of 10 to write large or small numbers

$$3\,560\,000\,000 \text{ m} = 3.56 \times 10^9 \text{ m}$$

$$0.000\,000\,492 \text{ s} = 4.92 \times 10^{-7} \text{ s.}$$

Example: Find the rest energy of an electron using $E=mc^2$ given that

$$c = 3.0 \times 10^8 \text{ m/s (speed of light)}$$

$$m = 9.0 \times 10^{-31} \text{ kg (mass of electron)}$$

Answer: $E = 8.1 \times 10^{-14}$ J

Unit conversion

A **conversion factor** is

- A ratio of units that is equal to 1
- Used to convert between units

$$2 \text{ min} = (2 \text{ min})(1) = (2 \text{ min})\left(\frac{60 \text{ s}}{1 \text{ min}}\right) = 120 \text{ s.}$$

Example: Convert 23 mpg to litres/100 km (ℓ/100 km)

$$2.54 \text{ cm} = 1 \text{ in}$$
$$12 \text{ in} = 1 \text{ ft}$$
$$5280 \text{ ft} = 1 \text{ mile}$$
$$1\text{US gal} = 3.785\ \ell$$

Answer: 10.2 ℓ/100 km

Dimensional (unit) Analysis

- Useful as a check on equations: [LHS] = [RHS]
- Example: relation between distance, acceleration, and time starting from rest

$$x = \frac{1}{2}at^2$$

$$[\text{L}] = \frac{1}{2}[\frac{\text{L}}{\text{T}^2}][\text{T}^2] = [\text{L}]$$

If your units do not work out, your answer cannot be correct!

Sometimes you can figure out the correct equation merely by making the units work!

Example: Using dimensional analysis estimate how long a stick of length *L* can remain balanced.

Answer: $t \sim \sqrt{\frac{L}{g}}$