Phys 100 2024

Lecture 7

Weds: Read 3.2-03.3

Fri: HW by 5pm

We need to establish meaningful and efficient ways of recording measurements in physics. Every measurement has an associated unit. For example we can drop a ball to the floor and record its time to fall

time = seconds

= s

We use the metric SI system of units. These have derived units (kilo, mega, milli, ...) to help with inconvenient numbers. Another form of help uses powers of 10.

Powers of 10

The mathematics that assists with large and small numbers involves powers of 10. First

$$10 \times 10 \times 10 \times 10 = 10000$$

$$= 10^4$$

four multiples of ten — four zeroes

In general

power — "10 to the power of n"

$$10^{(n)} = \underbrace{10 \times 10 \times 10 \times \ldots \times 10}_{n \text{ multiples (factors) of } 10} = \underbrace{1000\ldots00}_{n \text{ zeroes}}$$

For small numbers

$$10^{-n} = \frac{1}{10^n} = \frac{1}{\underbrace{10 \times 10 \times 10 \times \ldots \times 10}_{n \text{ factors of } 10}} = 0.\underbrace{00\ldots01}_{n-1 \text{ zeroes}}$$

A special power is

$$10^0 = 1$$

Quiz 1 90%

Then one can show:

$$10^{\text{first power}} \times 10^{\text{second power}} = 10^{\text{first power} + \text{second power}}$$

Quiz 2 95% → $10^3 \times 10^2 = 10^{3+2} = 10^5$

Also one can show

$$10^{\text{first power}} / 10^{\text{second power}} = 10^{\text{first power} - \text{second power}}$$

Quiz 3 → $\frac{10^5 \times 10^{-2}}{10^4} = \frac{10^{5+(-2)}}{10^4} = \frac{10^3}{10^4} = 10^{3-4} = 10^{-1} = \frac{1}{10}$

↳ 90%

$= 0.1$

DEMO: Secret Worlds (new powers of 10)

Scientific Notation

There is a standard way to express numbers and measured quantities using powers of 10. For example the average distance from Earth to Sun is

150, 196, 428 km

We can express this number as

distance = $\square.\square\square \times 10^{\square}$ scientific notation

single digit numbers

For example

$$410 = 4.10 \times 100 = 4.1 \times 10^2$$

Example: Express in

a) 61524 in scientific notation

b) Earth/Sun distance in scientific notation

Answer: a) $61524 = 6152.4 \times 10$

$= 615.24 \times 10 \times 10$

$= \ldots\ldots 6.1524 \times 10 \times 10 \times 10 \times 10 = 6.1524 \times 10^4$

b) $150\,196\,428\,m = 150\,196.428 \times 1000$

$= 150.196428 \times 1000 \times 10^3$

$= 1.50196428 \times 100 \times 10^3 \times 10^3$

$= 1.50196428 \times 10^2 \times 10^3 \times 10^3$

$= 1.50196428 \times 10^{2+3+3}\,m = 1.50196428 \times 10^8\,m$

Note that this can be done via decimal point shifts

$150196428 = 150196428.0 = 1.50196428 \times 10^8$

8 shifts

Quiz 4 - 95% Quiz 5-

2 Scientific notation

An electron has mass 9.11×10^{-31} kg and a proton has mass 1.67×10^{-27} kg. They are 3.5×10^{-10} m apart. Determine

$$\frac{\text{mass electron} \times \text{mass proton}}{\text{distance apart}}$$

and express the result in scientific notation.

Answer:

$$\frac{9.11 \times 10^{-31}\ \text{kg} \times 1.67 \times 10^{-27}\ \text{kg}}{3.5 \times 10^{-10}\ \text{m}}$$

$$= \frac{9.11 \times 1.67 \times 10^{-31} \times 10^{-27}\ \text{kg}^2}{3.5 \times 10^{-10}\ \text{m}}$$

$$= \underbrace{\frac{9.11 \times 1.67}{3.5}}_{4.35} \times \underbrace{\frac{10^{-31} \times 10^{-27}}{10^{-10}}}_{\frac{10^{-31-27}}{10^{-10}} = \frac{10^{-58}}{10^{-10}} = 10^{-58-(-10)} = 10^{-48}} \frac{\text{kg}^2}{\text{m}}$$

$$= 4.35 \times 10^{-48}\ \text{kg}^2/\text{m}$$

Motion

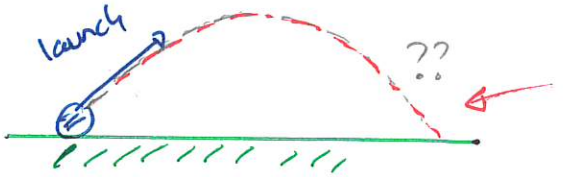
A central goal in classical physics is to describe how objects move.

DEMO: PhET Projectile Motion

* Launch projectiles and observe trajectories

The typical questions are.

How will object move?



How can we describe objects motion

Why do objects move as they do.

Why this shape of trajectory?

We ask these questions with the aims:

1) describe what motion may have occured in the past
2) describe what motion may occur in the future.
3) develop a general understanding of motion

DEMO: 1) Video - Hawk Eye Tennis

2) Video - Hawk Eye in Cricket. ~1:30

Classical physics provides a framework for understanding motion via:

Language for describing motion

* speed
* velocity
* acceleration...

Rules (laws) that use the language to understand all motion (of classical objects:

* Newton's Laws
* Energy conservation.

Describe: projectiles, solar system, athletics, air flight, gravity, terminal velocity...