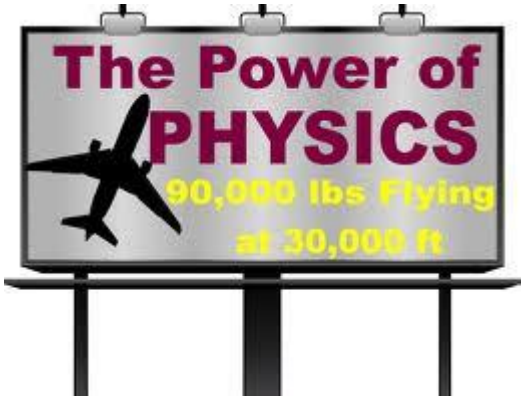
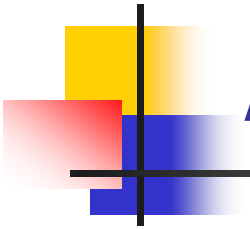
What Is Physics?

Pearland ISD





Mathematical concepts

- Physics experiments involve the measurement of a variety of quantities.
- These measurements should be accurate and reproducible.
- The first step in ensuring accuracy and reproducibility is defining the units in which the measurements are made.

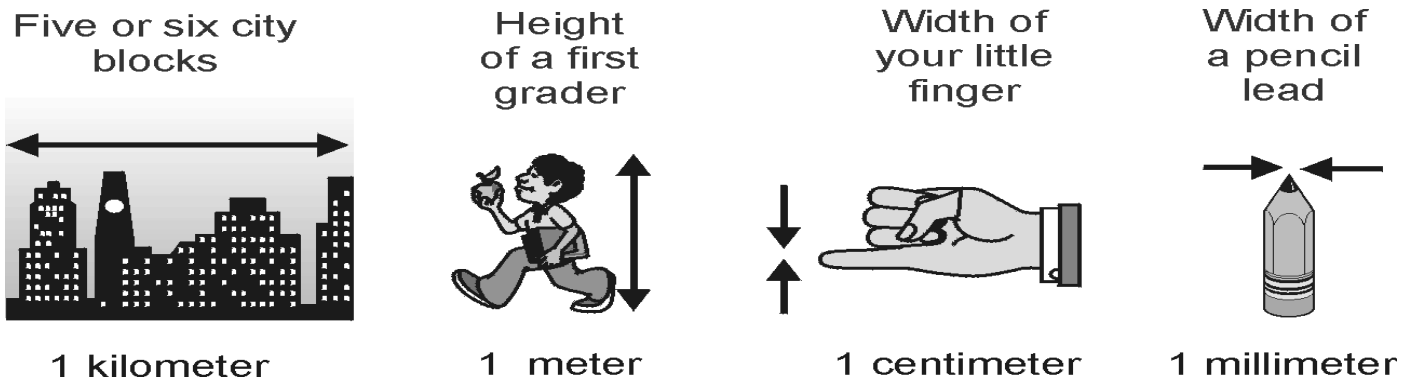
The Role of Units in Problem Solving

- Reasoning Strategy: Converting Between Units

1. In all calculations, write down the units explicitly.
2. Treat all units as algebraic quantities. When identical units are divided, they are eliminated algebraically.
3. Use the conversion factors located on the page facing the inside cover. Be guided by the fact that multiplying or dividing an equation by a factor of 1 does not alter the equation.

Dimensional analysis

- Dimensional analysis - is a process used in determining what units would result from a calculation. In order to be correct, a calculation must produce units of the proper dimension.



Converting units

The Role of Units in Problem Solving

- To convert units, multiply the quantity you wish to convert by fractions equaling one; that is, fractions with equivalent units in the numerator and denominator.
- For example:
  - convert 20 m/s to km/hour.
- $$20\,\frac{\text{m}}{\text{s}} \times \frac{1\,\text{km}}{1000\,\text{m}} \times \frac{60\,\text{s}}{1\,\text{min}} \times \frac{60\,\text{min}}{1\,\text{hr}} = 72\ \text{km/hr}$$

The Role of Units in Problem Solving

- Express the speed limit of 65 miles/hour in terms of meters/second.

- Use 5280 feet = 1 mile and 3600 seconds = 1 hour and 3.281 feet = 1 meter.

$$\text{Speed} = \left(65\,\frac{\text{miles}}{\text{hour}}\right)\left(\frac{5280\,\text{feet}}{\text{mile}}\right)\left(\frac{1\,\text{hour}}{3600\,\text{s}}\right) = 95\,\frac{\text{feet}}{\text{second}}$$

$$\text{Speed} = \left(95\,\frac{\text{feet}}{\text{second}}\right)\left(\frac{1\,\text{meter}}{3.281\,\text{feet}}\right) = 29\,\frac{\text{meters}}{\text{second}}$$

DIMENSIONAL ANALYSIS

The Role of Units in Problem Solving

- [L] = length [M] = mass [T] = time
- Is the following equation dimensionally correct?

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

$$[\mathrm{L}] = \left[\frac{\mathrm{L}}{\mathrm{T}}\right][\mathrm{T}]^2 = [\mathrm{L}][\mathrm{T}]$$

- NO!!!

1.3 The Role of Units in Problem Solving

- Is the following equation dimensionally correct?

$$x = vt$$

$$[\mathrm{L}] = \left[\frac{\mathrm{L}}{\mathrm{T}}\right][\mathrm{T}] = [\mathrm{L}]$$

- Yes!!

What is physics?

- Physics is the study of the physical world, that is, the world of matter and energy.
- Physics is everywhere; any problem that deals with temperature, size, motion, position, shape, or color involves physics.

Areas Within Physics

Name	Subjects
	motion and its causes
	heat and temperature
	specific types of repetitive motion
	light
	electricity, magnetism, and light

Areas Within Physics

Name	Subjects
mechanics	motion and its causes
	heat and temperature
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Areas Within Physics

Name	Subjects
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Areas Within Physics

Name	Subjects
mechanics	motion and its causes
thermodynamics	heat and temperature
vibrations and waves	specific types of repetitive motion
	light
	electricity, magnetism, and light

Areas Within Physics

Name	Subjects
mechanics	motion and its causes
thermodynamics	heat and temperature
vibrations and waves	specific types of repetitive motion
optics	light
	electricity, magnetism, and light

Areas Within Physics

Name	Subjects
mechanics	motion and its causes
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electromagnetism	electricity, magnetism, and light

Areas Within Physics

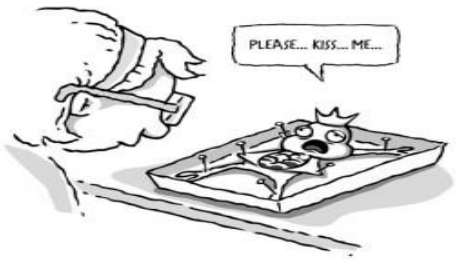
Name	Subjects
relativity	Particles moving at any speed, including very high speed
	Behavior of submicroscopic atomic particles

Areas Within Physics

Name	Subjects
relativity	Particles moving at any speed, including very high speed
quantum mechanics	Behavior of submicroscopic atomic particles

Physics uses the scientific method. –

- Scientific method – an organized process used to conduct scientific investigations or experiments.
- There is no one single procedure, but certain processes are usually present.
- This is the only guide to good science practice



Processes in the Scientific Method

- Make observations and collect data, that lead to a question.
- Formulate and objectively test hypothesis by experimentation.
- Interpret results, and revise the hypothesis and experiment if necessary.
- State conclusions, whether or not the data collected supports the hypothesis.
  - The conclusion should be stated in a form that can be evaluated by others.

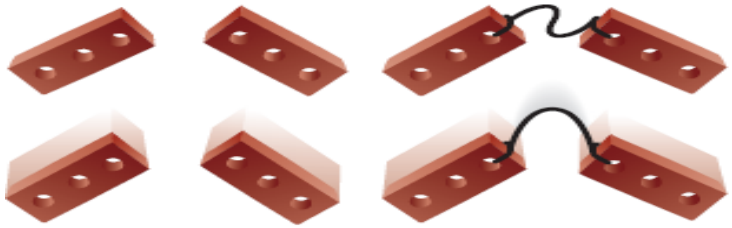
How Physicists Simplify Reality

- System – a set of items or interactions considered a distinct physical entity for the purpose of study;
  - usually, this involves a single object and the items that immediately affect it.

How Physicists Simplify Reality

- Model – a replica or description designed to show the structure or workings of an object, system, or concept.

Galileo's Thought Experiment



What does happen: Heavy objects fall as fast as lighter ones.

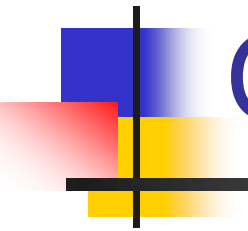
What does not happen: Heavy objects do *not* fall faster than lighter ones.

The Scientific Method

- Using models can help build hypotheses.
- Hypothesis –
  - a possible answer, based on background information available.
  - provides a plan or model for investigation or experimentation.
- Controlled experiment – an experiment involving the manipulation of a single variable or factor.

The Scientific Method

- Independent variable (horizontal-axis)- the quantity that is manipulated by the experimenter in an experiment in order to determine its effect on another quantity.
- Dependent variable (vertical-axis) - the quantity that is being measured; the experimenter tries to determine how the dependent variable is affected by changes in the independent variable.



Chapter 1

III. Measurements in Physics

Dimension

- In physics, dimension refers to the type of quantity being measured.
- For example:
  - Both the height of a building and the distance from here to Dallas have the dimension of **length**, though they are usually measured in different units.
  - A football player's age in years and the number of seconds he takes to run 40 yards are both measurements of the **time** dimension.

Measurement in Experiments

SI Base Units of Measurements		
Dimension	*Unit*	*Symbol*
length		
time		
mass		
current	.	
temperature		

Measurement in Experiments

SI Base Units of Measurements		
	unit	**symbol**
luminous intensity		
amount of a substance		

All other units are called derived units because they are based on combinations of two or more of the SI base units.

Accuracy and Precision

- **Accuracy** – how close a measured value is to the true or accepted value of the quantity being measured
- **Precision** – the degree of exactness with which a measurement is made and stated

Practice:
Accurate, Precise, Both or Neither

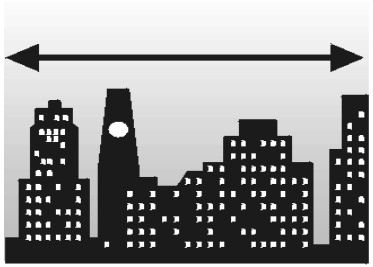
- The following students measure the density of a piece of lead three times. The density of lead is actually 11.34 g/cm^3. Considering all of the results, whose results were accurate? Whose were precise? Were any both accurate and precise? If so, whose?

  - **a.** Rachel: 11.32 g/cm^3, 11.35 g/cm^3, 11.34 g/cm^3
  - **b.** Daniel: 11.43 g/cm^3, 11.44 g/cm^3, 11.42 g/cm^3
  - **c.** Leah: 11.55 g/cm^3, 11.34 g/cm^3, 11.04 g/cm^3

Discovery Mini – Lab: Accuracy and Precision

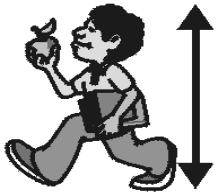
- Now go back to the Accuracy and Precision Mini-lab handout that you completed earlier today and complete your explanations for the ruler you think is better

Five or six city blocks



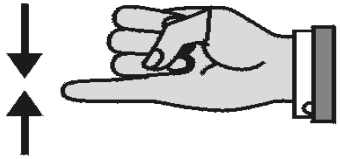
1 kilometer

Height of a first grader



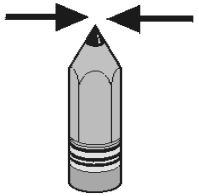
1 meter

Width of your little finger

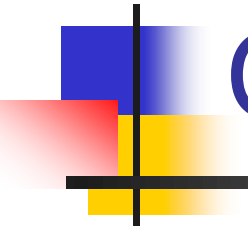


1 centimeter

Width of a pencil lead



1 millimeter



Chapter 1

IV. The language of Physics

Tools to make data easier to understand.

- Tables
  - Very useful for displaying data precisely.
  - The relationship between the quantities may not be clear.
- Graphs
  - Visually display the relationship between two quantities.
  - The precision of the data is limited by the scale of the graph.

Tools to make data easier to understand. – part of this slide is not in your notes ☺

- Equations
  - Mathematically display the relationship between two quantities.
  - Can be manipulated using algebra:

$$d = v \times t \quad (\text{distance} = \text{velocity x time})$$

$$v = \frac{d}{t} \quad (\text{velocity} = \text{distance} / \text{time})$$

Symbols used in physics equations

- Δ means "difference" or "change in."
- Σ means "sum" or "total."

Quantity	Symbol	Units	Unit Abbrev.
Change in position	Δx or Δy	meters	m
Time interval	Δt	seconds	s
Mass	m	kilograms	kg