What is Physics?

It is a Science

(What is science?)

Physics is a physical science (as compared to earth or life science).

Physics is the study of motion and energy.

Science

Science is a “study”

How is science different than other “studies”?

How is science different than English or Social Studies?

Science uses the Scientific Method.

When did “science” start?

What did people use instead of the scientific method?

Knowing by “thinking”

Before science knowledge was determined by philosophy.

Ancient Greek philosophy can be defined as gaining wisdom by using reason.

One example is the idea of impetus. This explanation of motion was proposed by Aristotle about 330 BC.

Knowing by “thinking”

Aristotle reasoned that an object will remain at rest unless given a substance called impetus.

Once given impetus the object would move in a straight line until the impetus was exhausted at which point it would immediately come to rest on the ground.

Impetus

Trajectory

Early Scientists

Nicolaus Copernicus

Galileo Galilei

Issac Newton

To be scientific ideas must be observable and testable.

If ideas do not agree with observations or do not match tests then they must be modified or rejected.

THE SCIENTIFIC METHOD

PURPOSE

WHAT DO YOU WANT TO LEARN?

Research

Find out as much about your topic as you can.

HYPOTHESIS

Predict the answer to the problem.

EXPERIMENT

Design a test to confirm or disprove your hypothesis.

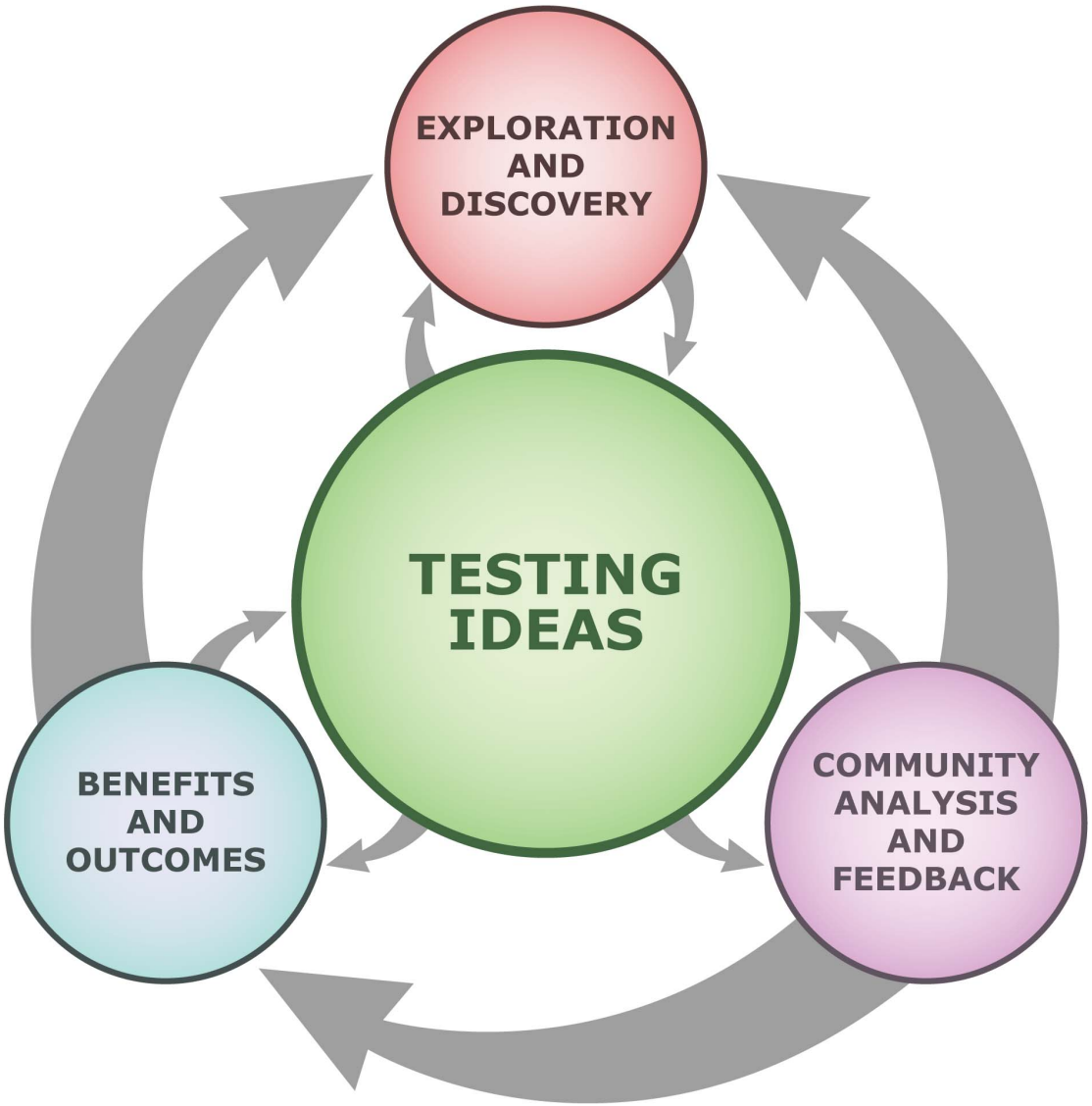
Analysis

Record what happened during the experiment.

Conclusion

Was your hypothesis correct ?

How science works



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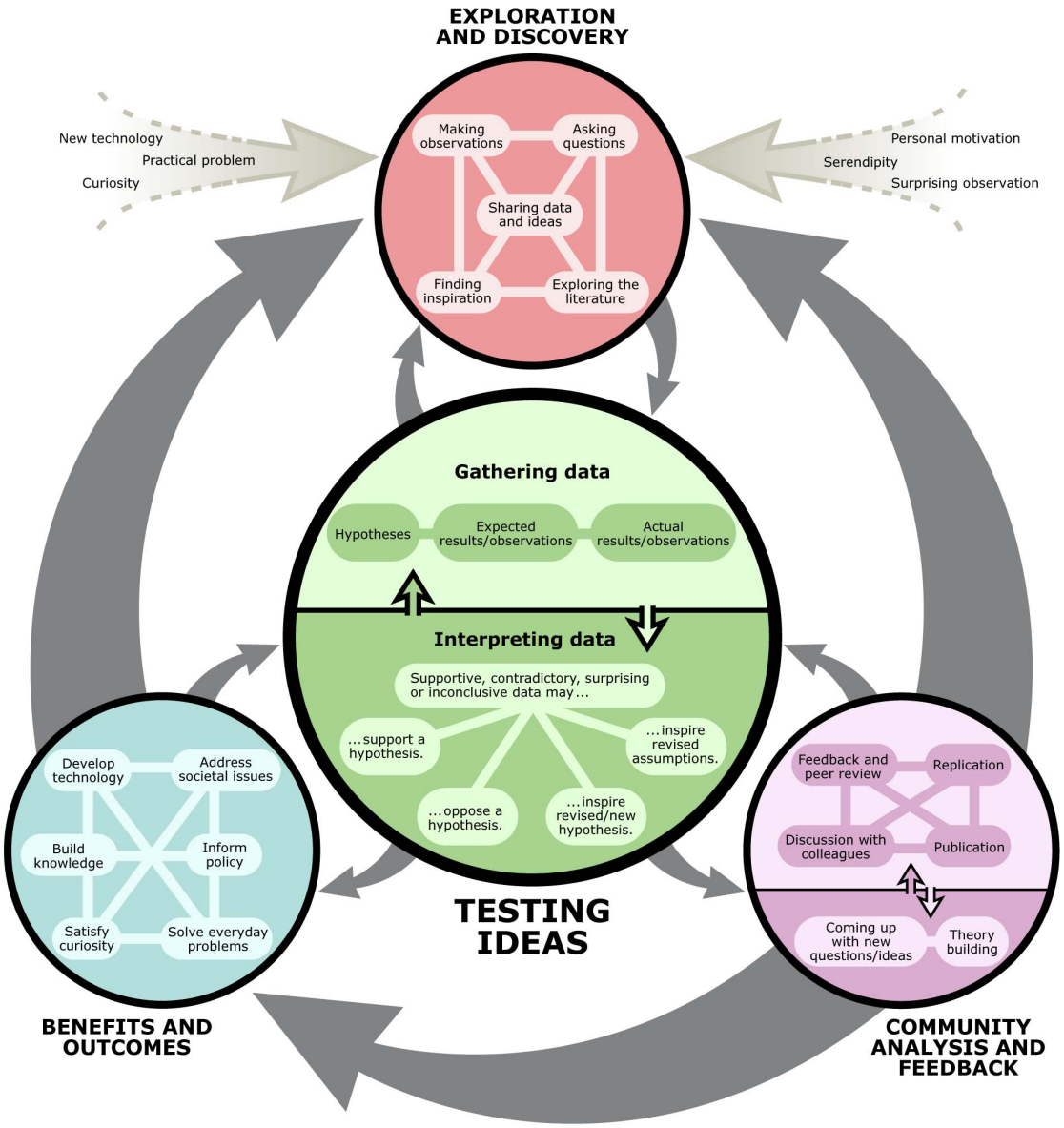

The Scientific Method

The scientific method is NOT a prescribed series of steps.

The scientific method involves:

- Observation (formal or informal collection of data)
- Explanation or summarization (hypothesis - “educated guess”)
- Testing of the hypothesis (collect and analyze more data)

New tests are continuing to be developed for all kinds of scientific ideas.

Laws and Theories

If a hypothesis survives MANY of these tests it becomes either a LAW or a THEORY.

A scientific law is a SUMMARY STATEMENT of many observations. It is very often expressed in math form.

Example: Newton's Second Law of Motion F=ma

A scientific theory is an EXPLANATION of observations. It provides a model or analogy of observations so that we can try to "make sense" of the observations.

Social Theories

A scientific theory is not the same as the term theory used in social situations.

A scientific theory must survive the same kinds of tests as a scientific law.

Similarities

In science both a law and a theory must survive the same kinds of tests. If a law or a theory does not meet the expected results of a test within the errors of measurement then it must either be adjusted or rejected.

Differences

A law is a summary statement. A law only describes what happens.

A theory is an explanation. A theory is a model, a mental picture. A theory tells us why.

Kinds of Data

Qualitative

describes, without a standard

It is hot outside. The ball is red. The weight is heavy.

Quantitative

quantity, standardized by numbers and units

The outside temperature is 29°C. The ball reflects light at 450 nm. The weight produces a gravitational force of 8,302 newtons.

System International
The "Metric System"

Science uses what many of you call the metric system because it is systematic (all prefixes mean the same thing) and it is world wide (common measurements in every country of the world).

Divider Prefixes

Prefix	Value	Example
yocoto (y)	10^{-24}	$1x10^{24}$ ym = 1 m
zepto (z)	10^{-21}	$1x10^{21}$ zm = 1 m
atto (a)	10^{-18}	$1x10^{18}$ am = 1 m
femto (f)	10^{-15}	$1x10^{15}$ fm = 1 m
pico (p)	10^{-12}	$1x10^{12}$ pm = 1 m
nano (n)	10^{-9}	$1x10^{9}$ nm = 1 m
micro (μ)	10^{-6}	$1x10^{6}$ μm = 1 m
milli (m)	10^{-3} or 1/1000	1000 mm = 1 m
centi (c)	10^{-2} or 1/100	100 cm = 1 m
deci (d)	10^{-1} or 1/10	10 dm = 1 m

Multiplier Prefixes

Prefix	Value	Example
Deca (D or da)	10	1 Dm = 10 m
hecto (h)	100	1 hm = 100 m
kilo (k)	1000 or 10^3	1 km = 1000 m
Mega (M)	1,000,000 or 10^6	1 Mm = $1x10^6$ m
Giga (G)	10^9	1 Gm = $1x10^9$ m
Tera (T)	10^{12}	1 Tm = $1x10^{12}$ m
Peta (P)	10^{15}	1 Pm = $1x10^{15}$ m
Exa (E)	10^{18}	1 Em = $1x10^{18}$ m
Zetta (Z)	10^{21}	1 Zm = $1x10^{21}$ m
Yotta (Y)	10^{24}	1 Ym = $1x10^{24}$ m

Required metric conversions

Prefix	Value	Example
kilo (k)	1000 or 10^3	1 km = 1000 m
centi (c)	1/100 or 10^{-2}	1 m = 100 cm or 1 cm = 1/100 m
milli (m)	1/1000 or 10^{-3}	1 m = 1000 mm or 1 mm = 1/1000 m

Scientific Notation

The “metric system” of using powers of ten as prefixes fits in with the use of scientific notation.

Scientific notation is a form of number writing for very large or very small numbers.

Standard scientific notation form:

$n.nn \times 10^{n}$

The decimal point must be after the first digit.

The reason for this rule is an instrument used for calculations called a slide rule.

Base Units

Name	Base quantity	abbreviation
length	meter	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
light intensity	candela	cd

Derived Units

Quantity	Unit Name	abbreviation
volume	Liter or cubic meter	L or m^3
density	kilogram/cubic meter	kg/m^3
force	Newton	N or $kg\ m/s^2$
pressure	Pascal	Pa or N/m^2
energy	Joule	J or $kg\ m^2/s^2$
area	square meter	m^2
concentration	molarity	M or mole/L

For more examples see http://physics.nist.gov/cuu/Units/units.html

Factor Label

How to show your work - make it clear what you are doing.

Science is about evidence. Showing your work is about giving evidence of what you know and what you are doing.

Alternate names: dimensional analysis, train track method, multiplying by one.

Example 1

The playing area of a football field is 100 yards long. How long is a football field in cm?

$$100 \text{ yards} \times \frac{36 \text{ inches}}{1 \text{ yards}} \times \frac{2.54 \text{ cm}}{1 \text{ inches}} = 9144 \text{ cm}$$

Example 2

The label on a pop bottle says it contains 591 mL. What is the volume in liters?

$$591 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} = .591 \text{ L}$$

Example 3

A measure of land area is the acre. A standard acre was measured by surveyors by using a measuring device called a chain. One acre is one chain wide by 10 chains long. One chain is 4 rods, a rod is 16.5 feet. How many square feet are in a “quarter section” (1/4 of a square mile or 160 acres)?

1 acre=10 square chains

1 chain=4 rods

1 rod=16.5 feet

Example 3

$$160 \text{ acres} \times \frac{10 \text{ chains}^2}{1 \text{ acre}} \times \frac{4 \text{ rods}}{1 \text{ chain}} \times \frac{4 \text{ rods}}{1 \text{ chain}} \times \frac{(16.5 \text{ ft})^2}{(1 \text{ rod})^2} = 6{,}969{,}600 \text{ ft}^2$$