

SCIENTIFIC INQUIRY OR THE SCIENTIFIC METHOD

Make an observation

Ask a question

Form a hypothesis that
answers the question

Make a prediction based
on the hypothesis

Do an experiment
to test the prediction

Analyze the results

Hypothesis is
CORRECT

Hypothesis is
INCORRECT

Report results

Try again...

A Rough Guide to TYPES OF SCIENTIFIC EVIDENCE

Being able to evaluate the evidence behind a claim is important, but scientific evidence comes in a variety of forms. Here, the different types of scientific evidence are ranked and described, particularly those relevant to health and medicinal claims.

INCREASING STRENGTH OF EVIDENCE



ANECDOTAL &
EXPERT OPINIONS

Anecdotal evidence is a person's own personal experience or view, not necessarily representative of typical experiences. An expert's stand-alone opinion, or that given in a written news article, are both considered weak forms of evidence without scientific studies to back them up.



ANIMAL & CELL
STUDIES
(experimental)

Animal research can be useful, and can predict effects also seen in humans. However, observed effects can also differ, so subsequent human trials are required before a particular effect can be said to be seen in humans. Tests on isolated cells can also produce different results to those in the body.



CASE REPORTS &
CASE SERIES
(observational)

A case report is a written record on a particular subject. Though low on the hierarchy of evidence, they can aid detection of new diseases, or side effects of treatments. A case series is similar, but tracks multiple subjects. Both types of study cannot prove causation, only correlation.



CASE-CONTROL
STUDIES
(observational)

Case control studies are retrospective, involving two groups of subjects, one with a particular condition or symptom, and one without. They then track back to determine an attribute or exposure that could have caused this. Again, these studies show correlation, but it is hard to prove causation.



COHORT
STUDIES
(observational)

A cohort study is similar to a case-control study. It involves selection of a group of people sharing a certain characteristic or treatment (e.g. exposure to a chemical), and compares them over time to a group of people who do not have this characteristic or treatment, noting any difference in outcome.



RANDOMISED
CONTROLLED TRIALS
(experimental)

Subjects are randomly assigned to a test group, which receives the treatment, or a control group, which commonly receives a placebo. In 'blind' trials, participants do not know which group they are in; in 'double blind' trials, the experimenters do not know either. Blinding trials helps remove bias.



SYSTEMATIC
REVIEW

Systematic reviews draw on multiple randomised controlled trials to draw their conclusions, and also take into consideration the quality of the studies included. Reviews can help mitigate bias in individual studies and give us a more complete picture, making them the best form of evidence.

Note that in certain cases, some of these types of evidence may not be possible to procure, for ethical or other reasons.



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It pays to keep an open
mind, but not so open
your brains fall out.

Carl Sagan

A LITTLE ABOUT YOUR PRESENTER

Born on the Southwest side of Chicago, William Pack got his first job in a magic shop at the age of 11. He is an award winning magician and storyteller, Victorian séance re-enactor, former card cheat, ex-casino surveillance, occasional author, and historian. His natural comedy and astonishing sleight of hand has made him a popular choice for banquet and party entertainment. Available for Corporate and Private events.



♣ PROFESSIONAL
♦ MEMORABLE
♥ ENTERTAINING
♠ FUN

WILLIAM PACK
MORE THAN MAGIC

Fermat's Library
@fermatlibrary

Here's a useful counterintuitive fact: one 18 inch pizza has more 'pizza' than two 12 inch pizzas



Area = $\pi(18/2)^2 = 254 \text{ in}^2$

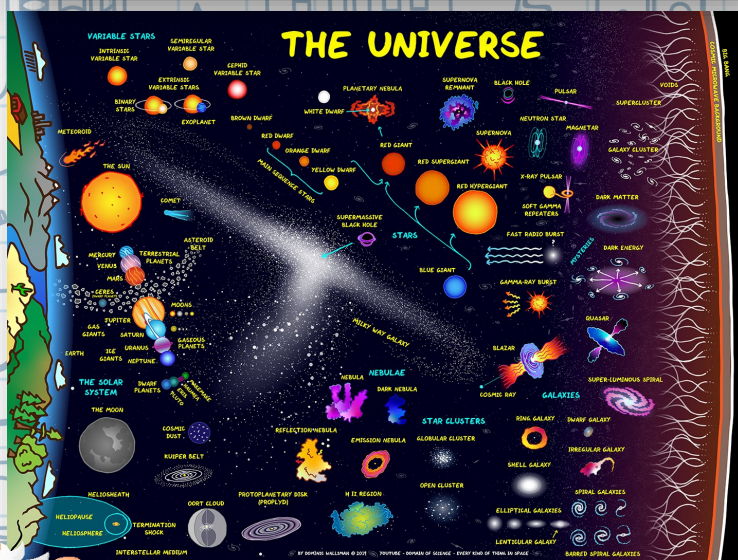
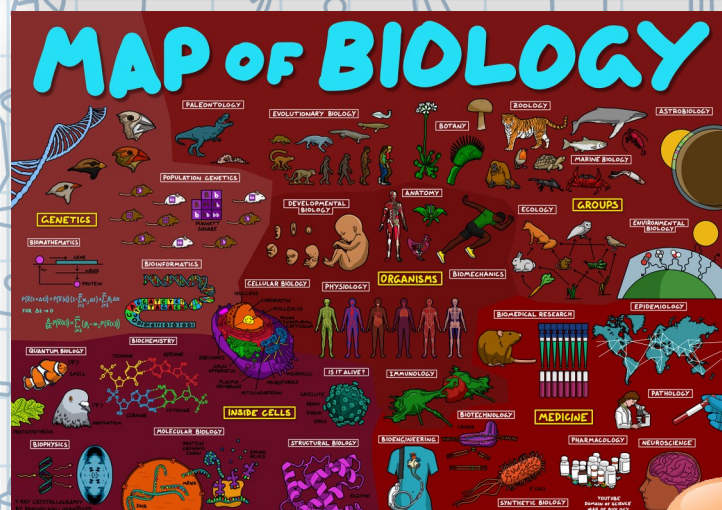
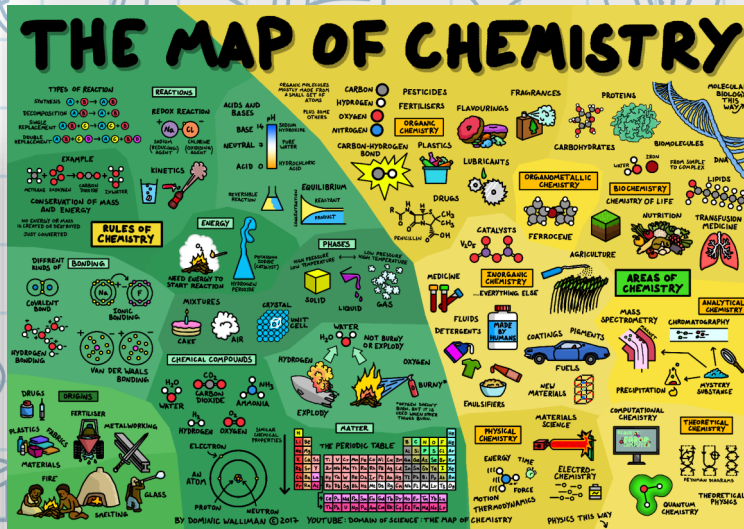
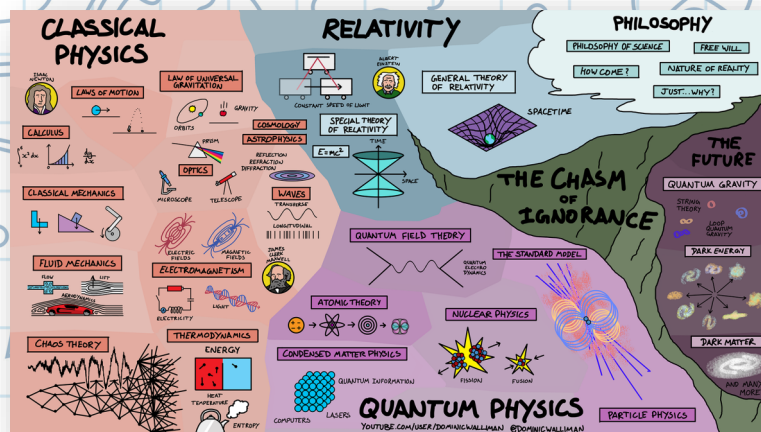


Area = $2\pi(12/2)^2 = 226 \text{ in}^2$

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THE BASIC SCIENCES



SUGGESTED BOOKS

Falling Felines and Fundamental Physics
Gregory J. Gbur

Science Matters
Robert M. Hazen & James Trefil

At Least Know This
Guy P. Harrison

**Understanding the Universe:
From Quarks to the Cosmos**
Don Lincoln

The Element in the Room
Helen Arney & Steve Mould

**Does My Goldfish Know Who I Am? &
Big Questions From Little People**
Gemma Elwin Harris

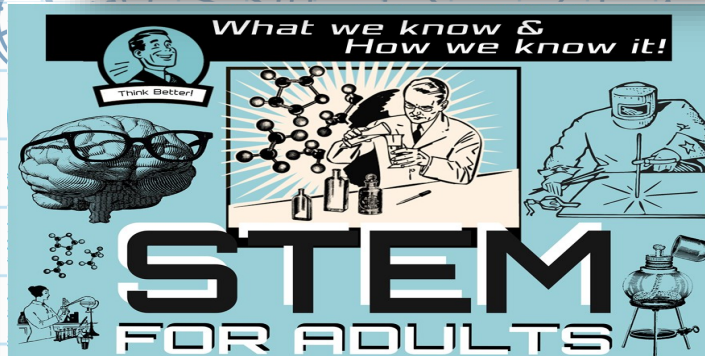
**Everything You need to Ace Science in One Big Fat
Notebook: The Complete Middle School Study
Guide**
(Workman Publishing)

Everyday Amazing
Beatrice the Biologist

The Science Book
(Dorling Kindersley Limited)

SUGGESTED YOUTUBE CHANNELS TO SUBSCRIBE TO.

Fermilab
Amoeba Sisters
AsapScience
CrashCourse
SciShow
Vsauce
Up and Atom
DoS - Domain of Science
(Domain of Science is where you can get
those cool maps of Biology, Physics, etc)
StarTalk
The Science Asylum
ScienceComedian
William Pack



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Law

Describes **how** something in nature behaves but **not why**.

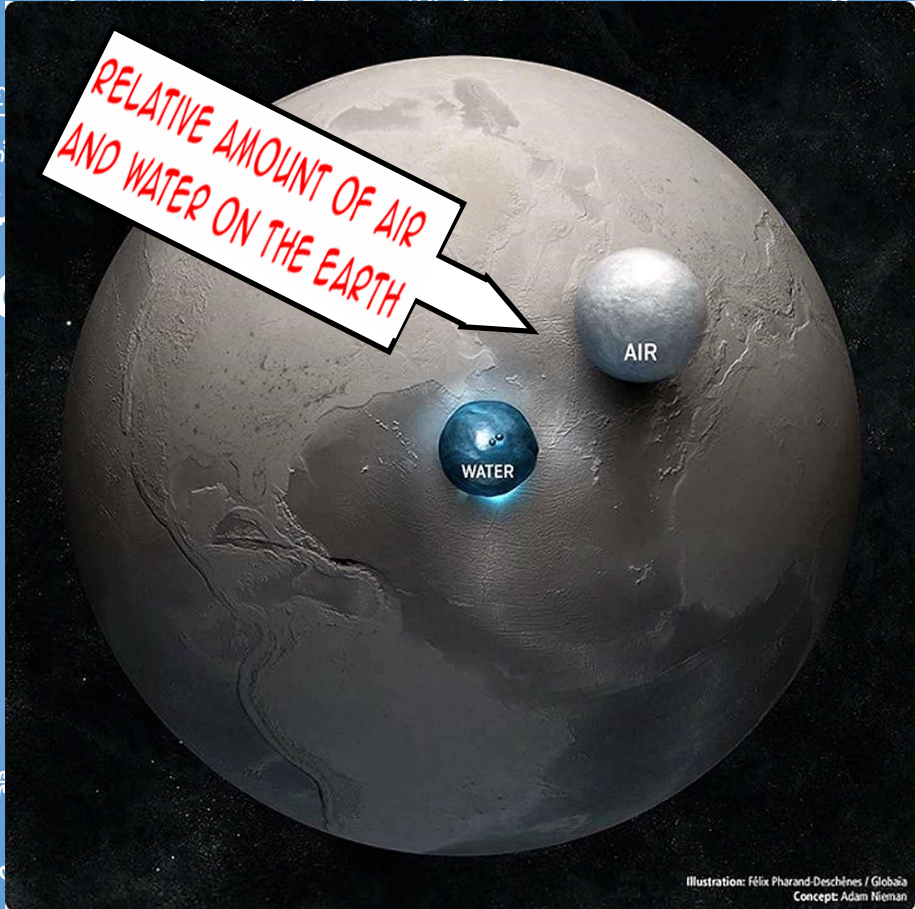
Example: Isaac Newton's Law of Universal Gravitation predicts the motion of objects under the force of Gravity, but doesn't explain why objects move that way.

Theory

A theory is a proposed explanation that has been extensively tested and based on many observations.

Example: Einstein's general theory of relativity explains gravity as a distortion of space (or more precisely, spacetime) caused by the presence of matter or energy. A massive object generates a gravitational field by warping the geometry of the surrounding spacetime.

RELATIVE AMOUNT OF AIR AND WATER ON THE EARTH



THE LAW OF THE CONSERVATION OF MASS

MASS IS NEITHER CREATED NOR DESTROYED BY ORDINARY CHEMICAL REACTIONS OR PHYSICAL TRANSFORMATIONS.

STARTS AND ENDS WITH THE SAME AMOUNT.

EXAMPLE:



Good Science

Testable
Replicable
Refutable
Falsifiable

BAD SCIENCE

1. Check the source
2. Widespread Scientific Criticism
3. Unqualified people
4. Look for exaggeration
5. Data does not support claims
6. Evidence is anecdotal
7. Conflict of Interest
8. False Balance