

One of the most difficult things for students and non-scientists to get 'straight' are the terms: Theory, Hypothesis, Law, Fact and Belief. This exercise consists of a series of statements, which you will mark as a statement of a Theory (T), Hypothesis (H), Fact (F), Law (L) or Belief (B).

Fact: A basic statement established by experiment or observation. All facts are true under specific conditions. Some facts may be false when re-tested with better instruments.

Law: A logical relationship between two or more things that is based on a variety of facts and proven hypothesis. It is often a mathematical statement of how two or more quantities relate to each other.

Hypothesis: A tentative statement such as 'if A happens then B must happen' that can be tested by direct experiment or observation. A proven hypothesis can be expressed as a law or a theory. A disproven hypothesis can sometimes be re-tested and found correct as measurements improve.

Theory: An explanation for why certain laws and facts exist that can be tested to determine its accuracy.

Belief: A statement that is not scientifically provable in the same way as facts, laws, hypotheses or theories. Scientifically disproven beliefs can still be held to be true.

- 1 – For every action, there is an equal and opposite reaction.
- 2 - $F = ma$
- 3 – Water freezes at 32 F
- 4 – The Earth is a sphere.
- 5 – The universe is expanding.
- 6 – Humans were created separately from all other life on Earth.
- 7 – Humans and gorillas evolved from a common ancestor species.
- 8 – Light is an electromagnetic phenomenon described by Maxwell's Laws
- 9 – Matter is comprised of atoms.
- 10 – The sun will die in 7.5 billion years.
- 11 – Earth's magnetic field is generated by a conducting fluid in its core.
- 12 – Sunspots are colder than the surface of the Sun.
- 13 – There are such things as ghosts.
- 14 - The solar system formed from a primordial disk of gas and asteroidal material.
- 15 - Matter can be converted into energy.
- 16 – Energy can be converted into matter.
- 17 – The positions of the planets can cause humans to act in specific ways.
- 18 - Momentum is the product of a body's mass and its velocity.
- 19 – The core of the Sun has a temperature of 14.5 million Centigrade.
- 20 – We will never know how life started on Earth.
- 21 – The Milky Way is a spiral-type galaxy.
- 22 – Black holes exist.
- 23 – The sun will rise tomorrow morning.
- 24 – The Earth is older than 10,000 years.
- 25 – Genetic mutations cause organisms to change over time.
- 26 – Primitive human-like creatures existed 2 million years ago.
- 27 – If I jump out a window I will die.
- 28 – The universe was created at the Big Bang.
- 29 – The first generations of stars appeared about 100 million years after the Big Bang.
- 30 – Space exists in 10-dimensions not just 3.
- 31 – Some numbers are more lucky than others
- 32 – More babies are born, and crimes take place, during the full moon.
- 33 – The Coriolis Force makes water go down a drain counterclockwise.
- 34 - The first multi-cellular organisms appeared on Earth about 560 million years ago.
- 35 – The inverse-square law for gravity and Newton's laws of motion explain why orbits are ellipses

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Notes and topics for discussion:

The distinction between a theory, a law, a fact and an hypothesis is subtle. Theories, laws and facts can start out as hypothesis when they are first proposed and before they are rigorously tested. Can facts be about events in the future?

Generally, a **Fact** is a very elementary statement based on some measurement such as 'Humans are about 6 feet tall' or 'Water boils at 212 F'. A **Law** is based on a collection of individual facts ,and is at attempt (usually with mathematics) to relate one set of measurable quantities to another (mass, speed, temperature, viscosity). Example, $F=ma$, $V = d/t$, $PV = nkT$. A **Theory** is an attempt to explain why certain laws **exist**, and why certain facts are true under specific conditions. Example 1: Planetary orbits are elliptical (A Law) **because** gravity is an inverse-square force (A Law) **and** matter operates under Newton's Laws of Motion. Example 2: Matter is comprised of atoms, and this explains how gases behave (Laws) , why we have specific chemical reactions (Laws), and why the Periodic Table exists (Facts).

Are some facts more certain than others? Water always boils at 212 F at sea level, but at higher altitudes it boils at lower temperatures. So every fact depends on the specific circumstances under which it was measured.