

Important Concepts and Definitions

(updated January 31, 2010)

1. *A priori* knowledge (before the fact)

Knowledge which can be gleaned independent of experience.

Example: Suppose you know John is a bachelor, you know before you ever see John that he does not have a wife. Additionally you know that he has not been married, or anything else that **must** go along with having a wife.

For our class, we will pursue the question as to how much Scientific knowledge is *a priori* (all, some, none?) This is not a trivial question. For example, many models of global warming predict what the future will be like, and we plan on that future *before* it happens (or, in this case, to take action to prevent it from happening). Other models predict what the early stages of the Universe were like, or what happens inside a black hole. These examples can **not** (at this time) be verified empirically, but we tend to count them as a part of our knowledge, since they are thought to follow the laws of Physics by necessity.

2. *A posteriori* knowledge (after the fact)

This is contrasted with *a priori* knowledge and deals with knowledge that we gain by experience or experiment. In the above example, you might know that if John is a bachelor that he is *unmarried* before you meet him, but until you meet him you will not know whether he is blond, thin, fat, tall, short, etc. The details are contingent on other aspects of John, not on his marriage status, and can be known immediately upon meeting him.

Again, an open question is whether all, or what part, of our knowledge ultimately depends upon *a posteriori* verification via experiments.

3. Deduction

The process of drawing inferences from premises such that **IF** *all* the premises are true, the conclusion *must by necessity* be true.

Example (the general form is known as “*modus tollens*”):

If Gravity is equivalent to space-time curvature, **then** light that passes close to the sun will be deflected by an angle determined by the mass of the sun.

Light that passed close to the sun was **not** deflected by an angle determined by the mass of the sun.

THEREFORE, Gravity is **not** equivalent to space-time curvature.

Note that time appears in this example, (premise one is a future conditional, premise two is in past tense, whereas the conclusion is a general statement that is made without reference to time)

Many more examples of simple deductive arguments can be found here:

<http://kslinker.com/VALID-INVALID-CHEAT-SHEET.pdf>

4. Induction

The process of drawing inferences from many examples to *the general conclusion* that future examples will resemble those already observed (the future will resemble the past).

Example:

Objects have always been observed to fall to the surface of the earth with an acceleration equal to 9.8 meters per second squared, hence future objects will fall at this same acceleration.

5. Rationalism

For this class I will use this term to mean that knowledge is obtainable through a process of deduction. This obviates (makes unnecessary) empirical verification.

An example of this attitude was given by Einstein, whose theory of gravity predicted a deflection of a distance star's light by the sun which was different than that predicted by Newton. When Sir Arthur Eddington went on an expedition in 1919 to test the theory during a solar eclipse, Einstein was asked what he would do if the experiment showed a different deflection of starlight than his theory predicted. He is quoted as saying, “Then I would feel sorry for the dear

Lord. The theory is correct anyway."

6. Empiricism

For this class, we will mean the view that knowledge is ultimately tied to experiment and experience. It should be contrasted with rationalism.

There are numerous historical examples of "impossible feats of science" many Philosophers and Scientist considered forever impossible – perhaps the most striking example being heavier than air flight, which was shown to be possible by the invention of the airplane.

There are many current unrealized (but dreamed of) technological advances which some feel will never happen (others take a "wait and see attitude")

Examples:

Sentient computers (computers which are self-aware and intelligent)

Quantum computers

Room temperature super-conductivity

Intelligent life elsewhere in the Universe

An Empiricist about such matters will always take a "wait and see" attitude about such things, even in light of seemingly sound arguments that state their impossibility.

For example, Roger Penrose, a well-known Oxford University Mathematician is on record for stating that non-quantum computers can **never** be sentient, no matter what advances we make in "classical" computer technology – others dismiss his argument as invalid and take a wait and see attitude.

Note to former Logic students:

It might be disconcerting that the validity of such an argument might be a matter of dispute. However, this shows the complexity of breaking down arguments to the correct symbolic form (where a computer could decide validity or invalidity using truth table methods)

7. Necessary truth

Something which must be true (has zero possibility of being false)

Examples:

Either it will rain today or it will not.

If the bar is closed, then it is not open.

An infinite number of coin tosses *never* comes up all heads (assuming the coin is fair)

$2 + 7 = 9$ (base 10)

If $2^p - 1$ is prime, then p must also be prime.

7. Contingent truth

Refers to a proposition which is sometimes true and sometimes false.

Examples:

Today is Feb. 27, 2010

It is 39 degrees in Tucson now.

A gallon of gas costs \$2.75

$2^p - 1$ is prime (some values of p make the statement true, others make it false)

8. The law of the excluded middle (Logic)

The logical law that states that the statement “either P or not P” is true, and there is no middle ground between. Here P stands for any sentence which can be said to have a truth value.

Examples:

Either it will rain today, or it will not.

Either the asteroid XG 17580 will crash into the earth July 2317 or it will not.

Either the Universe has a beginning in time, or it does not.