The Elements of Science

i>Clickers

- Available at the Price Center bookstore
- You will need to bring the clickers to every lecture
- For more info: http://clickers.ucsd.edu/

Basic Operation of i>Clicker

- Turn on the clicker by pressing the bottom “On/Off” button.
- Text will appear in the window at the top of the remote.
- Set frequency to
  - While clicker is off, hold power button until flashing text appears
  - then press the two letter code
- When I ask a question in class (and start the timer), select A, B, C, D, or E as your answer.
How do you know your answer was received?

- In the window next to the answer you submitted a check mark will appear.
- You can vote early and often, but only your last answer will be scored.
  - As long as the timer is going, you can change your answer by simply voting again.

Registering your i>clicker

- In order for me to give you points for your i>clicker responses, I must be able to link for clicker ID to your name and student ID. Send an email with this information to phil12@mechanism.ucsd.edu
  - your name
  - your student ID number
  - your clicker ID (located on the back of your clicker, below the scan code)

Other i>clicker information

- Before using a new clicker for the first time, pull the plastic tab out of the battery compartment.
- Check out www.iclicker.com for FAQs
- Email support@iclicker.com or phone 866-209-5698 for help
What Do Scientists Do?

- One proposal: Scientists observe patterns in what happens in the world
  - Mendel observed a pattern in the inheritance of traits in peas
  - Halley observed a pattern in the occurrence of a comet
- But they do much more: they attempt to explain why things happen
  - Mendel proposed factors which accounted for traits
  - Halley proposed an orbit for a comet

Hypotheses and Theories

- A hypothesis is a conjecture about the way some phenomenon in the world is brought about
  - Malaria is transmitted by mosquitoes
  - Mental imagery uses the same brain processes as perception
- A theory is a systematic set of hypotheses
  - Newton’s theory of motion
  - Freud’s psychodynamic theory
  - Darwin’s theory of evolution

It is just a theory!?

- Hypotheses and theories range from just conjectures or guesses to well-substantiated proposals
  - When first proposed, most hypotheses are just conjectures or proposals—guesses as to how things might be
  - What matters is whether appropriate evidence can be marshaled for them
- Hypotheses and theories that were once well-substantiated may turn out to be false!
  - The theory that the sun circled the earth was once very well supported
- Because hypotheses and theories go beyond the evidence, they always risk being falsified by future evidence
Clicker Question

How does a theory differ from a hypothesis?
- A theory is true whereas a hypothesis is just a guess.
- A hypothesis is a structured set of theories.
- A theory is a systematic set of hypotheses.
- A hypothesis is true whereas a theory is just a guess.

Predictions and Explanations

- We value hypotheses and theories because they give us power and satisfy our curiosity
- **Predictions**—specific detectable phenomena which we can infer from a hypothesis and to which the hypothesis is committed (false predictions count against the truth of a hypothesis)
  - From the hypothesis that mosquitoes transmit malaria, we predict that if we eliminate mosquitoes we will stop (or at least reduce) the spread of malaria
- **Explanations**—enable us to understand why something happens and often to alter it
  - From the hypothesis that a disease is produced by a vitamin deficiency, we can figure out how to treat that disease

Statements: Atoms of representation

- A statement is a sentence that has a **truth value**—it is either true or false (even if we do not know which)
  - Today is Saturday
  - A woman will be President of the US in 2020
  - DNA is found in the nucleus of cells
- A statement has an internal structure (subject, predicate, etc.), but for our purposes we will not go inside of a statement.
  - We will treat statements as atoms (indivisible)
  - They are the basic units with a truth value
Combining Statements

- While we won't divide them, we can combine them using connectives such that the truth value of the compound is determined solely by the truth value of the components
  - AND: true when both components are true
  - OR: true when at least one of the components are true
  - IF, THEN: true unless the first component is true and the second false
  - NOT: true if the component is false

Clicker Question

What is the distinctive feature of a statement?
- It reports the facts.
- It has one subject and one predicate.
- It has a truth value.
- It is written on paper.

Types of statements

- Contingent statements: whether they are true or false depends on how the world is
- Contradictions: false no matter what the truth value of the component statements are
- Tautologies: true no matter what the truth value of the component statements are
  - Definitions: stipulate that the two components have the same truth value
Clicker Question

The sentence
My name is Bill but Bill is not my name
is an example of
A contingent statement
A contradiction
A command
A tautology

Definitions: Important But Vastly Overrated!

Definitions attempt to provide the necessary and sufficient conditions for being an instance of a word.
Example: an odd number is a positive integer that is not divisible by two without remainder.
A necessary condition is a condition which must be met for something to be an instance of the term.
Being an positive integer is necessary for being an odd number.
A sufficient condition is one which suffices for being an instance.
Being both a positive integer and not being divisible by two is sufficient for being an odd number.
Sufficient conditions are especially interesting when there are different ways of satisfying a term.
What are the different ways that suffice to be a U.S. citizen?

Trying to define ordinary terms

Necessary and sufficient conditions can generally only be provided for technical terms (e.g., in mathematics or in legal contracts).
Most ordinary terms defy such definition: For any attempted definition, a counter-example can be found.
A counter example is either
An example that fits the definition but we would not count as an instance of a term
Or
An example that does not fit the definition but we would count as an instance of a term.
Define *bird*

Flying: Not all birds fly (and most insects do)

Feathers: is everything with feathers a bird?
Caudipteryx, Microraptor seem to have had feathers but are not birds

Doing without definitions
Using examples and similarity: start with typical cases

Robin  Chickadee  Blue jay  Finch

Extend to unusual cases

Defining Argument

- While this picture may represent what we typically call an argument

- For our purposes we will offer a specific definition
  - This is common in academic fields
  - Define terms for their own purposes, leaving behind the ordinary meaning
Arguments and justification

- An argument is a set of **statements**, some of which are offered as support for other statements in the set.
- Arguments serve to provide justification: they provide reasons to believe something.
- If someone asserts something which you do not believe, you frequently ask them to justify what they say.
- As we define argument, it need not involve another person—you can construct an argument to demonstrate that something is true without showing it to anyone.

Premises and Conclusions

- The statements offered in support are called premises.
  - Often indicated by words such as *Because, Since, Given that, On account of*, etc.
- The statements that are supported are called conclusions.
  - Often indicated by words such as *Thus, Therefore, This establishes that*, etc.
- Example: Today is Friday, thus, the sun will set.
- Example: Because there is water on Mars there will be life.

Clicker Question

In the argument:

- We can infer from the fact that the dog has lost its hair that there will soon be a lunar eclipse.

The statement “the dog has lost its hair” is:

- A premise
- A conclusion
- Neither a premise nor a conclusion
- Unable to determine from the information given.