Science & pseudoscience –
Part of chapter 3

Including guest appearance by religion &
popular (but incorrect) culture

Goals & Outcomes

• **Appreciating** science in general, and astronomy in specific.

• **Distinguishing** scientific from non-scientific work, and therefore understanding what science is.

• **Developing** a working knowledge of the scientific method and how to apply it to real world situations.

• Judge whether a particular study is a science or a “pseudo-science” using the scientific method.
Learning Objectives

- Understand the Scientific method
  - Limitations to pure objectivity
  - Compare to non-scientific analysis & religion
- Understand the definitions of the word “theory” as used by scientists compared to non-scientists
- Understand what kinds of questions can and cannot be addressed by science
- Know some of the “tricks” of pseudoscience that make it so believable.

Scientific Method

Cyclical process – can (re-)start anywhere in the cycle.

1. ________
   __________

2. ________

3. ________
   Real ________
   Real ________
   Real ________
   (Objectivity p. ___)

4. ________ - Careful ________ taken to
   ________ - Careful ________ taken to
   ________ - Careful ________ taken to
   ________ - Careful ________ taken to

5. ________
   (not in book)

6. If: ________
   or ________ the ________
   If: ________

Look for ________

Science is useless if ________!
Calif. Elementary School Science Standards for scientific inquiry

- From California Science Standards, taken from throughout the K-12 standards
  - What is science?
    - Scientific progress is made by asking meaningful questions and conducting careful investigations.
      - Distinguish between hypothesis and theory as scientific terms.
      - Recognize the usefulness and limitations of models and theories as scientific representations of reality.
  - Ask question
    - Develop a testable question.

Calif. Elementary School Science Standards for scientific inquiry

- From California Science Standards, taken from throughout the K-12 standards
  - Predictions:
    - Make predictions based on observed patterns and not random guessing.
    - Predict the outcome of a simple investigation and compare the result with the prediction.
    - Formulate and justify predictions based on cause-and-effect relationships
Calif. Elementary School Science Standards for scientific inquiry

- From California Science Standards, taken from throughout the K-12 standards
  - Testing hypotheses:
    - Collect data in an investigation and analyze those data to develop a logical conclusion.
    - Repeat observations to improve accuracy and know that the results of similar scientific investigations seldom turn out exactly the same because of differences in the things being investigated, methods being used, or uncertainty in the observation.
    - Conduct multiple trials to test a prediction and draw conclusions about the relationships between predictions and results.
    - Differentiate evidence from opinion and know that scientists do not rely on claims or conclusions unless they are backed by observations that can be confirmed.
    - Evaluate the accuracy and reproducibility of data.
    - Identify and communicate sources of unavoidable experimental error.

- Communication:
  - Communicate observations orally and through drawings.
    Draw pictures that portray some features of the thing being described.
  - Record observations and data with pictures, numbers, or written statements.
  - Record observations on a bar graph.
  - Communicate the steps and results from an investigation in written reports and oral presentations.
  - Identify and communicate sources of unavoidable experimental error.
Calif. Elementary School Science Standards for scientific inquiry

• From California Science Standards, taken from throughout the K-12 standards
  – Revising scientific models:
    • Formulate explanations by using logic and evidence.
    • Recognize whether evidence is consistent with a proposed explanation.
    • Make new observations when discrepancies exist between two descriptions of the same object or phenomenon.
    • Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
    • Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent (e.g., the Piltdown Man fossil or unidentified flying objects) and that the theory is sometimes wrong (e.g., the Ptolemaic model of the movement of the Sun, Moon, and planets).

Calif. Elementary School Science Standards for scientific inquiry

• From California Science Standards, taken from throughout the K-12 standards
  – Human influences:
    • Differentiate observation from inference (interpretation) and know scientists’ explanations come partly from what they observe and partly from how they interpret their observations.
    • Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent (e.g., the Piltdown Man fossil or unidentified flying objects) and that the theory is sometimes wrong (e.g., the Ptolemaic model of the movement of the Sun, Moon, and planets).
    • Differentiate evidence from opinion and know that scientists do not rely on claims or conclusions unless they are backed by observations that can be confirmed.
Hallmarks of Science – figure ________  
(Good scientific theories / good science)

There are 3 big ideas about “science” vs. other kinds of thinking.

1. Have ___________________________ (green circle)  
   ______________ means you must be able to _____________________________

2. Seek ______________________________________________  
   Why natural? ___________________________! (blue circle)  
   These first two usually split science and religion.

3. ___________________ that explains observations. (___________)  
   Make sure ______________________________ (page ____).
   ____________________________________ . Examples:
   • quantum physics, theory of relativity, “law of gravity.”

What’s in a name?  
Theories... page 82

Everyday English uses “guess,” “theory,” and “hypothesis” as ________________.

_____________________________  
Guess – any old random idea to explain observations

_____________________________  
A ____________________________.

Evolution is the only good model that is backed by ___________  
_______________. It is the ___________________________.
California Elementary School
Science Standards for evolution

• From California Science Standards, grade 7
  – Biological evolution accounts for the diversity of species developed through gradual processes over many generations.

Religion vs. Science

_________________________________________________________. (Gravity.)

____________________________. Not all religious ideas can be tested.

____________________________________________________

Science:
• how __________________________________________.
• ______________________________________________
• ______________________________________________.
• ____________________________________________

It’s _______ if you can’t do an experiment to prove it _____. ______

🌟 Religion isn’t always ______. That doesn’t mean it’s ______! 🌟
(Pseudo) Anti-Science ____
pseudo = false

Common and popular examples:

• Creationism -------------(Intelligent design) (NOT science; don’t teach it in science class)
• Astrology ------------ Predicting future by ________

_________ people = same birthday; _ births per __.
_________ babies born in US every day.

• Palm reading, Tarot cards - Semi-legit! ________ mixed with

interpretations! __________ reading!

Astrology, Palm Reading, etc. tend to ___________________. Or they ask leading questions, and they follow your lead.

I’m on a soapbox for this slide…

Anti-Science in popular American culture

• No scientific study has linked vaccines to having autism.
  – There used to be one science study, but it was recently disproven
  – Many scientific studies link lack-of-vaccines to getting sick.
  – In first half of 2008, measles more than tripled in the USA.
  – Most cases were kids who didn’t get a vaccine, fearing autism.
  – Measles can kill you. It is contagious.

– VACCINES SAVE LIVES!
  – See http://www.sciencebasedmedicine.org/?p=384

• Almost all (90+%) science indicates global warming is human-caused and will cause environmental and financial damage over the next 100 years.
  – My generation can’t / won’t fix the problem.
  – Your generation will have to.
Summary

Science

Testable

No conflict with religion

How can we test that? How can we know?