

TOPIC #2 -- ON SCIENCE AND BEING A SCIENTIST

I) Science Overview

II) Personal side of being a scientist

III) Scientific Methods

Traditional/formal:

observation ==> **hypothesis** ==>

prediction ==> **testing**

In practice: “weaving back & forth” between

inductive & **deductive** reasoning

IN-duction: individual obs ==> general conclusion

DE-duction: the big picture (theory) ==>

conclusion/prediction about individual obs

IV). Important Aspects & Critiques of Science

- Theories can never be positively proven to be true, but some can be disproved by “falsifying” them
- Facts and observations can become “theory laden”

V.) Science in action:

- curiosity
- persistence
- rare joys of discovery
- importance of reproducibility of results
- importance of communal review
- cumulative enterprise
- keep an open -- but skeptical – mind
- be ready to change any preconceived ideas if the evidence shows otherwise
- human error / fraud gets weeded out over time
- conflicts of interest may occur / ethics require that they be recognized and reported
- collaborative efforts important
- wonder-awe-joy-mystery!

More Science Quotes

- Science is the best tool ever devised for understanding how the world works.
- Science is a very human form of knowledge. We are always at the brink of the known.
- Science is a collaborative enterprise spanning the generations.
- We remember those who prepared the way . . . seeing for them also.
- If you're scientifically literate, the world looks very different to you – and that understanding empowers you.
- There's real poetry in the real world; science is the poetry of reality.
- We can do science, and with it, we can improve our lives.
- The story of humans is the story of ideas that shine light into dark corners.
- Scientists love mysteries; they love not knowing.
- Scientists don't feel frightened by not knowing things; they think it's much more interesting.
- There's a larger universal reality of which we are all a part.
- The further we probe into the universe, the more remarkable are the discoveries we make.
- The quest for the truth – in and of itself – is a story that's filled with insights.
- From our lonely point in the cosmos, we have – through the power of thought – been able to peer back to a brief moment after the beginning of the universe.
- Science changes the way your mind works. . . . to think a little more deeply about things.
- Science replaces private prejudice with publicly verifiable evidence.

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NOTE: This handout is yours to write on and take home with you.

CLASS ACTIVITY ON SCIENCE AND BEING A SCIENTIST

PART A: Cartoons About Science & Scientists

Fill in the blanks with the letter of the CARTOON (A –G) that best matches each of the PHRASES below:

- | | |
|-------|--|
| _____ | 1. Inductive reasoning |
| _____ | 2. Deductive reasoning |
| _____ | 3. Ever-changing nature of scientific knowledge |
| _____ | 4. Prediction & testing |
| _____ | 5. Conflict of interest |
| _____ | 6. Review of scientific results by colleagues in the same field |
| _____ | 7. Science is a cumulative enterprise |

PART B: Quotes By Scientists About Their Science

Fill in the blanks next to each numbered QUOTE below with the letter of the PHRASE (A-G) that best expresses an aspect of science being described in the quote:

- PHRASES:**
- A. Curiosity & self-discovery tend to motivate scientists**
 - B. Dedicated & persistent research yields benefits**
 - C. Scientists are attracted by the wonder, awe, & joy found in their research**
 - D. Inspiration emerges from a well-informed mind**
 - E. Theories cannot be verified, but they can be falsified**
 - F. Self-deception can color an observation**
 - G. Knowledge is ever-changing**

QUOTES:

- _____ 1. Newton's passage from a falling apple to a falling moon was an act of the prepared imagination. *John Tyndall (1820-1893) Irish physicist.*
- _____ 2. The joy of insight is a sense of involvement and awe, the elated state of mind that you achieve when you have grasped some essential point; it is akin to what you feel on top of a mountain after a hard climb or when you hear a great work of music. *Victor Weisskopf (b. 1908) Austrian-American physicist*
- _____ 3. Besides learning to see, there is another art to be learned -- not to see what is not. *Maria Mitchell (1818-1889) US Astronomer*
- _____ 4. No, it's a great life. It's harder than I ever imagined, in the sense that you have to get used to wasting an enormous amount of time. You have to get the discipline of sitting at your desk fooling around with ideas that almost never work and living for the rare moment when an idea does work. *Steven Weinberg (b. 1933) US physicist.*
- _____ 5. Ask questions. Don't be afraid to appear stupid. The stupid questions are usually the best and the hardest to answer. They force the speaker to think about the basic problem. *Paul Ehrenfest (1880-1933) Austrian physicist*
- _____ 6. The one universal ever-operating law throughout has been the law of change. Nature never stands still and never duplicates herself. Life is always in the process of becoming something else. *Laurence M. Gould (b. 1896-1995), US scientist*
- _____ 7. No amount of experimentation can ever prove me right; a single experiment may at any time prove me wrong. *Albert Einstein (1879-1955) Swiss-American physicist*