

# Enabling Critical Thinking Skills that Sustain Learning for a Lifetime

David T. Marx

*Physics Department*



10<sup>th</sup> Annual University-Wide Symposium on Teaching and Learning

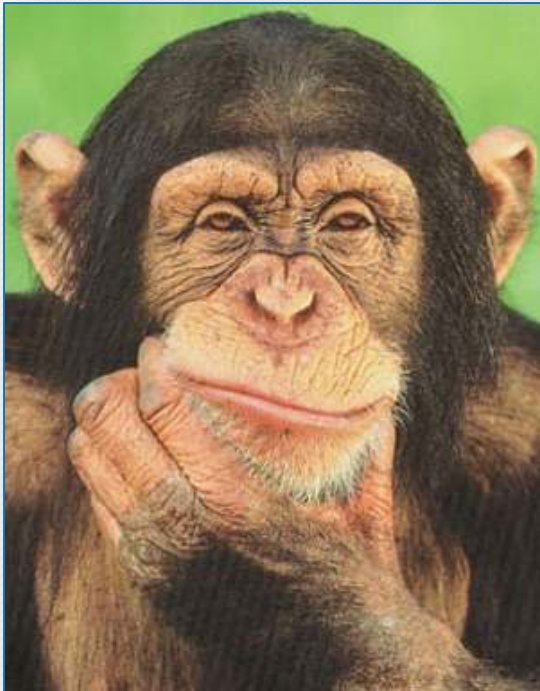
sustainable

TEACHING · LEARNING · LIVING

Wednesday, January 6, 2010

# Definition: Critical Thinking

- a skill
- a mental process
- a behavior / attitude

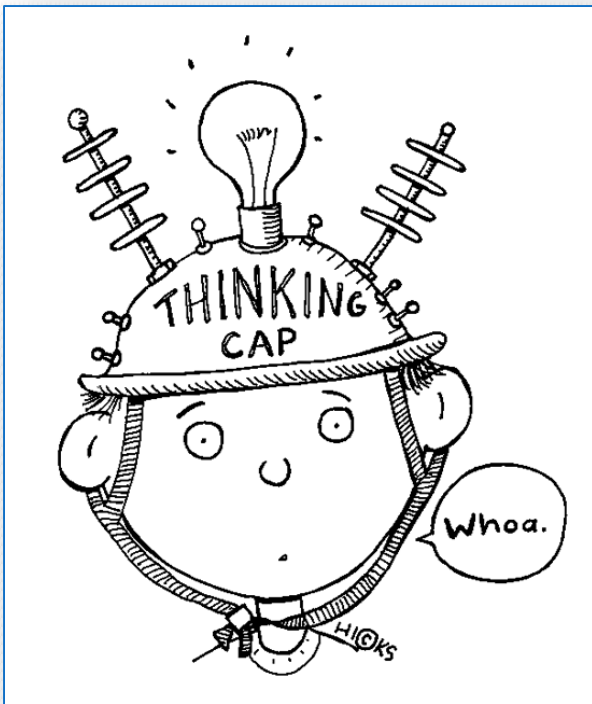


## Skill

- cognitive skills in interpretation, analysis, evaluation, inference, explanation, synthesis, and self-regulation
- We would like these skills to be applicable to a variety of contexts – but rarely does this work in practice.

# Definition: Critical Thinking

- a skill
- a mental process
- a behavior / attitude



## Mental Processes

- Includes: classifying, evaluating, observing, synthesizing, and extrapolating
- An observer (nor even the subject) cannot determine what mental processes are happening. The product is what is evaluated and important.

# Definition: Critical Thinking

- a skill
- a mental process
- a behavior / attitude



## Behavior / Attitude

- Critical thinking requires one to choose to do it. It's hard work. One has to have the right attitude.
- Tasks we seek to do are often difficult to do - *Try and Succeed* – *Try and Fail* – or *Don't try at all*.

# Critical Thinking

## What we can do...

- *Teach Concepts to provide the foundation and the background for learning.*
- *Give direction*
- *Motivate*
- *Enable students to make their own choices, to come to their own conclusions, and to form their own opinions.*



# Critical Thinking



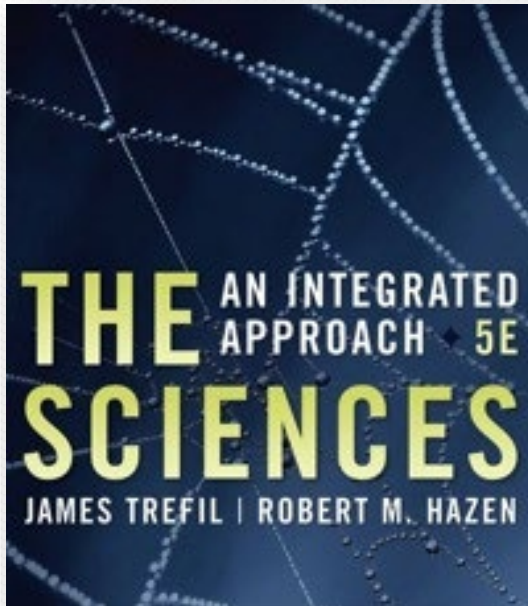
- Rationality
  - Decisions based on information available
  - Doesn't rely on authority
  - Knowledge must be true
  - Beliefs can be true or false
  - The majority opinion may be wrong.

## Physics General Education Courses

**Physics 102:**  
**Atoms to Galaxies**

### Interactive Engagement

**Physics 207:**  
**Energy & Climate Change**



- Clickers
  - Check-in Questions
  - Peer Instruction
  - Surveys
- Small Group Exercises
- Homework
- Semester-long Project

Group Members: \_\_\_\_\_

---

---

### Part One

As a group, imagine that you are members of a city board with the task of considering whether or not to build a coal-fired power plant in your community. Your town has a population of around 5000 and is located in Southern Illinois. The plant would be located near coal mines, either strip mines or deep tunnel mines in nearby communities. Those nearby communities have been suffering economically since many of the mines have been closed due to the high sulfur content of local coal. Your community has the backing of the State of Illinois, industry, and the Federal Government. You may add whatever you think is necessary to this scenario in your discussions.

1. List five questions you need answers for before you'll give your support to this project?
2. What are the pros of having the plant in your community?
3. What are the cons of having the plant in your community?
4. What environmental concerns do you have with regard to the plant?



- 1) Which Moon position (A-E) best corresponds with the moon phase shown in the upper right corner of Figure 1? Make sure that the moon position you choose correctly predicts a moon phase in which only a small crescent of light on the left-hand side of the Moon is visible from Earth.

Enter the letter of your choice: D

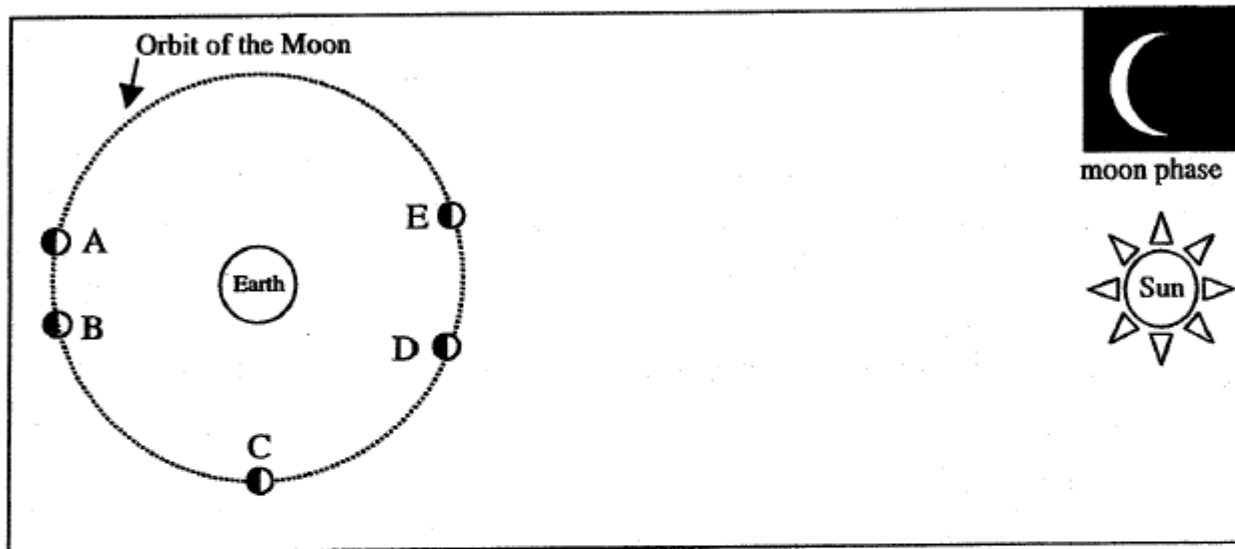


Figure 1

- 2) Give a reason why each of the other possible choices is not the correct position for the phase of the Moon shown in Figure 1.

The view of the moon has a sliver that is lit on the left side. In E, the sliver would be on the right. In C, the moon is half-illuminated as seen from Earth. At A and B, we would see the whole face of the moon pretty much fully illuminated (Full Moon).

## Physics 207: Fall 2009



- **Class Project on Global Warming**
  1. What are “greenhouse” gases? What are the quantities of these gases from both anthropogenic and natural sources?
  2. Learn about the activity of the Sun, including sun spots, energy output, and solar flares. How has the energy output of the Sun varied over time? How does the energy output of the sun affect temperatures on the Earth?


3a. Your first objective in this assignment is to seek out reliable data on the area and thickness (if available) of ice at the poles. You may not use Wikipedia for this. There are websites that give regular updates on this data and also give some degree of historic data. We want only primary sources for this assignment. No secondary sources will be accepted. You can use published data in peer-reviewed scientific journals or the kind of websites described above. Write about what you find, comment on the information, provide figures that you find that support your findings.

3b. Learn about the Earth's climate history, including estimates of the Earth's temperature during these eras. In the history of the Earth, it has undergone eras of ice (ice ages) and eras of extreme heat that resulted in mass extinctions. Find out about this and write in detail about it and provide any figures that back up the information you find. For this, you can use secondary sources, including Wikipedia, because finding primary sources for this is very hard. Secondary sources take the information generated by primary sources and synthesize the information to tell a more complete story.


4. In this assignment, we'll examine the historic temperature data that is being used to determine whether the earth as a whole is warming. Modern temperature data is gathered by satellites (since 1979) and by a network of thermometers. But historic temperature data is harder to come by and has a significant error associated with it. For this assignment you'll be going only to primary sources for this data (no news articles, no commentary articles, no Wikipedia, etc.) – we only want peer-reviewed articles written by the scientists that made the measurements or analyzed the data or the database websites such as those listed below.

Go to the following websites and learn about the datasets that are there and look for historical temperature data. Find out how the data is collected and what, if anything, is done to the raw data before the data is finalized. Look for historic land, sea, and atmospheric temperature data on these sites and copy graphs that are significant to your report and include them in your report. Also, try to find out what the uncertainty is for these measurements.

4b. The historical temperature record has been based on temperature proxies (tree ring data, ice cores, coral etc.) for the time before we had thermometers. Look into the peer-reviewed publications about temperatures proxies. Put any temperature data you find into your report, then find out what factors influence these proxies that affect the way we interpret the data.



As a member of the media, I find it discouraging to think that other journalists may have agendas and/or political ties that affect the content of a specific news source. To me this is totally unacceptable. Journalists have a responsibility to present news, unbiased, to the general public as a service. A lot of the issues of global warming discrepancies involve politics, treaties, and mostly money... even the scientists these days have a bad reputation.



Throughout this paper, I have shown the many instances in which I was shocked upon discovering facts the media and my academic learning of this subject had either failed to mention or skewed to advance the cause of the global warming fight...[I hope this] will lead others to seek out information regarding this topic and not just take what is provided through the mainstream media channels as fact.