Section 1: Nature of Science and Scientific Ethics

The following maps the videos in this section to the Texas Essential Knowledge and Skills for Physics TAC §112.39.

1.01 The Nature of Science

- Physics (b)(1)
- Physics (b)(2)
- Physics (b)(3)
- Physics (b)(5)
- Physics (c)(2)(A)
- Physics (c)(2)(B)
- Physics (c)(2)(C)
- Physics (c)(2)(D)
- Physics (c)(2)(E)

1.02 Scientific Ethics

- Physics (b)(4)

1.03 Impact of Science

- Physics (c)(3)(A)
- Physics (c)(3)(B)
- Physics (c)(3)(C)
- Physics (c)(3)(D)
- Physics (c)(3)(E)

Note: Unless stated otherwise, any sample data is fictitious and used solely for the purpose of instruction.

1.01
The Nature of Science

Science involves the use of empirical evidence to explain phenomena in nature. These explanations can be used to make predictions about future events.

- ***Scientific inquiry*** is the deliberate, planned practice of investigating the natural world using scientific methods.
- Humanity has amassed a vast wealth of knowledge through scientific inquiry, and this knowledge is being refined and added to every day.
- Many scientific theories are expressed conceptually in plain language, while many others are expressed in the language of mathematics.
- Many scientific questions are still unanswered for a variety of reasons.
    - Some require mathematical methods that have not yet been developed.
    - Some require experimental equipment that has not been devised, built, or funded.
    - Some require experimental or theoretical methods that have yet to be devised.
    - Many unanswered scientific questions simply have not yet been asked at all!
- Science is a tool for answering empirical questions, but it is not suited to handle non-empirical questions that are not scientifically testable, such as some of the questions raised by philosophers.

Hypothesis – A tentative, testable statement that has the *possibility* of being supported by observational evidence

Theory – A testable description of nature that has been well-researched and supported by multiple scientists working independently

- Hypotheses that have been reliably and repeatedly supported can be incorporated into scientific theories.
- Scientific theories, while generally considered reliable and time-tested, are under continual scrutiny and can be modified or overturned based on new evidence.

Scientific system – A collection of interacting cycles, structures, and processes that can be described in terms of space, time, energy, and matter

- Systems in nature can be described by ***scientific models***, which are condensed conceptual or mathematical descriptions of those systems.
- Patterns in scientific systems can be used to make predictions about the future.

1.02
Scientific Ethics

Scientific ethics – The practice of science in a socially responsible, truthful, and moral way

- A commitment to unbiased truth is a fundamental tenet of scientific ethics. Scientists should always seek the truth, whatever it may be.
    - A scientist should set aside all opinions when performing and analyzing the results of any scientific experiment.
    - Scientists should remain free of ***conflicts of interest***. For example, if a company pays a scientist to perform a study on their product's safety and offers the scientist an incentive to produce a favorable result, that conflict of interest can cloud the scientist's objectivity.
- Scientists should be open to the idea that they may be wrong and should objectively consider the opinions of those who disagree with them.
- Scientists should be aware of the ways in which their work could be interpreted by the public and should not use that knowledge nefariously. For example, purposely publishing a questionable or untrue result that could make people respond in ways that would benefit the publishing scientist would be considered unethical behavior. Scientists should not abuse the trust placed in them by the public.
- Scientific research using human or animal subjects should always be done with the consent of those involved and with the subjects' well-being in mind. Research subjects should always know that they are involved in an experiment and should be informed of any risks that the experiment may pose to them.
- Not all scientists behave ethically. Throughout history, many gruesome violations of scientific ethics have occurred, and scientists should study history so that they do not repeat the mistakes of the past.

1.03
Impact of Science

- Once you have developed a scientific way of thinking, you can use it in your everyday life to make better choices and to be a more informed member of society.
    - When you encounter an article that presents data to assist in making a point, consider whether the data presented truly supports the conclusions being made.
    - When products claim to be "scientifically proven," locate and read the studies that support those claims, and decide for yourself.
    - Use mathematical models from scientific disciplines to make predictions applicable to your life. For example, you could use your knowledge of exponential and linear growth to make personal financial projections.
    - Engage in more meaningful conversations with peers by using scientific knowledge (especially that of physics) to explain and deepen your understanding of phenomena you observe every day.
- For many businesses, scientific knowledge and quantitative reasoning skills are highly desirable qualities in prospective employees.
    - Level of scientific literacy and education correlates positively with higher-paying careers.
    - Higher-level (and higher-paying) tasks in the economy often require a significant understanding of science, mathematics, critical thinking, and logical reasoning.
    - According to Glassdoor, a web resource about employment, four of the top five highest-paying college majors of 2016 were in fields of engineering. All of them required high levels of scientific study (Glassdoor, 2016).

References

Glassdoor. (2016). “50 Highest Paying College Majors.” Retrieved from https://www.glassdoor.com/blog/50-highest-paying-college-majors