

## SCIENTIFIC REASONING AND THE PRINCIPLES OF SCIENCE

Science, at its essence, is a process of discovery relying on testable ideas to produce explanations of the natural world. This process, grounded in the Nature of Science and Scientific Reasoning, has resulted in fundamental Scientific Principles allowing us to explain natural phenomena and make informed decisions. Scientific explanations, in turn, often rely on mathematics as the language that describes the natural world.

The Air Force needs science-proficient officers who can make decisions in a world increasingly influenced by scientific and quantitative data. Therefore, the goal of this outcome is to develop science-proficient officers, officers who exercise *scientific habits of mind*<sup>1</sup>. This means cadets will be capable in the concepts, practices, and evaluation of the natural and mathematical sciences. Or, put simply, *know, do, and apply*.

The three proficiencies listed below provide the basis for teaching and assessing the goal. The bullets provide a description of the kinds of performance expected to display that proficiency. The descriptions, framed as actions, are intended to convey the idea that the scientifically literate person both understands and is capable of undertaking a basic set of practices<sup>2</sup>.

These proficiencies are not discipline specific but are instead integral themes that apply across the natural and mathematical sciences. Repeated exposure is necessary to develop science-proficient and quantitatively literate officers. Therefore, cadets must encounter these proficiencies across multiple disciplines, such as biology, chemistry, mathematics, and physics.

USAFA GRADUATES WILL BE ABLE TO:

**Proficiency 1:** Demonstrate understanding of the basic **principles, concepts, and language** in the natural and mathematical sciences.

Foundational knowledge and skill in the scientific disciplines is crucial in developing a scientifically literate individual. Summarized generally, a scientifically literate individual understands the basic concepts and mathematical tools of the scientific disciplines. Built upon this foundation is the ability to approach and solve problems from a scientific mindset and the ability to assess scientific information pertinent to decision making.

Cadets can demonstrate this proficiency by the following

- Recall and apply appropriate scientific knowledge
- Identify and use explanatory models
- Make and justify appropriate predictions

**Proficiency 2:** Engage in the **methods and practices** of the natural and mathematical sciences.

No matter what career path is chosen, the study of science will enrich critical thinking skills and expand appreciation of the natural world. Summarized generally, a scientifically literate individual understands how science works. More specifically, a scientifically literate individual knows how to ask scientific questions, how to collect and evaluate empirical data, how to identify patterns in those data, how to access and read relevant primary research, and how to determine the strengths and limitations of different methodologies.

Cadets can demonstrate this proficiency by the following

- Plan and carry out discovery-based investigations
- Identify assumptions and propose methods to explore a question scientifically
- Record observations and collect data
- Analyze and interpret data
- Generate tables and graphics to convey data
- Construct explanations of findings based on principles and evidence

**Proficiency 3:** Apply scientific habits of mind to **access** and **evaluate** scientific information that is pertinent to decision-making.

Leadership requires continuous decision-making. It is essential that Air Force officers recognize questions for which scientific information is relevant and that they have the skills to access and evaluate scientific information. Leaders should recognize that science is an ongoing process that results in reliable knowledge that is nonetheless subject to change.

Cadets can demonstrate this proficiency by the following

- Describe science as an ongoing intellectual pursuit of knowledge that is subject to change
- Identify the types of questions that science can address
- Acquire scientific information from published literature that is relevant to a subject or a question
- Distinguish between sound scientific work and flawed science or pseudoscience

<sup>1</sup> [http://undsci.berkeley.edu/article/think\\_science](http://undsci.berkeley.edu/article/think_science)

<sup>2</sup> <http://www.oecd.org/pisa/test/PISA2015-Released-FT-Cognitive-Items.pdf>