

# Exploring the Dark Universe

## Applicable Indiana Science Standards

### Grade 6

#### Standard 1 The Nature of Science and Technology

##### *Scientific Inquiry*

- 6.1.2 Give examples of different ways scientists investigate natural phenomena and identify processes all scientists use, such as collection of relevant evidence, the use of logical reasoning, and the application of imagination in devising hypotheses and explanations, in order to make sense of the evidence.

##### *The Scientific Enterprise*

- 6.1.6 Explain that computers have become invaluable in science because they speed up and extend people's ability to collect, store, compile, and analyze data; prepare research reports; and share data and ideas with investigators all over the world.

##### *Technology and Science*

- 6.1.7 Explain that technology is essential to science for such purposes as access to outer space and other remote locations, sample collection and treatment, measurement, data collection and storage, computation, and communication of information.

#### Standard 2 Scientific Thinking

##### *Computation and Estimation*

- 6.2.1 Find the mean and median of a set of data.
- 6.2.2 Use technology, such as calculators or computer spreadsheets, in analysis of data.

##### *Communication Skills*

- 6.2.5 Organize information in simple tables and graphs and identify relationships they reveal. Use tables and graphs as examples of evidence for explanations when writing essays or writing about lab work, fieldwork, etc.
- 6.2.6 Read simple tables and graphs produced by others and describe in words what they show.

### **Standard 3**

#### **The Physical Setting**

##### *The Universe*

- 6.3.1 Compare and contrast the size, composition, and surface features of the planets that comprise the solar system, as well as the objects orbiting them. Explain that the planets, except Pluto, move around the sun in nearly circular orbits.

### **Standard 5**

#### **The Mathematical World**

##### *Shapes and Symbolic Relationships*

- 6.5.4 Demonstrate how graphs may help to show patterns — such as trends, varying rates of change, gaps, or clusters — which can be used to make predictions.

## **Grade 7**

### **Standard 1**

#### **The Nature of Science and Technology**

##### *The Scientific View of the World*

- 7.1.1 Recognize and explain that when similar investigations give different results, the scientific challenge is to judge whether the differences are trivial or significant, which often takes further studies to decide.

##### *Scientific Inquiry*

- 7.1.4 Describe that different explanations can be given for the same evidence, and it is not always possible to tell which one is correct without further inquiry.

##### *Technology and Science*

- 7.1.7 Explain how engineers, architects, and others who engage in design and technology use scientific knowledge to solve practical problems.

### **Standard 2**

#### **Scientific Thinking**

##### *Computation and Estimation*

7.2.3 Decide what degree of precision is adequate, based on the degree of precision of the original data, and round off the result of calculator operations to significant figures\* that reasonably reflect those of the inputs.

7.2.4 Express numbers like 100, 1,000, and 1,000,000 as powers of 10.

#### *Communication Skills*

7.2.7 Incorporate circle charts, bar and line graphs, diagrams, scatterplots, and symbols into writing, such as lab or research reports, to serve as evidence for claims and/or conclusions.

### **Standard 3** **The Physical Setting**

#### *The Universe*

7.3.1 Recognize and describe that the sun is a medium-sized star located near the edge of a disk-shaped galaxy of stars and that the universe contains many billions of galaxies and each galaxy contains many billions of stars.

7.3.2 Recognize and describe that the sun is many thousands of times closer to Earth than any other star, allowing light from the sun to reach Earth in a few minutes. Note that this may be compared to time spans of longer than a year for all other stars.

#### *Matter and Energy*

7.3.11 Explain that the sun loses energy by emitting light. Note that only a tiny fraction of that light reaches Earth. Understand that the sun's energy arrives as light with a wide range of wavelengths, consisting of visible light and infrared and ultraviolet radiation.

### **Standard 5** **The Mathematical World**

#### *Reasoning and Uncertainty*

7.5.4 Describe that the larger the sample, the more accurately it represents the whole. Understand, however, that any sample can be poorly chosen and this will make it unrepresentative of the whole.

### **Standard 7** **Common Themes**

7.7.4 Use symbolic equations to show how the quantity of something changes over time or in response to changes in other quantities.

## **Grade 8**

## **Standard 1**

### **The Nature of Science and Technology**

#### *The Scientific View of the World*

- 8.1.1 Recognize that and describe how scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory leads to looking at old observations in a new way.

## **Standard 2**

### **Scientific Thinking**

#### *Manipulation and Observation*

- 8.2.4 Use technological devices, such as calculators and computers, to perform calculations.

#### *Communication*

- 8.2.7 Participate in group discussions on scientific topics by restating or summarizing accurately what others have said, asking for clarification or elaboration, and expressing alternative positions.
- 8.2.8 Use tables, charts, and graphs in making arguments and claims in, for example, oral and written presentations about lab or fieldwork.

#### *Critical Response Skills*

- 8.2.9 Explain why arguments are invalid if based on very small samples of data, biased samples, or samples for which there was no control sample.

## **Standard 3**

### **The Physical Setting**

#### *Matter and Energy*

- 8.3.15 Identify different forms of energy that exist in nature.

#### *Forces of Nature*

- 8.3.16 Explain that every object exerts gravitational force on every other object and that the force depends on how much mass the objects have and how far apart they are.

## **Standard 5**

### **The Mathematical World**

- 8.5.3 Demonstrate that mathematical statements can be used to describe how one quantity changes when another changes.

- 8.5.4 Illustrate how graphs can show a variety of possible relationships between two variables.

## **Standard 7**

### **Common Themes**

#### *Models and Scale*

- 8.7.3 Use technology to assist in graphing and with simulations that compute and display results of changing factors in models.
- 8.7.4 Explain that as the complexity of any system increases, gaining an understanding of it depends on summaries, such as averages and ranges, and on descriptions of typical examples of that system.

## **HS Earth and Space Science**

### **Standard 1**

#### **Principles of Earth and Space Science**

##### *The Universe*

- ES.1.3 Compare and contrast the differences in size, temperature, and age between our sun and other stars.
- ES.1.4 Describe Hubble's law. Identify and understand that the "Big Bang" theory is the most widely accepted theory explaining the formation of the universe.
- ES.1.5 Understand and explain the relationship between planetary systems, stars, multiple-star systems, star clusters, galaxies, and galactic groups in the universe.
- ES.1.8 Discuss the role of sophisticated technology, such as telescopes, computers, space probes, and particle accelerators, in making computer simulations and mathematical models in order to form a scientific account of the universe.

## **HS Physics**

### **Standard 1**

#### **Principles of Physics**

##### *The Relationships Between Motion and Force*

- P.1.6 Describe and measure motion in terms of position, time, and the derived quantities of velocity and acceleration.
- P.1.10 Demonstrate an understanding of the inverse square nature of gravitational and electrostatic forces.

*The Behavior of Waves*

- P.1.22 Describe waves in terms of their fundamental characteristics of velocity, wavelength, frequency or period, and amplitude. Know that radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves, whose speed in a vacuum is approximately  $3 \times 10^8$  m/s (186,000 miles/second).
- P.1.24 Use the concepts of reflection, refraction, polarization, transmission, and absorption to predict the motion of waves moving through space and matter.

*The Nature of Atomic and Subatomic Physics*

- P.1.35 Describe sources and uses of radioactivity and nuclear energy.