Lesson 2 | The Sun and Other Stars

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Launch Lab

LESSON 2: 15 minutes

What are those spots on the Sun?

If you could see the Sun up close, what would it look like? Does it look the same all the time?

Procedure

1. Examine a **collage of Sun images**. Notice the dates on which the pictures were taken.

2. Discuss with a partner what the dark spots might be and why they change position.

3. Select one spot. Estimate how long it took the spot to move completely across the surface of the Sun. Record your estimate in the Data and Observations section below.

Data and Observations

Think About This

1. What do you think the spots are?

2. Why do you think the spots move across the surface of the Sun?

3. **Key Concept** How do you think the Sun changes over days, months, and years?
**The Sun and Other Stars**

**Directions:** Use the terms below to complete the concept map.

1. A ________ is a large ball of gas.

2. and ________ clusters are two types of clusters.

3. ________.

4. ________ occurs.

5. the core, the ________, and the ________.

6. the ________, the ________, and the ________.

7. ________, which plots luminosity v. temperature.

---

**Content Vocabulary**

- chromosphere
- convection zone
- corona
- globular
- Hertzsprung-Russell diagram
- nuclear fusion
- photosphere
- radiative zone
- star
- stellar
A. How Stars Shine

1. When the nuclei of several atoms combine to form one larger nucleus, the process of ________________ occurs.

2. Nuclear fusion releases huge amounts of ________________.

3. A large ball of gas that is held together by gravity and that has a core so hot that nuclear fusion occurs is called a(n) ________________.

B. Composition and Structure of Stars

1. The ________________ is the closest star to Earth.
   a. Studying spectra of the Sun helps scientists figure out ________________ composition.
   b. The Sun and most ________________ are formed mainly of the gases ________________ and helium.

2. When a star first forms, ________________ in its core fuses, forming helium; the helium is ________________ than the hydrogen, so the helium sinks to the inner part of the star’s ________________.

3. A typical star has three inner layers: the ________________, the radiative zone, and the ________________ zone.

4. The three outermost layers of a star form the star’s ________________. The layers exist in the following order (moving outward): ________________, chromosphere, and ________________.

5. The ________________ of the Sun can stay the same for millions of years, but its ________________ can change in minutes, months, or years.
   a. The photosphere has ________________, which are areas of strong magnetic activity that are dark because they are ________________ than the rest of the photosphere.
   b. A(n) ________________, which is a cloud of gas that loops into the ________________, can last for weeks.
   c. A(n) ________________ is a bright, violent eruption that can last for minutes or hours.
Lesson Outline continued

d. ________________________, or CMEs, are huge bubbles of gas flung out from the corona that can reach beyond Earth and can disrupt radio signals on Earth.

e. The ________________________ is made up of charged particles that stream away from the Sun.

f. Particles from CMEs or from the ________________________ interact with Earth’s ________________________, causing ________________________ such as the northern lights.

C. Groups of Stars

1. Some stars are ________________________ stars that have no stellar companion.

2. The most common star system is a(n) ________________________ system, where two stars orbit each other.

3. By studying the orbits of binary stars, astronomers can determine the stars’ ________________________.

4. Many stars exist in large groupings called ________________________.

D. Classifying Stars

1. Scientists use a star’s ________________________—the light it emits spread out by wavelength—and the star’s ________________________ to classify the star.

2. A star’s color is usually related to the star’s ________________________.
   a. ________________________ stars are the coolest stars, and ________________________ stars are the hottest.
   b. A star’s color is usually also closely related to its ________________________; the blue-white stars have the ________________________ mass, and the red stars have the ________________________ mass.

3. A graph that shows increasing luminosity of stars on the y-axis and decreasing temperature of stars on the x-axis is a(n) ________________________ diagram.

4. Most stars on the H-R diagram fall within an area that passes from the upper-left corner to the lower-right corner, called the ________________________ sequence.
   a. At the ________________________ of the H-R diagram are a group of stars called ________________________ or supergiants.
   b. At the ________________________ of the H-R diagram are a group of stars called ________________________.
Can you model the Sun’s structure?

Making a two-dimensional model of the Sun can help you visualize its parts.

**Procedure**

1. Read and complete a lab safety form.
2. Use **scissors** to cut out each **Sun part**.
3. Use a **glue stick** to attach the corona to a sheet of **black paper**. Glue the other pieces to the corona in this order: chromosphere, convection zone, radiative zone, core, and other solar properties.
4. Glue only the top edge of the photosphere over the convection zone.

**Analyze and Conclude**

1. Draw the path a particle of light would follow from the core to the photosphere.

2. **Key Concept** How does this activity model a star’s ability to shine?
The Sun and Other Stars

Directions: On the line before each definition, write the letter of the term that matches it correctly. Each term is used only once.

1. shell of cooler hydrogen above a star’s core
   - A. nuclear fusion
   - B. stellar composition
   - C. star
   - D. radiative zone
   - E. convection zone
   - F. photosphere
   - G. chromosphere
   - H. corona
   - I. sunspots
   - J. solar flares
   - K. solar wind
   - L. binary star system

2. sudden increases of brightness caused by violent eruptions on the Sun

3. elements, including helium and hydrogen gas, that make up a star

4. orange-red layer above the photosphere

5. appear as dark splotches on the Sun

6. occurs when the nuclei of several atoms combine into one larger nucleus

7. two stars that orbit each other

8. apparent surface of a star

9. charged particles that stream away from the Sun

10. large ball of gas held together by gravity with an extremely hot core

11. zone above the radiative zone in which hot gas moves toward the surface

12. wide outermost layer of a star’s atmosphere
### The Sun and Other Stars

**Directions:** Answer each question or respond to each statement in the space provided.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explain how nuclear fusion causes a star to shine.</td>
<td>1.</td>
</tr>
<tr>
<td>What are the three layers of the Sun’s atmosphere? Which layer is most visible from Earth?</td>
<td>2.</td>
</tr>
<tr>
<td>Describe five types of solar activity that occur over short periods of time. Which one extends to the edge of the solar system?</td>
<td>3.</td>
</tr>
<tr>
<td>Compare blue-white stars to red stars. How is a star’s color related to its mass?</td>
<td>4.</td>
</tr>
<tr>
<td>Which two properties are related on a Hertzsprung-Russell diagram?</td>
<td>5.</td>
</tr>
<tr>
<td>What are the characteristics of stars on the main sequence of the Hertzsprung-Russell diagram?</td>
<td>6.</td>
</tr>
</tbody>
</table>
A star is a large ball of gas that has a hot core where nuclear fusion occurs. The Sun is the closest star to Earth. Like most stars, the Sun is made of hydrogen and helium gas. The Sun has six layers: the core, the radiative zone, the convection zone, the photosphere, the chromosphere, and the corona. As stars form, hydrogen fuses into helium; the denser helium sinks to the inner core. Surrounding the core is the radiative zone, which is a shell of cooler hydrogen. Surrounding the radiative zone is the convection zone, where hot gas moves toward the surface and cooler gas moves deeper into the interior. Three outer layers are found beyond the inner layers. The apparent surface of a star is the photosphere. The chromosphere is the orange-red layer above the photosphere. Finally, the corona is the wide, outermost layer of a star.
Word-Usage Activity: Avoiding Double Negatives

The table below shows common negative and affirmative words. Negative words indicate the idea of “no.” Affirmative words indicate the idea of “yes.”

<table>
<thead>
<tr>
<th>Negative</th>
<th>Affirmative</th>
</tr>
</thead>
<tbody>
<tr>
<td>never</td>
<td>ever, always</td>
</tr>
<tr>
<td>nobody</td>
<td>anybody, somebody</td>
</tr>
<tr>
<td>none</td>
<td>one, all</td>
</tr>
<tr>
<td>no one</td>
<td>everyone, someone</td>
</tr>
<tr>
<td>nothing</td>
<td>something, anything</td>
</tr>
<tr>
<td>nowhere</td>
<td>somewhere, anywhere</td>
</tr>
<tr>
<td>scarcely, hardly</td>
<td>some, any</td>
</tr>
</tbody>
</table>

Only one negative word is necessary to express a negative meaning.

**Nobody** did anything this afternoon.

Everyone did **nothing** this afternoon.

A double negative occurs when two negatives are used in the same sentence. Double negatives are not considered proper in modern English. In fact, a double negative conveys a positive.

**Nobody** did **nothing** this afternoon.

If **nobody** did **nothing**, then **everyone** must have done **something**. Double negatives should be avoided in proper speech and writing.

**Directions:** Underline the word(s) that correctly completes each sentence.

1. You do not need (no/any) special equipment to view the constellations.

2. I cannot (ever/never) find the constellation called Orion the Hunter.

3. It is probable that no one will (never/ever) travel to some parts of the universe.

4. If there are too many bright lights in the area, no one can see (anything/nothing) in the night sky.

5. Although space travel has been possible for decades, hardly (no one/anyone) has left Earth’s atmosphere.

6. No one should (ever/never) look directly at the Sun because it can damage a person’s eyes.
The Sun and Other Stars

Directions: Use your textbook to answer each question or respond to each statement.

1. The core of a star is so hot that nuclear fusion occurs.
   How does nuclear fusion cause a star to shine?

2. Though the interior features of the Sun stay the same for millions of years, the Sun’s atmosphere can change over years, months, or minutes.
   What are some features of the Sun that change over short periods of time?

3. The main sequence stars on the H-R diagram form an area that runs diagonally across the graph.
   Contrast the luminosity and surface temperatures of blue main sequence stars and red main sequence stars.

4. The Sun is a yellow star.
   Describe the Sun’s location on the H-R diagram.
The Sun and Other Stars

Key Concept  How do stars shine?

Directions: On each line, write the term from the word bank that correctly completes each sentence. Each term is used only once.

<table>
<thead>
<tr>
<th>Cause</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A substance gets ________________</td>
<td>Its atoms move more quickly.</td>
</tr>
<tr>
<td>2. The atoms that make up a substance move.</td>
<td>The atoms ________________</td>
</tr>
<tr>
<td>3. Nuclear ________________ occurs.</td>
<td>A great amount of energy is released.</td>
</tr>
<tr>
<td>4. A gas becomes hot, and its atoms move more quickly.</td>
<td>The ________________ of some atoms stick together and combine.</td>
</tr>
<tr>
<td>5. The nuclei of several ________________ combine into one larger nucleus.</td>
<td>Nuclear fusion occurs.</td>
</tr>
<tr>
<td>6. ________________ fusion occurs.</td>
<td>Material is converted into heat and light.</td>
</tr>
<tr>
<td>7. The energy from a star’s core travels through the star and radiates into space.</td>
<td>The star ________________</td>
</tr>
</tbody>
</table>
Key Concept Builder

The Sun and Other Stars

Key Concept  How are stars layered?

Directions: Use the diagram to respond to each statement on the lines provided.

1. This layer of the Sun is a shell of cooler hydrogen above a star’s core. __________________

2. Over time, hydrogen in this layer of the Sun fuses into more complex nuclei. __________________

3. This wide, outermost layer of the Sun has an irregular shape and a temperature higher than the chromosphere. __________________

4. This layer of the Sun is above the star’s core and contains cooler and less-dense hydrogen. __________________

5. In this interior layer of the Sun, hot gas moves up toward the surface and cooler gas moves deeper into the interior. __________________

6. Immediately above the photosphere of the Sun is this orange-red layer. __________________

7. This atmospheric gas layer of the Sun is the apparent surface of a star. It is the dense, bright part you can see. __________________

8. Stars fuse hydrogen into helium. The denser helium sinks to the inner part of this layer of the Sun. __________________
### Key Concept Builder

**The Sun and Other Stars**

**Key Concept**  How does the Sun change over short periods of time?

**Directions:** Put a check mark in the column that each feature describes.

<table>
<thead>
<tr>
<th>Changing Features of the Sun</th>
<th>Sunspots</th>
<th>Prominences and Flares</th>
<th>Coronal Mass Ejections</th>
<th>The Solar Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Huge bubbles of gas are ejected from the corona.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Created by charged particles that stream continually away from the Sun</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Regions of strong magnetic activity that appear as dark blotches on the Sun</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Sudden increases in brightness found near sunspots or prominences</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Reduced surface temperature creates areas that are darker than the surrounding material.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Clouds of gas that make loops and jets extending into the corona</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Can interact with Earth’s magnetic field to cause the northern lights</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Violent eruptions that can last from minutes to hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Much larger than flares and can last for several hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Extends to the edge of the solar system</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Begin at or just above the photosphere</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Key Concept Builder**

**LESSON 2**

**The Sun and Other Stars**

**Key Concept** How do scientists classify stars?

**Directions:** Circle the term in parentheses that correctly completes each statement. Use the diagram to answer questions 5–8.

1. (Properties, Chromospheres) used to classify stars include temperature, color, and mass.

2. Blue-white stars are (hotter, cooler) than red stars.

3. Stars with intermediate temperatures are orange, (yellow, red), and white.

4. For most stars on the main sequence, greater mass means (lower, higher) temperature.

5. The stars with lower temperatures are shown on the (left, right) side of the diagram.

6. The largest and (hottest, coolest) stars are shown at the top right of the diagram.

7. Hot and dim stars that are not on the main sequence are (white dwarfs, red giants).

8. The red supergiants shown on the diagram are (hot, cool), luminous, and unusually large.
**Auroras: Paintings in the Sky**

Most of the people who are fortunate enough to see auroras are viewing them from Antarctica and the northern areas of Greenland, Scandinavia, Siberia, Canada, and Alaska.

**What Do You See and Where?**

Although no two auroras are ever alike, they characteristically appear in the dark night sky as giant waves, bands, or curtains of green, red, blue, yellow, or purple waving and swirling light. The North Pole aurora is called the aurora borealis, and the aurora at the South Pole is called the aurora australis.

**What Makes Them Happen?**

To understand how auroras occur, you have to first review some factors about the space around Earth. One factor is the atmosphere—a mixture of several gases. Another is a magnetic field that surrounds Earth. To visualize this field, make a drawing of Earth with a bar magnet in the core pointing north and south. Draw lines to represent the magnetic field: The lines go into and out of Earth at its magnetic poles. Draw 12 lines going out of Earth's South Pole and into Earth's North Pole, six on each side.

A third factor is an invisible plasma made of many charged particles. Charged particles in a magnetic field travel along the magnetic field lines as though they were circling the lines in a long spiral.

Meanwhile, Back at the Sun

The Sun also has an atmosphere and a magnetic field that extend into space. Charged particles from the Sun’s atmosphere are constantly escaping the Sun’s gravity and streaming outward at very high speeds, finally exiting the solar system. Together, these particles and the Sun’s magnetic field are called the solar wind. This wind is always pushing on Earth’s magnetic field, compressing its shape; the compressed field is called the magnetosphere. Sometimes, the pressure from the solar wind creates an electric voltage between the magnetosphere and the poles. This voltage pushes electrons at high speed toward Earth’s magnetic poles. They zoom along the field lines until huge numbers of electrons are pushed into the atmosphere, where they collide with gas atoms, giving the atoms energy that causes them to release light and more electrons. In this way, the gases in the atmosphere begin glowing and conducting flowing electric currents into and out of the polar region.

**Like a Neon Sign**

The way that the aurora works is similar to a neon sign, except that in the aurora, the conducting gas is in the atmosphere instead of inside a glass tube, and the current travels along magnetic field lines, instead of along copper wires.

**Applying Critical-Thinking Skills**

**Directions:** Respond to each statement.

1. **Compare** the source of the voltage in a neon tube with the source in an aurora.

2. **Examine** Earth’s magnetic field on your diagram. Describe where most auroras occur and explain why.
Challenge

Sunspots? The Titanic?

You are a science historian preparing a presentation on how changes in the condition of the natural world have affected the course of human history. You read in a history journal about the 1912 maiden voyage of the RMS Titanic, the largest ship afloat at that time, which was traveling from Southampton, England, to New York City. On April 14, the Titanic collided with a massive iceberg and sank in less than 3 hours.

An article in a science journal mentioned that, in the early 1900s, the climate was much colder than it is today, and it was much more likely that a ship would encounter icebergs than it is today. At that time, large icebergs from the Greenland ice sheet would often drift southward into the Atlantic Ocean and into shipping lanes between Europe and America. It proposed that some climate changes of the twentieth century might be related to changes in sunspot activity. Research the subject and collect data in Tables 1, 2, and 3.

Graph and Analyze Data

1. Construct line graphs from data in Tables 1 and 2 and a bar graph from data in Table 3.

2. Prepare your presentation describing your conclusion about whether sunspot activity was related to the sinking of the Titanic. Provide evidence and explanations.

<table>
<thead>
<tr>
<th>Table 1: Sunspot Numbers: 1860–1980</th>
<th>Table 2: Mean Global Sea Surface Temperatures 1860–1980</th>
<th>Table 3: Icebergs Far South 1900–1980</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>Number of Sunspots</td>
<td>Year</td>
</tr>
<tr>
<td>1860</td>
<td>95.8</td>
<td>1860</td>
</tr>
<tr>
<td>1870</td>
<td>139.0</td>
<td>1870</td>
</tr>
<tr>
<td>1880</td>
<td>32.3</td>
<td>1880</td>
</tr>
<tr>
<td>1890</td>
<td>7.1</td>
<td>1890</td>
</tr>
<tr>
<td>1900</td>
<td>9.5</td>
<td>1900</td>
</tr>
<tr>
<td>1910</td>
<td>18.6</td>
<td>1910</td>
</tr>
<tr>
<td>1920</td>
<td>37.6</td>
<td>1920</td>
</tr>
<tr>
<td>1930</td>
<td>35.7</td>
<td>1930</td>
</tr>
<tr>
<td>1940</td>
<td>67.8</td>
<td>1940</td>
</tr>
<tr>
<td>1950</td>
<td>83.9</td>
<td>1950</td>
</tr>
<tr>
<td>1960</td>
<td>112.3</td>
<td>1960</td>
</tr>
<tr>
<td>1970</td>
<td>104.5</td>
<td>1970</td>
</tr>
<tr>
<td>1980</td>
<td>154.6</td>
<td>1980</td>
</tr>
</tbody>
</table>