Edgenuity

# Warm-Up | The Sun

**Lesson Question**

What are the Sun's characteristics?

## Lesson Goals

**Examine** the structure and behavior of the Sun.

**Identify and describe** different features of the Sun.

**Explain** how the Sun produces energy.

**Describe** units used to measure the distance between the Sun and the Earth.

## Words to Know

*Fill in this table as you work through the lesson. You may also use the glossary to help you.*

| | |
|---|---|
| nuclear fusion | the process where lighter nuclei are combined to produce a larger, heavier nucleus |
| corona | the outer layer of the Sun's atmosphere |
| radiation zone | the layer of the Sun surrounding the core where energy is transferred by radiation |
| photosphere | the lowest layer of the Sun's atmosphere; it gives off light |
| convection zone | the outermost layer of the Sun's interior where energy is transferred outward by convection |

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## Words to Know

| | |
|---|---|
| chromosphere | the middle layer of the Sun's atmosphere |
| solar flare | a sudden eruption of energy from a small area of the Sun's surface |
| astronomical unit | the average distance between the Earth and the Sun |
| sunspot | a dark area on the surface of the Sun that is cooler than surrounding areas |
| prominence | an eruption of material from the surface of the Sun that forms a loop due to the Sun's magnetic field |
| solar wind | a stream of electrically charged particles that flows outward from the Sun's corona in all directions |

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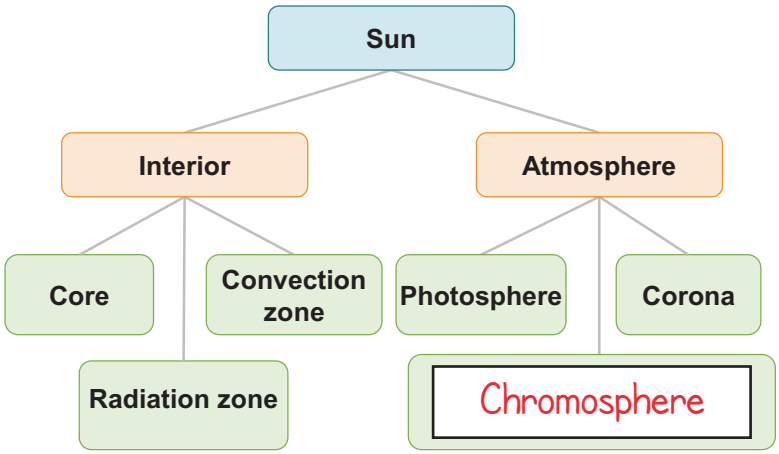
# Instruction | The Sun

Slide 1

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## Sun Facts

- Location: center of the solar system
- Diameter: 1,393,000 km
- Mass: $1.989 \times 10^{30}$ kg
- Distance from Earth: 149,600,000 km
- Age: 4.6 billion years
- Composition by mass: 71% hydrogen, 27% helium, 2% other elements
- Surface temperature: 5,500°C

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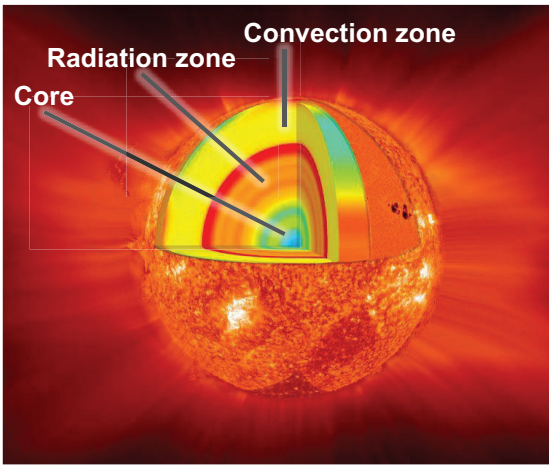
## The Sun's Interior

- Core
  - The innermost layer of the Sun.
  - Energy is produced in the core.
  - The temperature in the core is 15,000,000 °C.




- Radiation **zone**
  - The layer of the Sun surrounding the core where energy is transferred through radiation.
  - Its temperature ranges from 7,000,000 °C to 2,000,000 °C.

- Convection **zone**
  - The outermost layer of the Sun's interior.
  - Energy is transferred outward toward the surface of the Sun by convection.
  - Its temperature is 2,000,000 °C.

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## The Sun's Atmosphere

- Photosphere
  - The lowest layer of the Sun's atmosphere.
  - It gives off light.
  - Its thickness is 100 km.
  - Its temperature is 5,500 °C.

- Chromosphere
  - The middle layer of the Sun's atmosphere.
  - Its thickness is 2,000 km.
  - Its temperature is 6,000 °C to 20,000 °C.

- Corona
  - The outermost layer of the Sun's atmosphere.
  - It extends millions of kilometers into space.
  - Its temperature is 2,000,000 °C.

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## Nuclear Fusion

- **Nuclear fusion** is the process where lighter [nuclei] are combined to produce a larger, heavier nucleus.
- Ingredients: hydrogen gas, extreme heat, and pressure
- Products: [helium] gas and energy

**Hydrogen + Heat and Pressure = Helium + Energy**

## Energy from Fusion

- Four atoms of [hydrogen] combine to form one atom of helium.
- The four hydrogen atoms have more mass than one [helium] atom.
- The “extra” mass is converted into energy during fusion.
- The energy is released.

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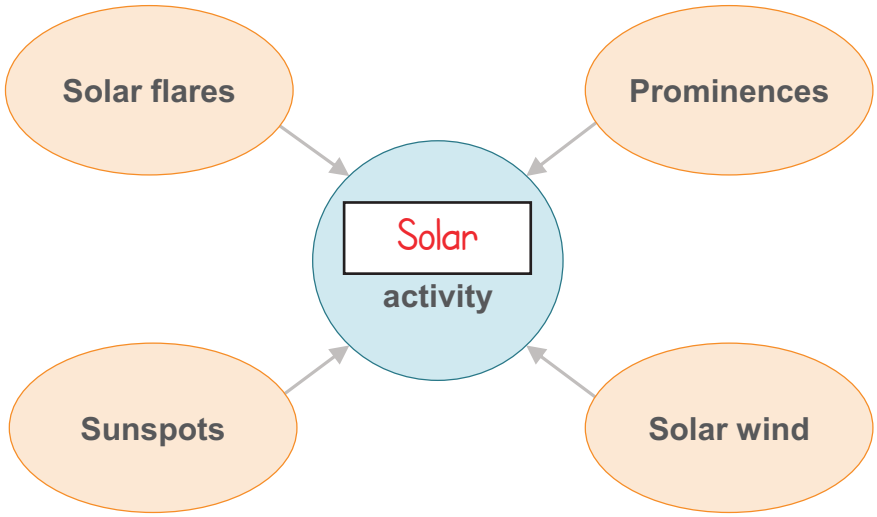


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## Distance from Earth to the Sun

- 93,000,000 miles
- 149,600,000 kilometers
- Astronomical unit – the average distance between the Earth and the Sun
  - Abbreviated “AU”
  - 1 AU = 149,597,870.7 kilometers

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## Solar Activity

- **Sunspots**
  - are dark areas on the surface of the Sun that are cooler than surrounding areas.
  - appear in groups and vary in size.
  - increase and decrease in number over an 11-year period.

## Solar Activity

- **Solar flares**
  - are sudden eruptions of energy from a small area of the Sun's surface.
  - extend into the corona.
  - have temperatures between 10,000,000 °C and 20,000,000 °C.
  - occur near sunspots.
  - disturb radio communications on Earth.

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## Solar Activity

- **Prominences**
  - are eruptions of material from the surface of the Sun that form a loop due to the Sun's [magnetic] field.
  - are loop shaped.
  - are composed of cool, dense gas.
  - can disturb radio communications on Earth.

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## Solar Activity

- The **solar wind**
  - is a stream of [electrically] charged particles that flows outward from the Sun's corona in all directions.
  - extends well beyond [Earth].
  - travels at about 400 km/s.
  - distorts Earth's magnetic field.
  - creates [aurora].
  - disrupts [satellite] communication systems and other electrical systems.

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## Aurora

- Auroras represent the impact of the solar wind on Earth's magnetic field.
- The [particles] of the solar wind flow along lines of the magnetic field.
- These particles collide with gas atoms, causing them to give off light.
- Auroras occur in both [hemispheres].
- Examples include the aurora borealis (northern lights) and the aurora australis (southern lights).

## Magnets and Magnetic Fields

Magnets [attract] objects that contain iron, nickel, or cobalt.

- Magnets form magnetic fields around them.
- A magnet can only push or pull on objects that are in its magnetic field.



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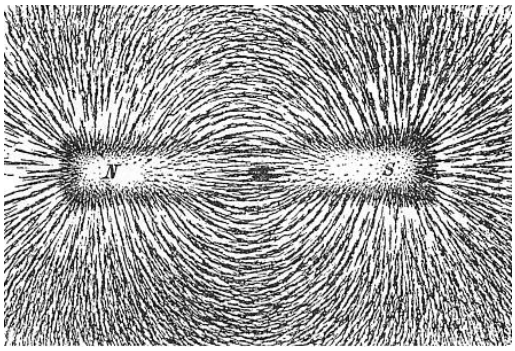
Slide 15

## Magnets and Magnetic Fields

Magnets attract objects that contain iron, nickel, or cobalt.

- Magnets form magnetic [fields] around them.
- The curved [lines] in the image show the pattern of the magnetic field of the magnet.




## Magnets and Magnetic Fields

Magnets attract objects that contain iron, nickel, or cobalt.

- A magnet can only push or pull on objects that are in its magnetic [field].
- In this image, the paper clips within the magnet's magnetic field are [pulled] towards the magnet.

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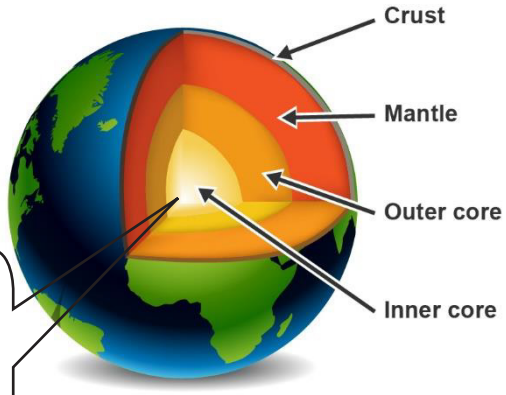
## Earth's Magnetic Field

Earth's magnetic field is a result of two phenomena.

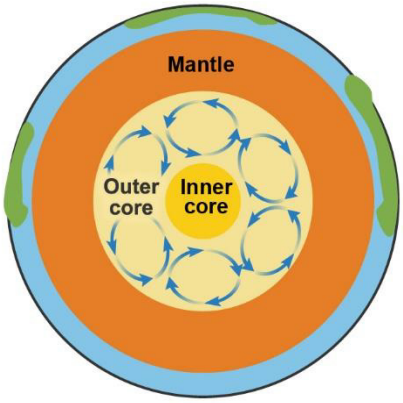
- The constant motion of the [metals] in Earth's core
- The rotation of Earth




The core is composed of a [liquid] outer core and a solid inner core, believed to be made up of iron, nickel and other metals including cobalt.

## Formation of Earth's Magnetic Field

- [Crystallized] metals sink, and non-crystallized metals rise.
- Motion causes the formation of small magnetic fields.

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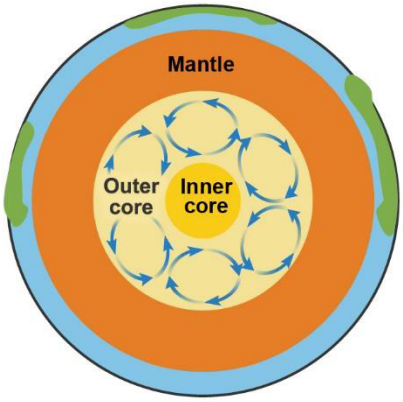
## Formation of Earth's Magnetic Field

The constant motion of the metals in Earth's core contributes to the formation of Earth's magnetic field.

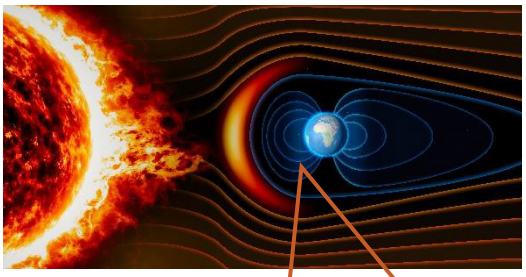



- Crystallized metals sink, and non-crystallized metals [rise].
- Motion causes the formation of small magnetic [fields].

## Rotation and Earth's Magnetic Field

The [rotation] of Earth around its axis plays a role in the formation of Earth's magnetic field.

- The [small] magnetic fields align to produce a giant magnetic field.
- The magnetic field extends thousands of kilometers out toward space.



This image shows the shape of Earth's magnetic field and particles from the [Sun] interacting with it.

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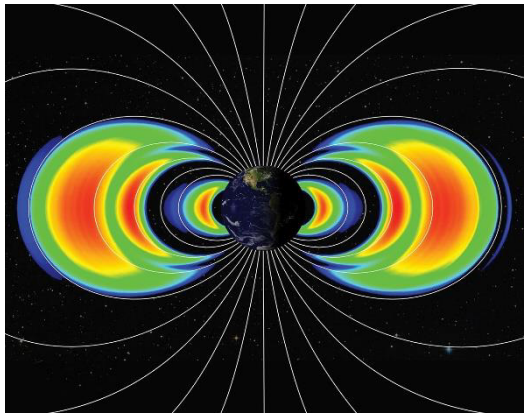
## Van Allen Belts

High-energy particles from the Sun are trapped by Earth's magnetic field.

- The trapped particles form zones called Van Allen belts.



## Van Allen Belts

High-energy particles from the Sun are trapped by Earth's magnetic field.

- The trapped particles form zones called Van Allen belts.
- The belts were named after James Van Allen.



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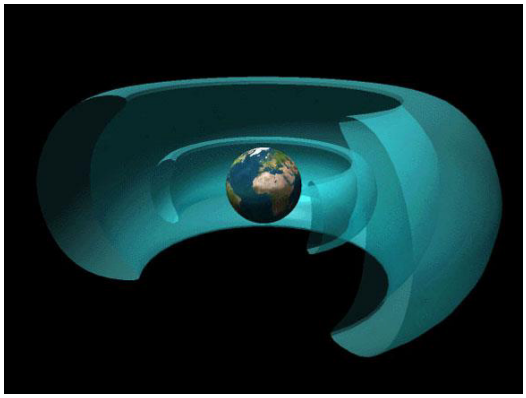
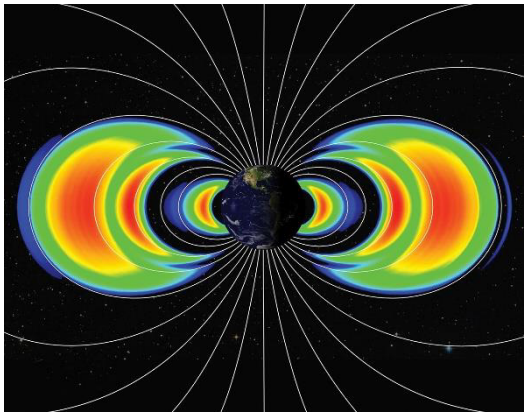
## Van Allen Belts

- It was previously thought that there only [two] belts.
- A third belt is believed to appear sometimes.
- Scientists describe the shape as [donut]-like.



## Van Allen Belts

- The third belt is the [biggest] yellow one with the orange shapes.
- Understanding how the Earth's magnetic field and Van Allen Belts form helps us understand how earth is protected from the Sun's [particles].



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# Summary | The Sun

**Lesson Question**

What are the Sun's characteristics?

## Answer

(Sample answer) The Sun is massive star that is located at the center of the solar system. It is mostly composed of hydrogen and helium. The fusing of the Sun's hydrogen takes place inside the Sun. This process, fusion, releases helium and energy. The surface of the Sun also contains solar activity such as sunspots, solar flares, prominences, and solar winds.

Slide 2

## Review: The Sun

- Characteristics of the Sun
  - General information: star, large, massive, 4.6 billion years old, composed mostly of [hydrogen] and [helium], and located at the center of the solar system
  - Interior: core, radiation zone, convection zone
  - Atmosphere: photosphere, chromosphere, corona
- Distance from Earth to the Sun
  - 93,000,000 miles
  - 149,600,000 kilometers
  - 1 AU = the average distance from the Earth to the Sun

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# Summary | The Sun

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## Review: Nuclear Fusion

- This is a process where lighter nuclei are [combined] to produce a larger, heavier nucleus.
- It requires extreme temperatures and pressures.
- In the Sun, hydrogen atoms fuse to form a helium atom and energy.
- The energy produced during [nuclear fusion] is released.

## Review: Solar Activity

- [Sunspots]
  - Appear in groups, vary in size, cycle over an 11-year period
- Solar flares
  - Occur near sunspots, disturb radio communications on Earth
- [Prominences]
  - Are loop shaped, composed of cool, dense gas, disturb radio communications on Earth
- Solar wind
  - Distorts Earth's magnetic field, creates aurora, and disrupts satellite communication

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# Summary | The Sun

*Use this space to write any questions or thoughts about this lesson.*

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