Sun

Suggested time: 1.25 Hours

What's important in this lesson:

- demonstrate an understanding of the structure, and nature of our solar system
- investigate the appearance and describe the major components of the Sun using appropriate scientific terminology
- understand the composition and physical properties of the Sun, and how it produces solar energy.
- describe the effects the Sun has on the Earth and its atmosphere (e.g., the Sun as an energy source, solar activity, aurora borealis)

Complete these steps:

1. Complete the Diagnostic/Introductory Activity. Get this checked as being completed on your Course Checklist.

2. Use the textbook, *Science 9 Concepts and Connections* and get started on the student handout. If you are having difficulty with a section, note this in the box below: (Questions for Teacher) and move on to the next activity in your student handout. You may need to use the internet for further information in addition to your student handout.

3. Once the student handout is complete check your answers or have your teacher review your answers with the Answer Key. Get this checked as being completed on your Course Checklist.

4. You'll need at least 10-15 minutes to complete the quiz on the material you've reviewed today. If you've got at least that much time ask your teacher for the quiz and hand the quiz in when you're done. If you don't have enough time move on to the Reflective Activity and try the quiz next day.

5. Complete the Reflective Activity. Get this checked as being completed on your Course Checklist.

Hand-in the following to your teacher:

1. The lesson quiz.

Student Instruction Sheet: Unit 4 Lesson 3

Questions for the teacher:

Diagnostic/Introductory Activity:
Unit 4 Lesson 3

Match the words in column A with the definitions found below. Place the corresponding letter in the space provided.

	Column A	**Column B**
	Heliocentric	
	Star	
	Nebulae	
	Sun	
	Nuclear Fusion	
	Convective	
	Radiative	

a) Of or relating to a reference system based at the center of the Sun.

b) A diffuse mass of interstellar dust or gas or both, visible as luminous patches or areas of darkness depending on the way the mass absorbs or reflects incident radiation.

c) Lighter substances (Hydrogen) combine to form a new heavier substance (Helium), releasing energy in the process.

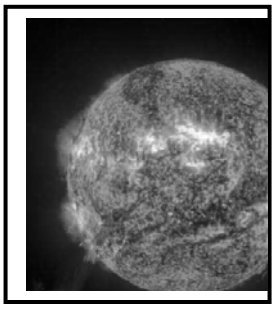
d) Energy that is radiated or transmitted in the form of rays or waves or particles example: the act of spreading outward from a central source

e) A star that is the basis of the solar system and that sustains life on Earth, being the source of heat and light. It has a mean distance from Earth of about 150 million kilometers (93 million miles) a diameter of approximately 1,390,000 kilometers (864,000 miles) and a mass about 330,000 times that of Earth.

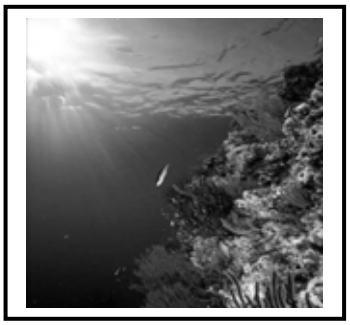
f) How big is it! - more than 1 million planet Earths could fit in it.

g) Fluid circulation driven by temperature gradients; the transfer of heat by this automatic circulation.

h) A self-luminous celestial body consisting of a mass of gas held together by its own gravity in which the energy generated by nuclear reactions in the interior is balanced by the outflow of energy to the surface, and the inward-directed gravitational forces are balanced by the outward-directed gas and radiation pressures.

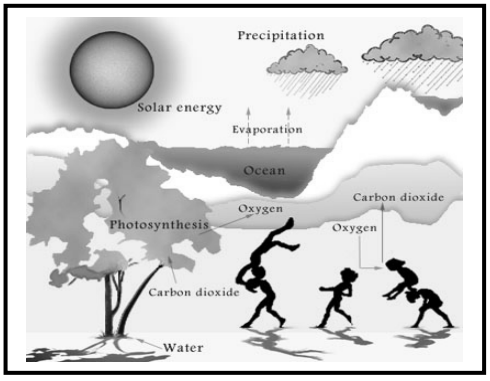


The Sun



- The sun is a star at the centre of our **solar system**.
- It provides energy needed by all plants and animals **(fig. 1).**
- The gravitational pull of the sun keeps the planets in a steady orbit.

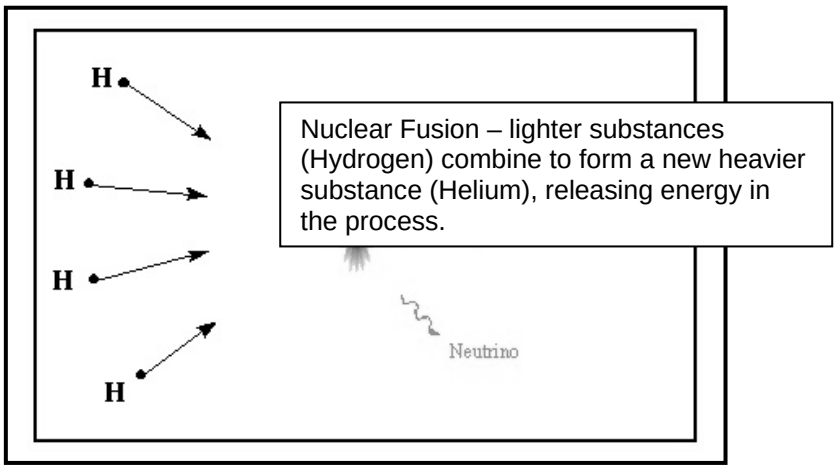
Solar System: the Sun and everything that orbits it, including the planets, their moons, asteroids, and comets



Sun provides energy **(Fig. 1)**

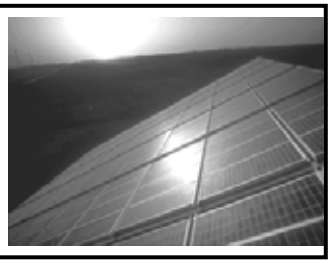
The Sun is one of billions of stars that populate our Universe.

The Sun is composed mostly of Hydrogen and some Helium (and ~2% other elements) and is therefore completely gaseous. The Sun produces huge amounts of heat and light energy through a process called **nuclear fusion**.



At high enough temperature and pressure, 4 hydrogen nuclei (protons) can fuse into a helium nucleus (two protons and two neutrons).In the process, mass is converted into energy. A star processes hydrogen for the majority of its life before dying quietly as a planetary nebula or violently as a supernova. The Sun is in the middle of its hydrogen-burning stage, and will live another few billion years before dying.

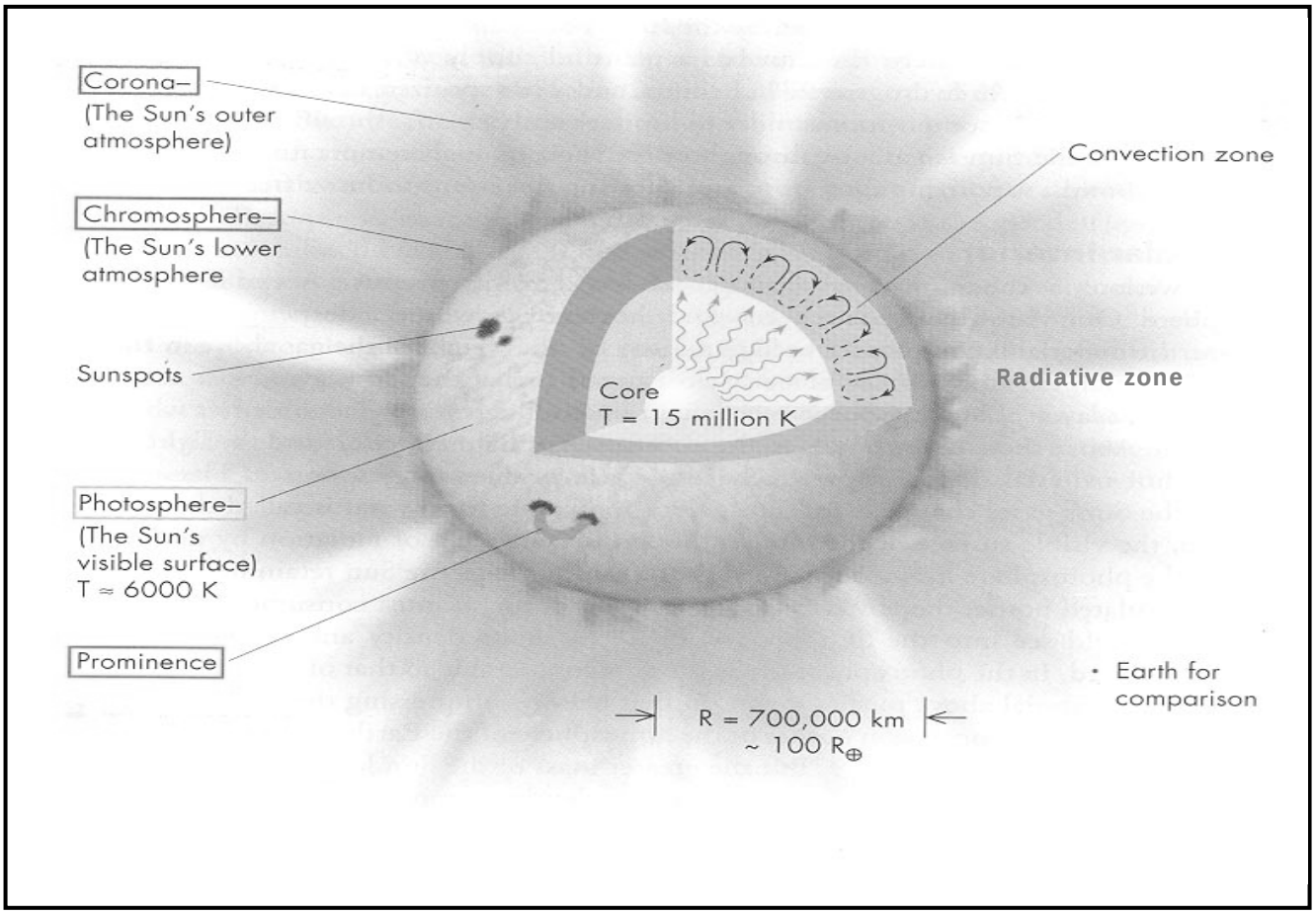
- The Sun has been producing energy for 5 billion years.
- The Sun has used up about 25% of its energy
- Scientists estimate the Sun will continue to produce energy for another 5 billion years before it runs out of hydrogen for nuclear fusion.



Solar Energy:

- Solar panels capture heat and light energy from the sun.
- Solar energy is an environmentally-friendly

Key Components of the Sun



The Core: The core is the centre of the Sun and extends to 25 percent of the Sun's radius. Gravity pulls all of the mass inward and creates intense pressure. This pressure is what forces the hydrogen atoms to come together in nuclear fusion reactions.

Photon – the smallest unit of light/electromagnetic energy.

Radiative Zone: The radiative zone surrounds the Sun's core. In this zone, the energy from the core is carried outward by **photons**.

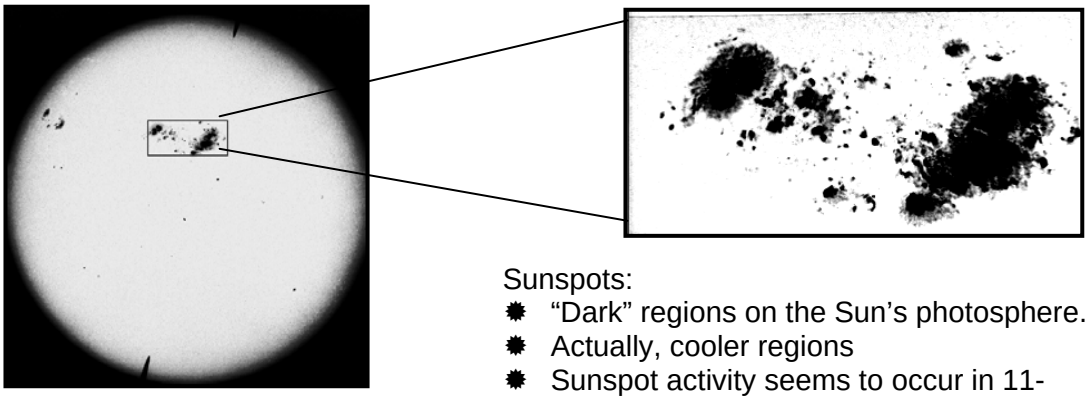
Convective Zone: The convective zone, which is the final 30 percent of the Sun's radius, is dominated by convection currents that carry the energy outward to the surface. These convection currents are rising movements of hot gas next to falling movements of cool gas.

Above the surface of the sun is its atmosphere, which consists of three parts:

- Photosphere
- Chromosphere
- Corona

Photosphere: The surface of the Sun is called the photosphere and is yellow and granular in appearance. The photosphere is the lowest region of the Sun's atmosphere and is the region that can be seen from Earth. It is 300-400 km wide and has an average temperature of 5,800 degrees Kelvin.

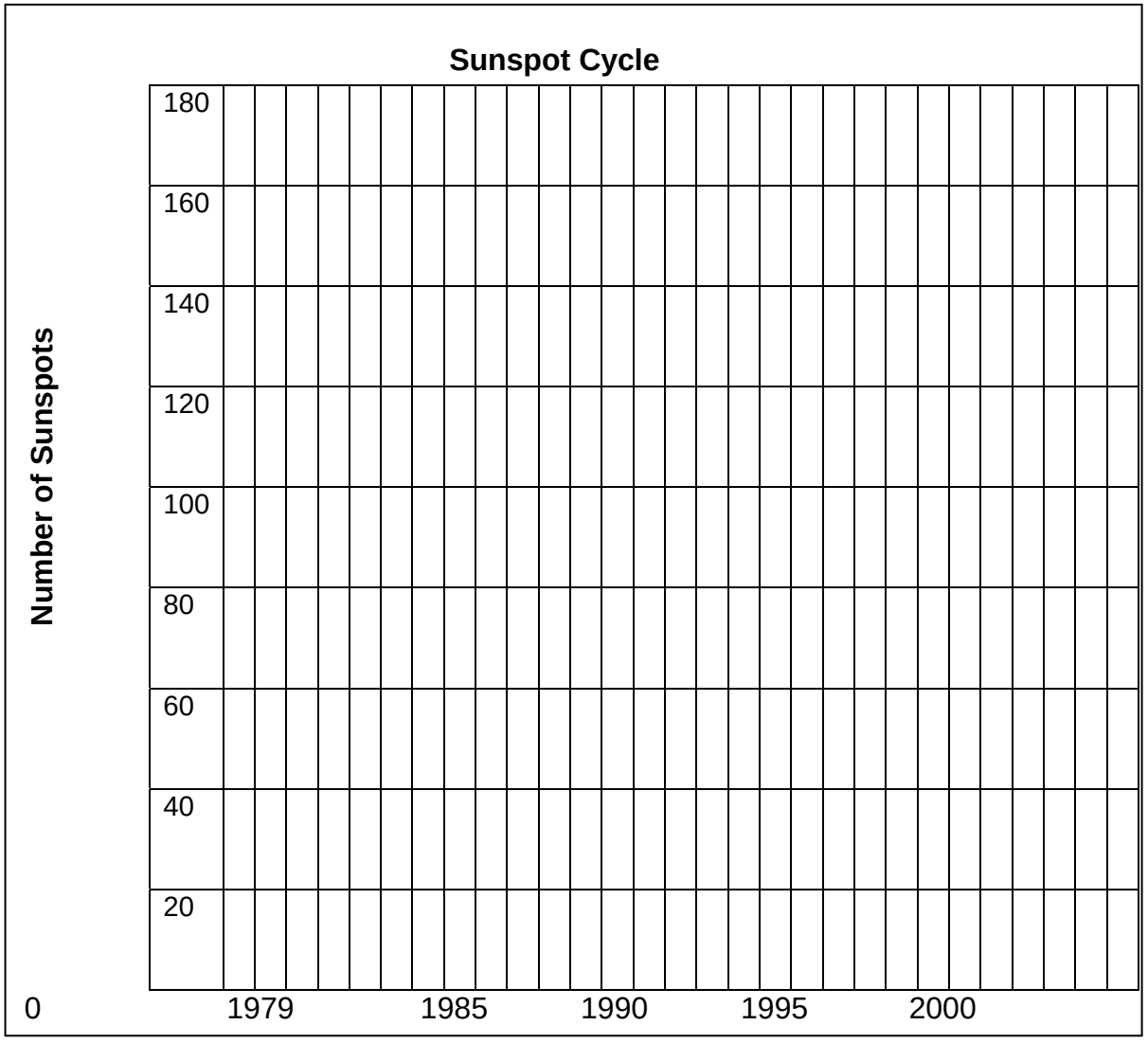
The surface of the Sun was originally thought to be perfect and uniform, but we now know the photosphere is marked by numerous irregularly shaped dark patches called **sunspots**. Sunspots are depressed areas on the Sun which have a lower temperature than the surrounding surface. These sunspots are temporary, and their numbers follow an 11-year cycle between times of maximum and minimum. They often occur in complex groups and are associated with the aurora on the Earth because they are the origin of solar flares.



Sunspots:

- "Dark" regions on the Sun's photosphere.
- Actually, cooler regions
- Sunspot activity seems to occur in 11-year cycles (between times of maximum and minimum activity).
- During times of maximum, hundreds of sunspots are visible, but during a minimum, the photosphere can be absent of any sunspots.

Activity 1: Using the data provided in the chart on the next page, plot a graph to illustrate the Sun's cycle from the years 1979 to 2000 and answer the questions that follow.



Year	Number of Sunspots
1979	155
1980	155
1981	141
1982	116
1983	67
1984	46
1985	18
1986	13
1987	29
1988	100
1989	146
1990	142
1991	156
1992	95
1993	55
1994	30
1995	18
1996	8
1996	21
1997	64
1998	93
1999	121
2000	111

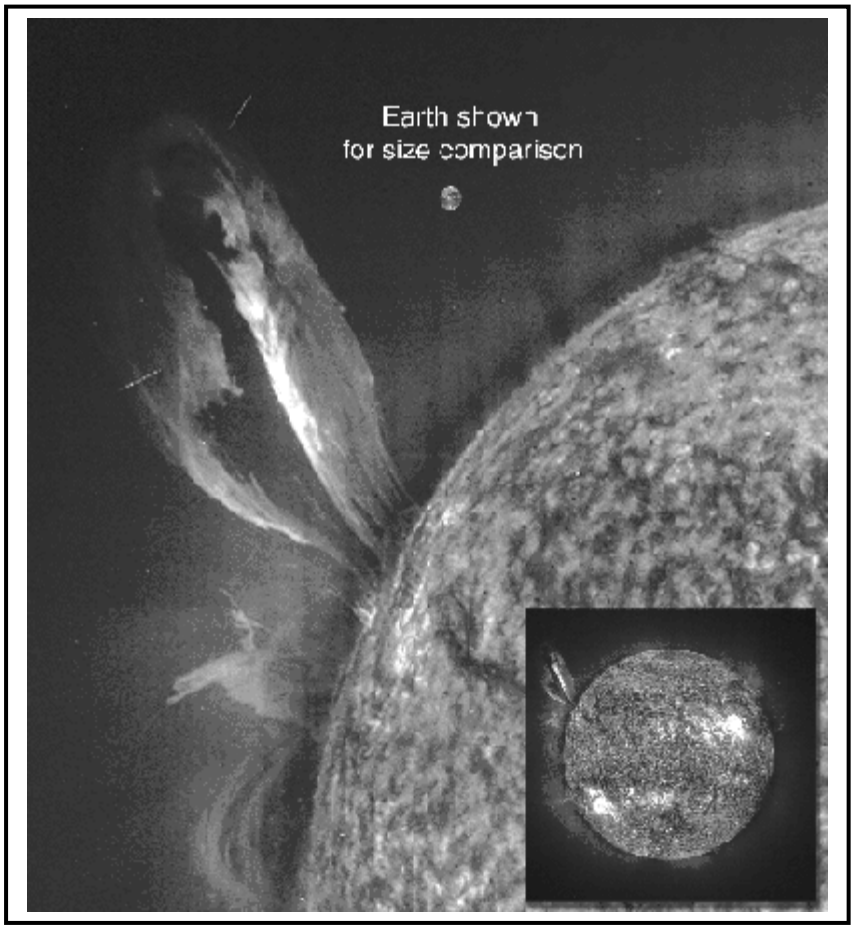
1(a). In what years was sunspot activity at its peak (complete cycle)?.

1. _____ 2. _____

1(b). How many years between peaks? 4. _____ .Is this the number of years in one sunspot cycle? 5. circle answer (yes / no.)

1(c). Since the increase in sunspots is associated with an increase in the release of gas, electrons, visible light, ultraviolet light and X-rays, would you predict Earth's atmosphere to also be bombarded with these particles 6. circle answer (yes / no).

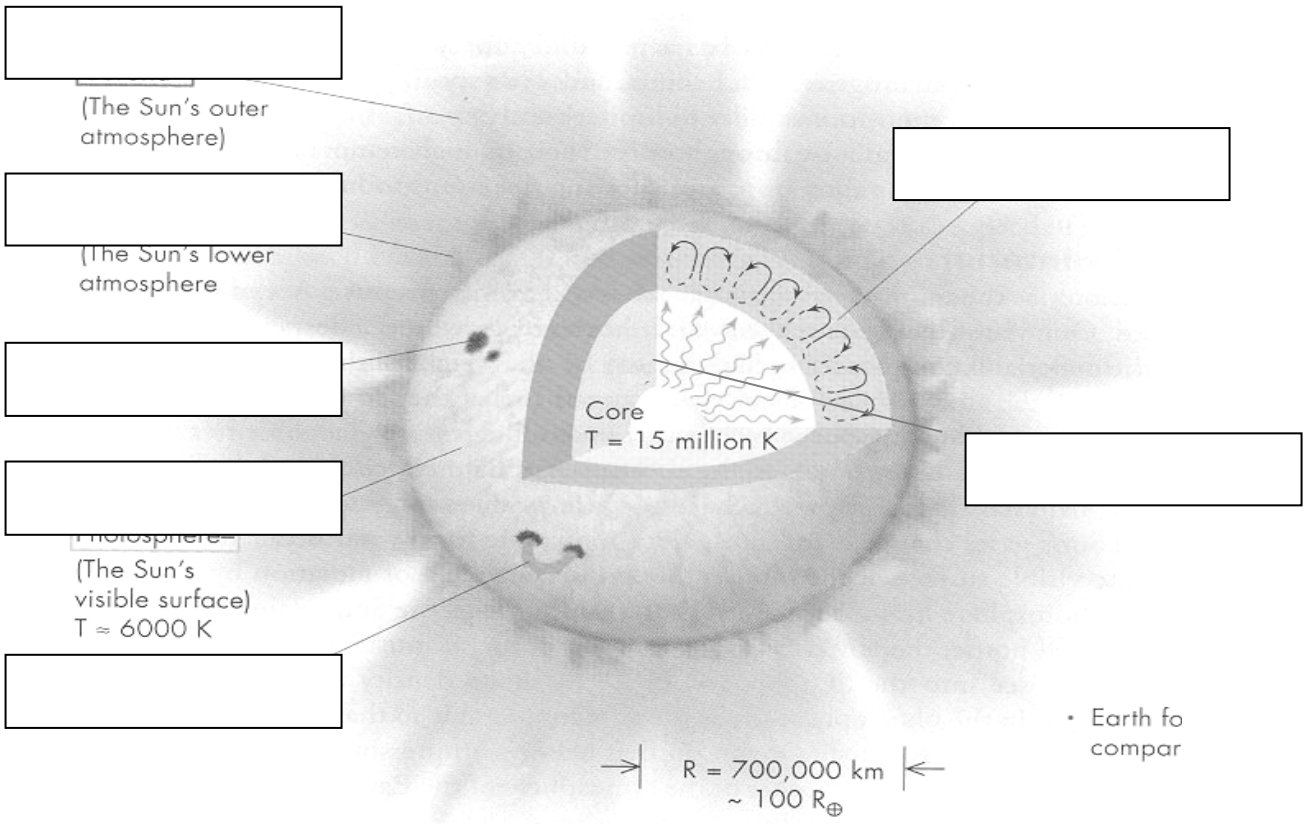
Chromosphere: The chromosphere lies above the photosphere to about 1,200 miles or 2,000 km. The temperature rises across the chromosphere from 4,500 degrees Kelvin to about 10,000 degrees Kelvin. The chromosphere is thought to be heated by convection within the underlying photosphere. Occasionally, clouds of gases from the chromosphere will rise and orient themselves along the magnetic lines from sunspot pairs. These arches of gas are called **prominences**. Prominences can last two to three months and can extend 30,000 miles (50,000 km) or more above the Sun's surface.



Corona: The corona is the final layer of the Sun and extends several million miles or kilometers outward from the photosphere. It can be seen best during a solar eclipse and in X-ray images of the sun. The temperature of the corona averages 2 million degrees Kelvin; although no one is sure why the corona is so hot, it is thought to be caused by the sun's magnetism.

Activity 2:

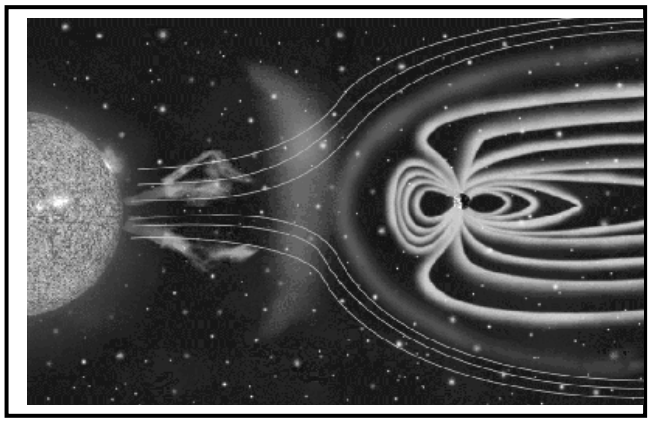
1. The Sun is primarily composed of _____.
2. The process by which the Sun generates huge amounts of heat and light energy is called _____ _____.
3. _____ _____ is an environmentally-friendly source of energy.
4. Label the following diagram.



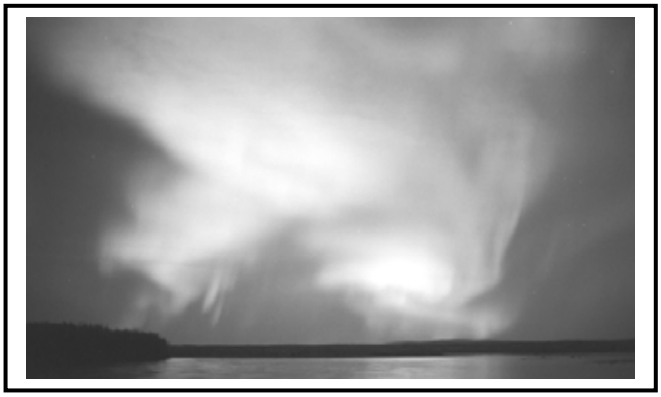
Solar Flares and Auroras

Solar Flares

Sometimes in complex sunspot groups, abrupt, violent explosions from the Sun occur. These are called **solar flares**. Solar flares are thought to be caused by sudden magnetic field changes in areas where the Sun's magnetic field is concentrated. Solar flares are accompanied by the release of gas, electrons, visible light, ultraviolet light and X-rays. When this radiation and particles reach the Earth's magnetic field, they interact with it at the poles to produce the **auroras** (borealis, australis) as shown.



The sun's magnetic field and directly affects the Earth and the rest of the solar system. Magnetic storms approaching Earth are illustrated here.



Charged particles from solar flares produce shifting lights over the North and South Poles

* Aurora Borealis = Northern Lights
* Aurora Australis = Southern Lights

Solar flares can also disrupt communications, satellites, navigation systems and even power grids. The radiation and particles ionize the atmosphere and prevent the movement of radio waves between satellites and the ground or between the ground and the ground. The ionized particles in the atmosphere can induce electric currents in power lines and cause power surges. These power surges can overload a power grid and cause blackouts.

Studying the Sun

Because the Sun is so incredibly bright, we cannot safely look at it without damaging our eyes. The Sun can be viewed with the use of special filters or via projection. Filters can be fitted onto telescopes to block out most of the incoming light, leaving images astronomers can safely view and study. Various filters allow astronomers to observe different areas of the sun, including sunspots and prominences. Image projection is a simple method which involves the projection of the Sun through a small telescope onto a piece of paper. This method does not show any of the solar atmosphere, but sunspots will be visible. We must never look directly at the Sun without safety precautions, but with them in place, our star is a wonderful object to study.

Summary

The Sun's core is a power house of energy, that helps bring life to Earth. Nuclear energy radiates outward through two distinct layers, the radiative and convective zones.

The solar atmosphere is composed of three main layers: the chromosphere, the transition zone and the corona. Prominences and flares erupt into the atmosphere, releasing energy and particles into the corona and eventually extending into the solar wind.

The Sun is an important object to study, but because it is so luminous it is extremely dangerous to look at the Sun without adequate protection. The use of a special filter or the method of projection allows the Sun to be studied safely to better understand the processes within the stars. The Sun and the stars are incredible objects, and without them, life on Earth would not exist.

Activity 3:
Complete each statement using a term or terms from the list below: Write your answer in the space provided. some terms can be used more then once.

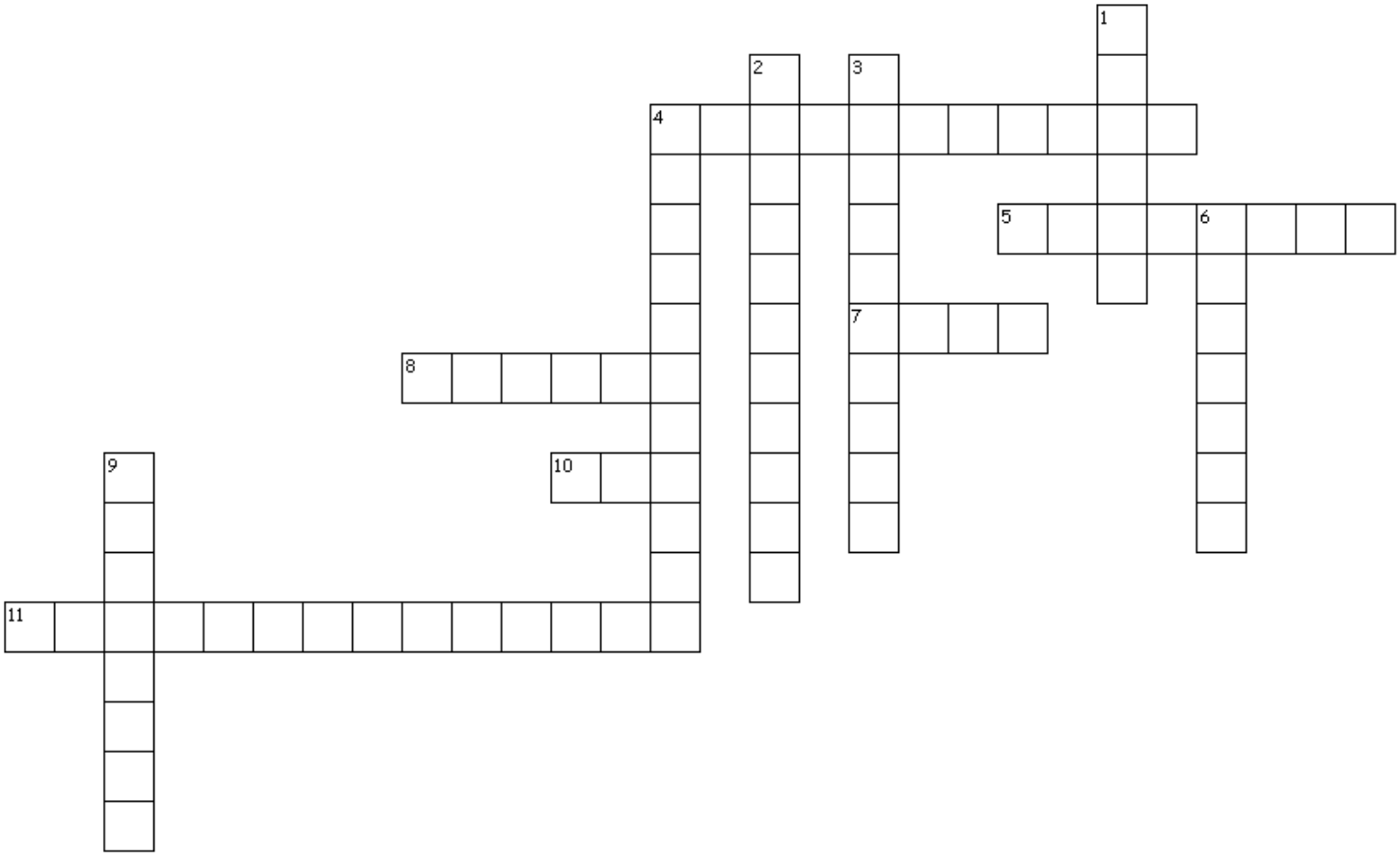
eye damage	energy
projecting	sunspots
nuclear fusion	depressed
radiative zone	area's
convective	prominences
zone	communication
photosphere	star
	see

1. Looking directly at the Sun can cause _____. You can prevent this by _____ an image on to a piece of paper.
2. The core of the Sun is where _____ takes place.
3. Solar energy is transferred from the core outward through the _____ and the _____.
4. The Sun's surface is called the _____. This is the layer of the Sun we can _____.
5. The Sun has used up 25% of its _____.
6. The photosphere has _____. These are _____ on the Sun which has a lower temperature than the surrounding surface.
7. Arches of gas called _____ connect the magnetic lines from sunspot pairs.
8. Solar flares can disrupt_____ satellites, navigation systems and even power grids.
9. The Corona extends several million miles or kilometers outward from the _____.
10. The Sun is a _____ at the centre of our solar system.

From the list of words and concepts provided, complete the table by identifying two points for each layer of the Sun.

• photons • seen best during a solar eclipse • 4,500 degrees Kelvin to about 10,000 degrees Kelvin • surrounds the Sun's core • surface of the Sun	• falling movements of cool gas. • convection currents • prominences • 2 million degrees • nuclear fusion reactions • Sunspots • centre of the Sun
1. The Core	**1.**
	2.
2. Radiative Zone	**1.**
	2.
3. Convective Zone	**1.**
	2.
4. Photosphere	**1.**
	2.
5. Chromosphere	**1.**
	2.
6. Corona	**1.**
	2.

Reflection Activity



Across
4. Sun's surface seen from Earth
5. depressed areas on Sun
7. 25% of Sun’s radius
8. nuclear....
10. star at the centre of our solar system
11. northern lights

Down
1. final layer of the Sun
2. disrupts communications
3. rising currents, falling cool gas
4. arches of gas
6. carries energy outward
9. Sun is composed mostly of....