Investigating Stars Name:_____Block:_____

FYI: Forces Inside a Star **E3:R6a**

1. Read FYI: *Forces Inside a Star*

   As you read use the spaces below to write down any information you find especially interesting. Also define the bold terms used in the text. If you run across any other words that you don't know the meaning of, write those down and ask your teacher to help you with them.

Word/Term	Definition/Question
Electromagnetic Force	Why do we combine electric and magnetic force into the **electromagnetic force**?
Electric charges	Like charges _____ such that positive charges _____ other _____ charges. Negative charges are _____ to positive charges.
Stronger?	Which is stronger, the electromagnetic force or the gravitational force?
Strong Nuclear Force	What does the **strong nuclear force** hold together? Without it, what would happen to atoms?
Weak Nuclear Force	The weak nuclear force acts to cause the _____ _____ of some atomic nuclei. In beta decay and in the fusion reactions that power stars, large amounts of tiny (nearly zero mass) neutral particles are produced. These particles are called _____ and _____.
Stellar Contests	In every star there is a contest between _____ _____ pulling inward from the tremendous mass of the star, and the _____ _____ pushing outward from the nuclear fusion reaction inside the star.

1. What are the four (4) fundamental forces found in nature?

2. Which of these forces is most responsible for the size and temperature of a star?

FYI Forces Inside a Star

Every moment of our lives, we experience forces—the pushes and pulls that change an object's shape or motion. The electromagnetic force is a fundamental force that determines much about how matter behaves. As its name implies, this force can be split into two parts: the electric force and the magnetic force. We use the single term *electromagnetic* to describe both forces because they are linked—electricity produces magnetic forces and magnetic fields produce electric effects. They are like opposite sides of the same coin. Inside an atom, the electric force plays a much more important role than the magnetic force does. For this reason, we will examine only the electric part of the electromagnetic force here.

The electric force is the attraction and repulsion of positive and negative electric charges. Opposite charges attract, such that negative charges are attracted to positive charges; like charges repel, such that positive charges are repelled by other positive charges. The attraction of positive protons and negative electrons in an atom is an example of this force at work. Almost all the forces you experience in a day are the result of the electric force. Your body, a collection of atoms, stays together due to the attraction between electrons and protons. Your muscles are able to push and pull thanks to a series of electric forces between atoms. The electric force is much stronger than the gravitational force. As a result, you do not fall through the floor. Thanks to the electric force, the floor's atoms attract one another strongly. Even though gravity pulls you toward the center of Earth, the floor's atoms stick tightly together and prevent you from falling through.

Another fundamental force, the most powerful one of all, is the **strong nuclear force**. It acts as extremely strong glue, holding the particles in the nucleus together. Without the strong nuclear force, nuclei would disintegrate spontaneously because protons, with their positive charges, repel one another. However, the nuclear force is so strong that it overcomes the electromagnetic force. Despite its strength, nuclear force works only at very close distances, when particles are no more than one ten trillionth (0.00000000000001) of a meter apart.

The **weak nuclear force** is a fundamental force too weak to hold anything together. Instead, it works to cause the radioactive decay of some atomic nuclei. The process of **beta decay** is governed by the weak nuclear force. A free neutron, not bound up in a nucleus, will break down into a proton, electron, and a particle of almost zero mass called an **antineutrino**. **Neutrinos** and antineutrinos are produced in great numbers during the nuclear fusion of hydrogen into helium in stars. The weak force is also responsible for synthesizing different chemical elements in stars and in supernova explosions, through processes involving the capture and decay of neutrons.

Gravitational force is another fundamental force. Though it is always an "attractive" force, pulling objects together, the strength of the attraction depends on the masses of the objects and how far apart they are. You, a human being, have mass, and you are being pulled toward the center of our massive Earth. But you are also being pulled toward the moon, the sun, and the person next to you. Even so, the gravitational forces from these

objects are insignificant compared to Earth's pull, so you never notice them. Because gravitational force increases with increasing mass, the interiors of stars are compacted so that incredible pressures build, with a resulting increase of temperature. Within this environment, the gravitational force is so strong that even protons, which generally repel one another, are crushed together so tightly that the nuclear force unites them. In this way, gravitational force and the nuclear force work together to form new elements inside stars.

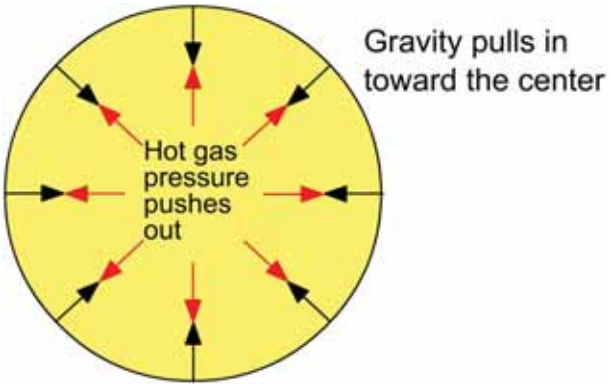
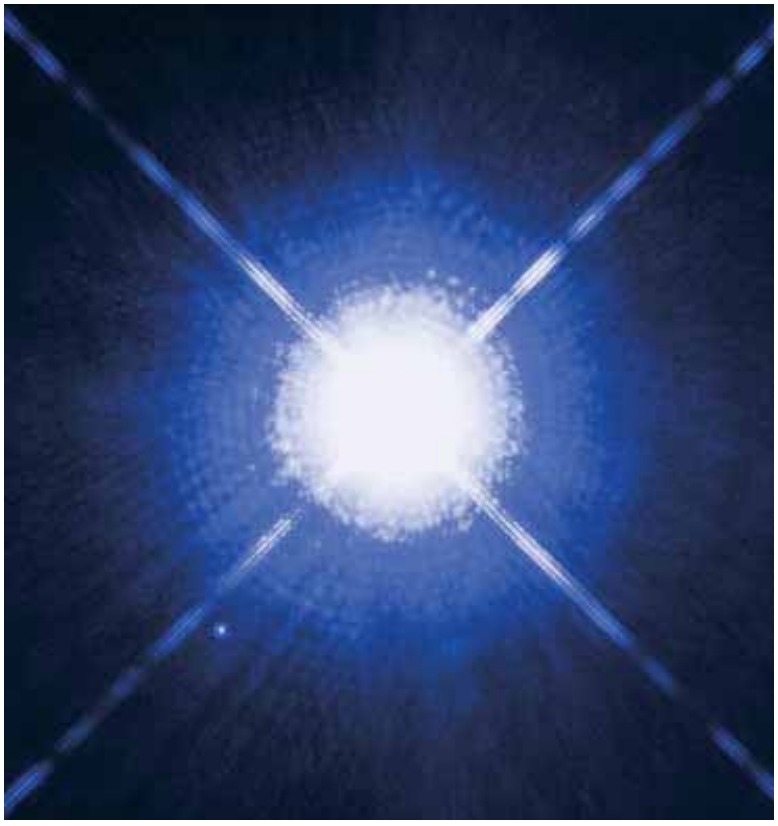


Figure 2-14: Diagram of the forces within a star. The life of a star is a continual war between gravitational force pushing inward and gas pressure from fusion in the core of the star pushing outward.

For every star there is a contest between the gravitational force pushing inward from the tremendous mass of the star, and the **gas pressure** pushing outward from the nuclear fusion reaction inside the star. The balance determines the size and temperature of the star for most of its lifetime. Most stars go through stages of their lives when these forces are not balanced. Stars will then pulsate and get larger or smaller, hotter or cooler, brighter or dimmer as they respond to these unbalanced forces.



An image of Sirius A and its companion star—Sirius B—a white dwarf star