Investigating Stars Name:____Block:____________

FYI: Variable Stars **E4:R2**

1. Read FYI: *Variable Stars*

   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
Variable Stars	Stars that go through __________ of _____________ are known as **variable stars**.
Intrinsic Variable Stars	If a star's variability is caused by ___________ changes _________ the star, it's called an **intrinsic variable**.
Extrinsic Variable Stars	If a star's variability is caused by the ___________ of the star or by one star in a __________system ___________ the other, it's called an **extrinsic variable**.
Pulsating Variable	Pulsating variables can change by several ___________ of brightness over a timescale of _______, __________, or ___________.
Semiregular Variable Stars	**Semiregular variables** are ___________ and _____________ in how they change brightness.
Eruptive Variable Stars	**Eruptive variables** go through a ________ change in brightness but ________ repeat the change.
Type 1 supernova	A **Type 1 Supernova** occurs when a ________ dwarf star slowly draws material from a companion star. When the mass exceeds _______ solar masses, the star can no longer support itself and explodes as a **Type 1 Supernova**.
Nova	In a **Nova**, the small dwarf star accumulating matter from its companion star stays below the ________ solar masses and does not explode in the same way.
Eclipsing Binary	In an **eclipsing binary**, one star in a binary system ___________________________the other. (4 words)
Extra space for additional words or interesting information.	

1. What are the periods of the four stars given in Figure 3-6?

2. What is the difference between a pulsating variable and an eruptive variable? Give an example of each.

FYI Variable Stars

Though many stars spend a very stable life on the main sequence of the H-R diagram, others go through periods of instability and are known as **variable stars**. A star is stable on the main sequence as it fuses hydrogen into helium and while the thermal pressure outward created by the nuclear fusion is balanced with the gravitational force pulling the star's material inward. Once a star evolves off the main sequence, however, it may become unstable in that the forces are unbalanced and the star's equilibrium is compromised. As episodes of shell fusion (pushing material outward) alternate with episodes of collapse that heat the stellar core (drawing material inward), stars change many of their properties. Stars lose mass slowly in this way as outer layers of gas are expelled during the oscillations. Stars also change brightness, surface temperature, color, and even spectral class. Studying variable-star behavior gives astronomers a deeper understanding of the life cycle of stars and contributes to our knowledge of the evolution of galaxies. Ultimately, studying these stars helps us understand the evolution of the universe as a whole. Several types of variable stars are also useful for finding distances to clusters of stars and even to galaxies millions of light-years away from Earth.

Over 75 types of variable stars exist; some are rare, while some are very common. They are classified as either **intrinsic**— the variability is caused by physical changes within the star, or **extrinsic**—the variability is caused by the rotation of the star or by one star in a binary system eclipsing the other.

The **intrinsic variable stars** can be separated into two categories: pulsating and eruptive variables. **Pulsating variables** can change by several magnitudes of brightness over a timescale of days, months, or years. Some classes of pulsating stars repeat their cycles in a highly consistent way (Cepheid and RR Lyrae stars) and are used extensively to find the distances to other galaxies. Other pulsating stars are irregular and unpredictable (**semiregular** variable stars). The **eruptive variables** can be thought of as stars that go through one huge change in brightness but rarely repeat the change. Type 1 supernovae fall into this class. Instead of exploding due to the formation of iron in the star's core, a **Type 1 supernova** occurs when a white dwarf star slowly draws material from a companion star. When the mass of the white dwarf star exceeds 1.4 solar masses, the star cannot support itself, and it collapses and explodes into space. A similar type of binary system causes a **nova**, also classified as an eruptive variable. In the case of a nova, however, the mass of the white dwarf remains below the 1.4 solar masses and does not explode in the same way. The hydrogen accumulating on the surface of the white dwarf reaches the heat and density required for initiating fusion. The ensuing explosion spreads material from the surface of the white dwarf instead of destroying the star completely. Sometimes the nova event will recur dozens or hundreds of years later when the amount of surface hydrogen again builds up.

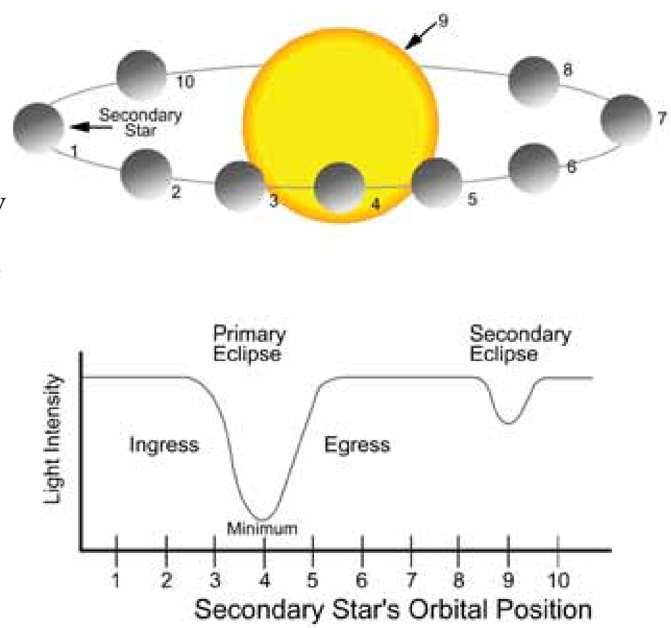

Figure 3-5: Diagram and light curve of an eclipsing binary star system. Notice that the greatest change of light occurs when the orbiting star passes in front of its larger partner.

Extrinsic variables can also be separated into two categories—eclipsing binaries and rotating variables. To produce an **eclipsing binary**, one star in a binary system passes in front of the other. The binary system has to be edge-on to our solar system in order for us to see the magnitude changes produced by the eclipse. A planet can also pass in front of a star and alter the brightness of its host star. The changes in brightness are incredibly small: one part in 10 million. But astronomers using sophisticated instruments have discovered dozens of extrasolar planets this way.

One famous example of an eclipsing binary is Algol, in the constellation of Perseus. It is one of the only variable stars for which you can notice, with your naked eye, changes in brightness over a course of several days.

Algol is really a three-star system. The secondary star, Algol B, a yellow G8IV subgiant star, passes in front of the larger primary star Algol A, a B8V star, every 2.9 days.

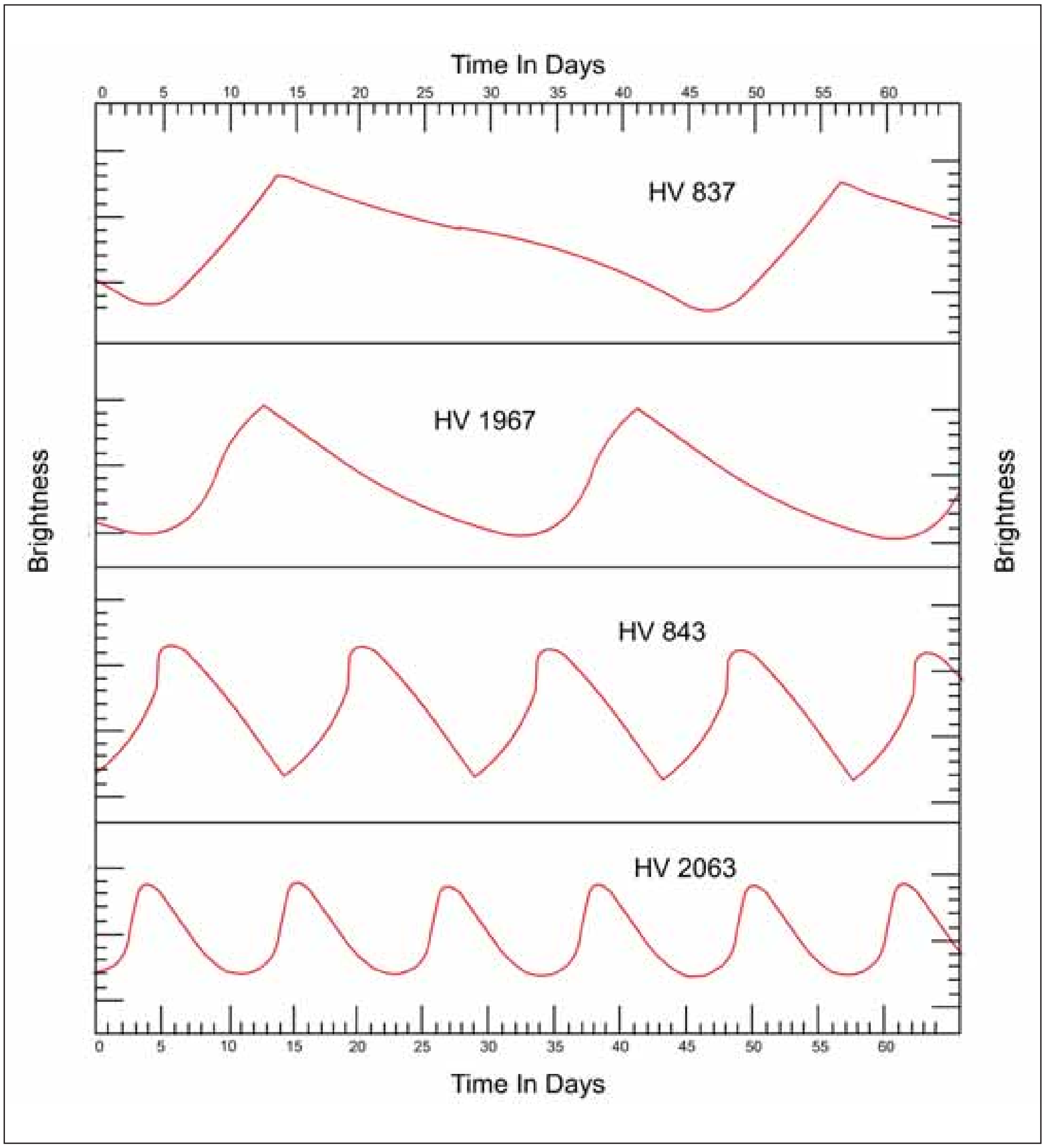

Figure 3-6: Light curves of four Cepheid variables

Algol A dims when eclipsed and the entire eclipse lasts about 10 hours. In mythology, Algol represented the eye of Medusa, a snake-haired creature whose head Perseus chopped off. To ancient cultures, Algol was an "evil eye" blinking slowly in the night sky.

The time it takes to complete the cycle of maximum brightness to minimum and back to maximum brightness is called the **period** of the variable star. The graph of the changing brightness of a star over time is called the **light curve** of the star (See Figure 3-5). Light curves are very useful in determining the period of pulsating variables which, in some cases, help determine their brightness and, in turn, their distance from Earth.

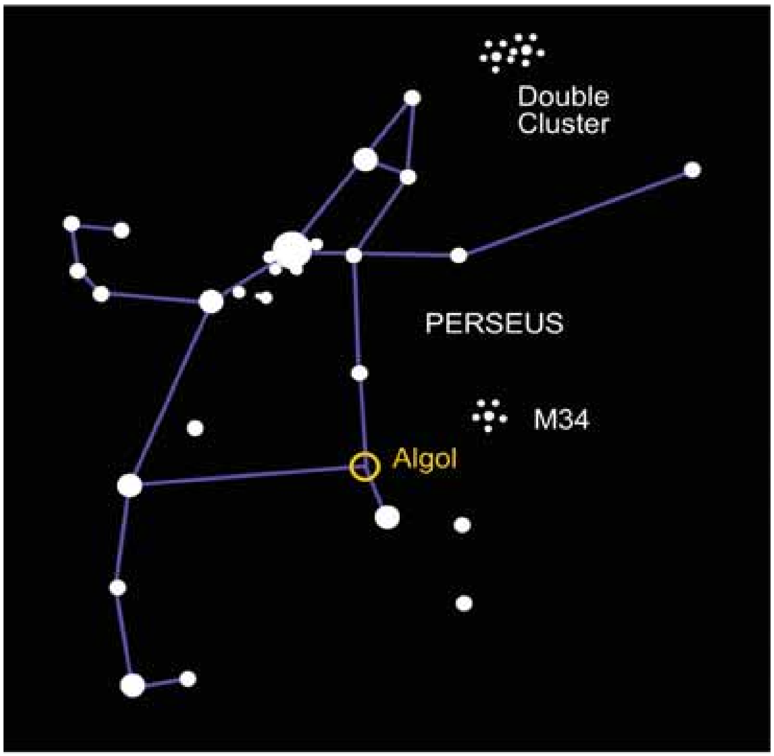

Figure 3-7: Diagram of the constellation Perseus