Lecture 4.6 Stellar Evolution I

Approximate Lifetime
Stars of different masses live for different amounts of time. The higher the mass of the star the _________ _______ its lifetime. A quick rule-of-thumb for stellar lifetimes is:

Protostars
Protostars are the collapsing clouds of dust that will form stars. These collapsing clouds become a star when they start burning _______________ into _______________ in the core.
Protostars which fully collapse but never do ignite fusion are called ____________ dwarfs. They tend to have a mass less than ________ solar masses.

Red Dwarfs
These stars are small and probably the most common type of star. They have a mass range of about _____ _____ to _________ solar masses. Because of their small size and the nature of energy transport, it turns out that red dwarfs are fully ______________ convective. This means that they can also burn their entire stock of hydrogen. Red dwarfs are extremely long lived. Their lifetimes exceed the known age of the universe. But eventually they will burn all their hydrogen and become helium ____________ dwarfs.

Solar Mass Stars
These stars are defined by the mass range such that they will never fuse ________________ into ______ higher mass elements. This mass range includes about __________ to __________ solar masses.
While a star is burning hydrogen into helium in the core it is on the main sequence. Stellar evolution law #1 describes the exit from the main sequence:

1. Stellar Evolution Law #1: ________________________________________________________________
   ______________________________________________________________________________________
With helium ash in the core, there is hydrogen burning shell around the ashen core. This setup causes an expansion of the non-burning elements of the star. The star gets large and red – a red giant.
During this expansion the helium ash core is contracting under the weight of the star. This squeezing causes it to heat up. Eventually the ash core will reach about _____ million degrees Kelvin which is the temperature at which helium will fuse into ____________ via the ___________________________ process. For solar mass stars this is a violent, sudden, explosion which almost, but doesn't quite explode the star, called a Helium Flash. With helium now fusing stellar evolution law #2 comes into play:

2. Stellar Evolution Law #2: ________________________________________________________________
   ______________________________________________________________________________________
The solar mass star will now move onto the ____________ branch. But eventually the helium in the core will be exhausted and a carbon ash core will result. This brings stellar evolution law #1 into play again with a carbon ash core, helium burning shell, and a hydrogen burning shell. This multi-layered situation is unstable and the star will pulsate and shed its outer layers. The end result is the star gets rid of most of itself leaving behind expanding spherical shells of gas called a ________________ nebulae and a carbon ash ________ dwarf.