HW 7,8,9 ANSWERS

HW#7

If the initial interstellar cloud in star formation has a mass sufficient to form hundreds of stars, how does a single star form from it?
A: The cloud fragments into smaller clouds and forms many stars at one time.

A typical protostar may be several thousand times more luminous than the Sun. What is the source of this energy?
A: From the release of gravitational energy as the protostar continues to shrink

For gravity to contract a spinning interstellar cloud, what must be present in sufficient amount?
A: mass

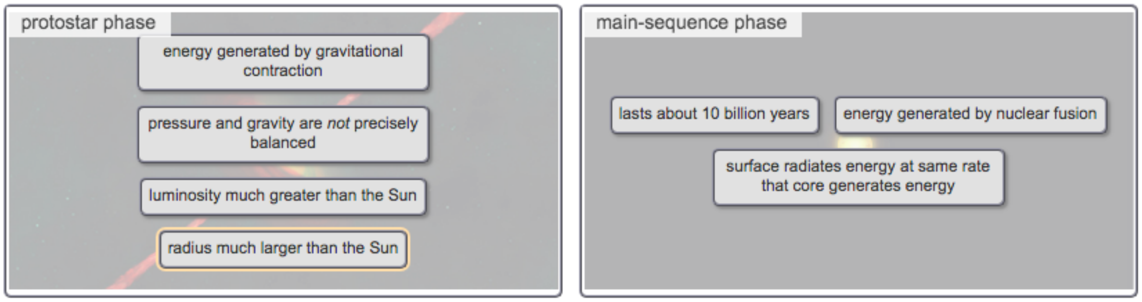
What is the key factor that determines the temperature, density, radius, luminosity, and pace of evolution for a pre-stellar object?
A: mass

What process characterizes the T Tauri phase of protostellar evolution?
A: strong proto-stellar winds and material ejected in high velocity jets
-The T Tauri phase expels residual gas and dust from the region closest to the young protostar, probably affecting the subsequent evolution of any nearby planets.

What temperature is required to initiate nuclear fusion in a stellar core?
A: 10,000,000 K
-At 10 million K, protons begin fusing into helium via the proton-proton chain; the protostar finally becomes a true star.

Which event marks the birth of a star?
A: Fusion of hydrogen atoms into helium atoms

Each item following is a characteristic of *a one-solar-mass star* either during its protostar phase or during its main-sequence phase. Match the items to the appropriate phase.



What inevitably forces a star like the Sun to evolve away from being a main sequence star?
A: Helium builds up in the core, while the hydrogen burning shell expands.

Hydrogen-shell burning proceeds increasingly faster due to which of the following?
A: heat released from the core's contraction

What temperature is needed to fuse helium into carbon?
A: 100 million K

During the hydrogen shell burning phase…
A: the star grows more luminous.

What is a planetary nebula?
A: The ejected envelope of a red giant surrounding a stellar core remnant

For our Sun, the production of carbon will be the end of its nucleosynthesis.
A: True

In a white dwarf, what is the source of pressure that ultimately halts its contraction?
A: electrons packed so closely that they become incompressible

In its last stage of evolution, what will the Sun become?
A: white dwarf

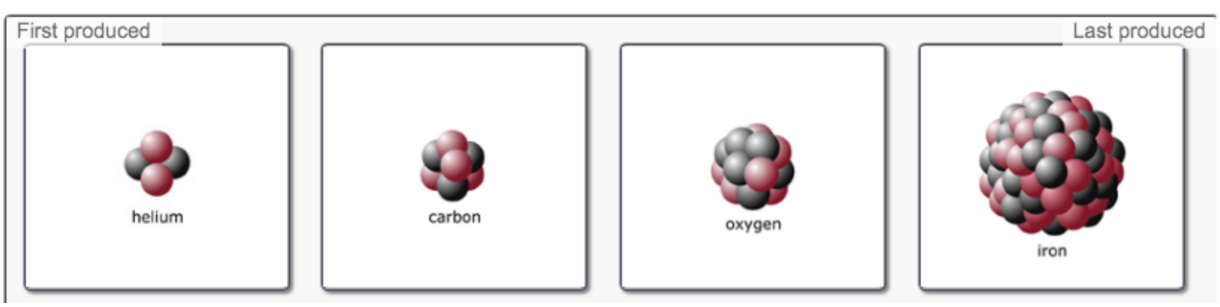
What is the size of the core of a typical white dwarf star?
A: about the size of Earth

-In some cases, the white dwarf remnant is even smaller than Earth.

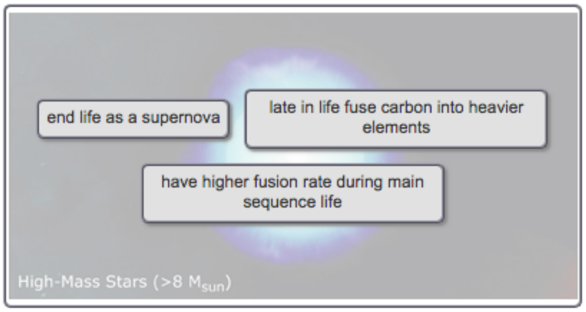
The following figures show various stages during the life of a star with the same mass as the Sun
They occur, from first to last….

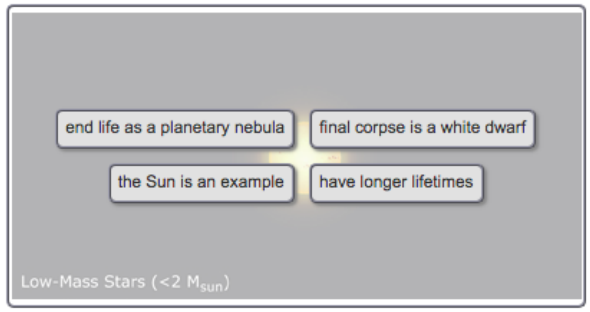
These are various stages during the life of a high-mass star.Ranked from when they occur, from first to last.

Provided following are various elements that can be produced during fusion in the core of a high mass main sequence star
Ranked by on when they are produced, from first to last…



Listed following are characteristics that describe High Mass and Low Mass stars, respectively.





Why are star clusters almost ideal "laboratories" for stellar studies?
A: Stars in clusters have the same age, similar composition, and are at the same distance away.

Why do stars tend to form in groups?
A: A large interstellar cloud fragments into smaller clouds that eventually form stars.

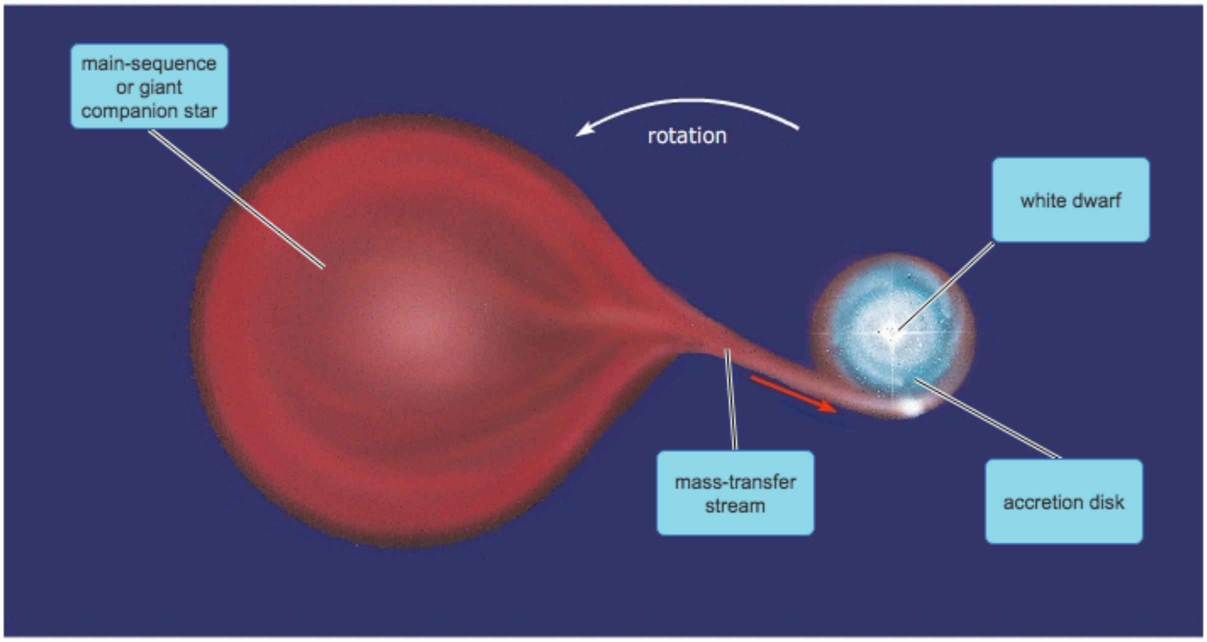
All globular clusters in our Milky Way are about how old?
A: Around ten billion years old

What are the characteristics of globular cluster stars?
A: Old age and hundreds of thousands to millions of member stars

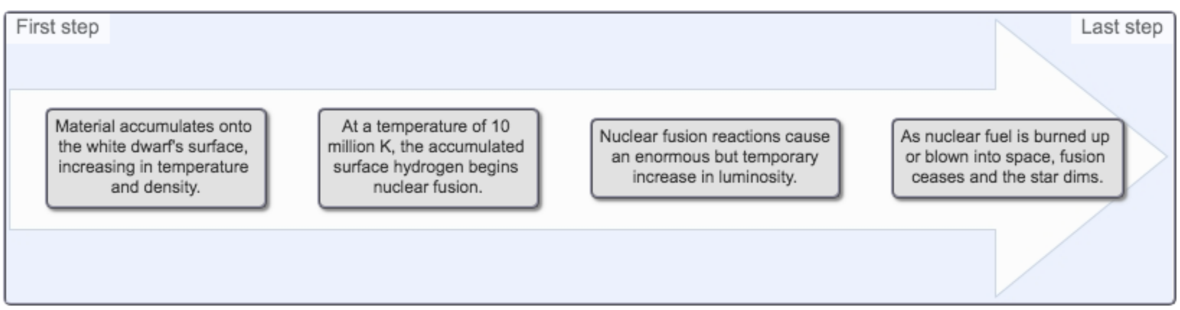
What are the characteristics of an open cluster of stars?
A: A few hundred, mainly main sequence stars

HW#8

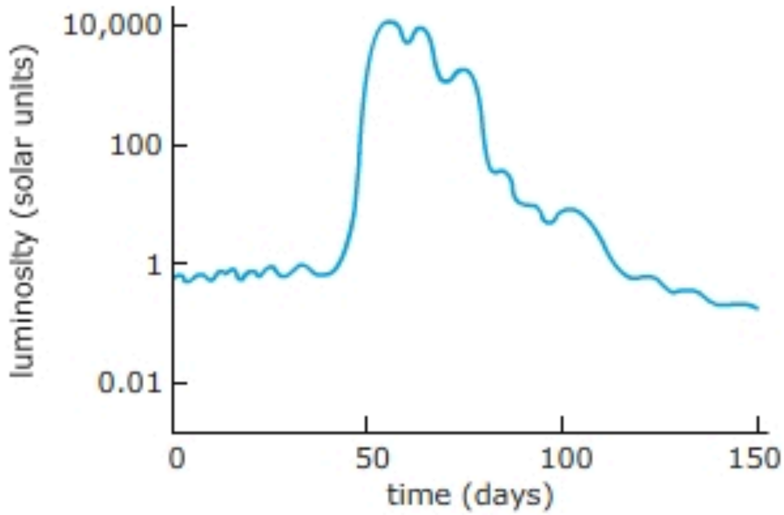
Eta Carinae is an example of a…
A: supermassive star



In a binary-star system that produces a nova, the white dwarf pulls matter from the companion star. The matter forms an accretion disk that orbits the white dwarf. Then a specific sequence of events must take place for a nova event to occur.



Once nuclear fusion starts for the material on the surface, it proceeds at a furious rate. The white dwarf flares up, then fades away as some of the nuclear fuel is exhausted. The rest of it is blown into space. Neither the companion nor the white dwarf is destroyed in the nova process, so once fusion ceases, they return to their original states and repeat the process. Astronomers have observed many such scenarios, called *recurrent novae*.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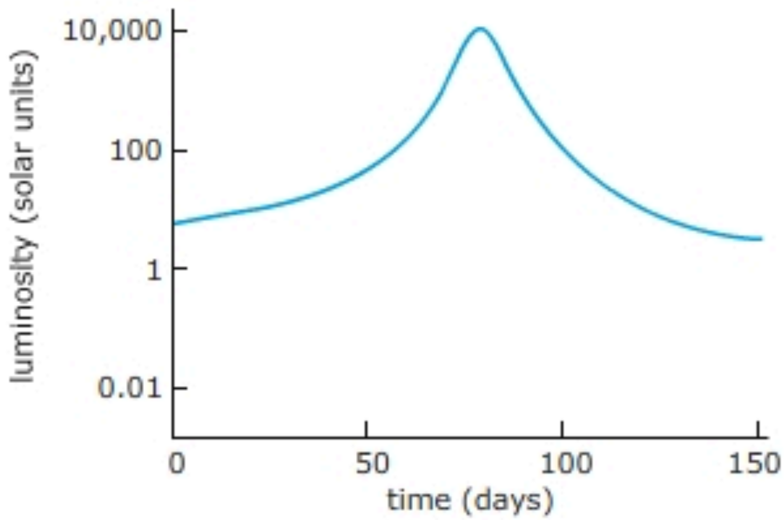
100
1
0.01
luminosity (solar units)
0
50
100
150
time (days)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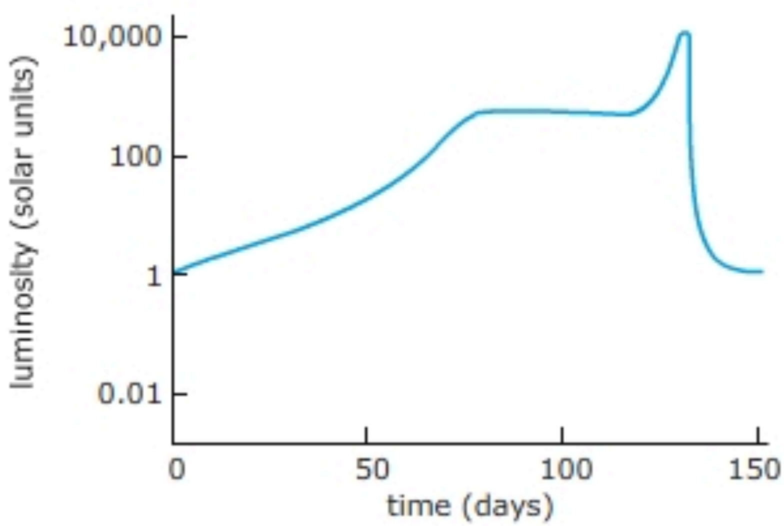
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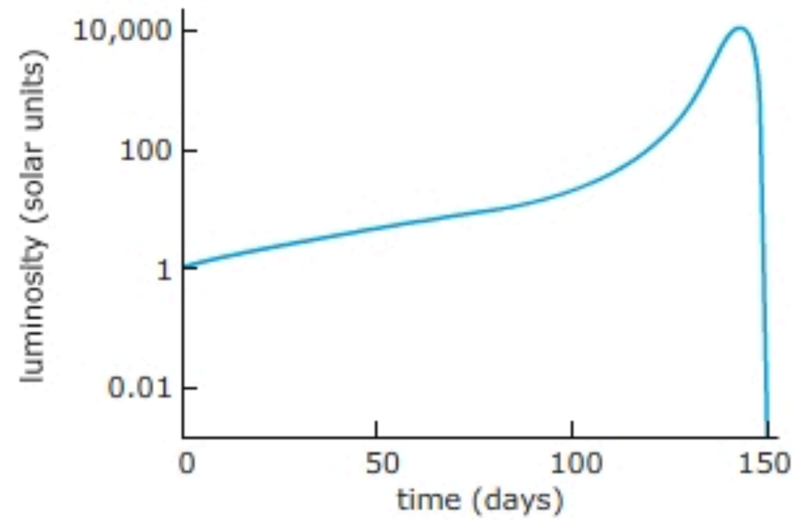

A light curve of a nova event shows a sudden increase in luminosity in a matter of days, followed by a gradual fade over several months, until the white dwarf's luminosity returns to normal.

The Chandrasekhar mass limit is
A: 1.4 solar masses

What mechanism produces a nova?
A: If a white-dwarf star is close enough to a binary-companion star to steal material from it, the material eventually heats up to a temperature high enough to cause fusion on its surface
The new fuel is quickly used up, so the nova is a short-lived phenomenon. It can occur repeatedly, however, as the white dwarf "steals" more material.

Will the Sun ever explode as a Type I supernova?
A: No. It lacks a binary companion.

What would happen if mass is added to a 1.4 solar mass white dwarf?
A: The star would erupt as a carbon detonation (type I) supernova

A Type I supernova involves the collapsing core of a high mass star
A: False

A carbon-detonation supernova starts out as a white dwarf in a close binary system.

A: True

As a 4-10 solar mass star leaves the main sequence on its way to becoming a red supergiant, its luminosity…
A: remains roughly constant

Which of the following is the best description of the interior structure of a highly evolved high-mass star late in its lifetime but before the collapse of its iron core?
A: An onion-like set of layers forms, with the heaviest elements in the innermost shells surrounded by progressively lighter ones

An iron core cannot support a star because
A: iron cannot fuse with other nuclei to produce energy

Type II supernovae have little hydrogen in their spectra; it had been used up already
A: False

The remains of type II supernovae (massive star, core collapse supernovae) are seen in the sky as…
A: nebulae that are expanding at thousands of kilometers per hour

What are the differences between the processes responsible for Type I and Type II supernovae?
A: Type I supernovae occur only in binary or other multiple-star systems, whereas Type II supernovae occur in isolated single, high-mass stars

Which stars eventually undergo supernova explosions?
A: the most massive stars

Why does the spectrum of a carbon-detonation supernova (Type I) show little or no hydrogen?
A: This supernova is the detonation of a carbon white dwarf that contains virtually no hydrogen

What is stellar nucleosynthesis?
A: The formation of heavier elements inside stars

The heaviest nuclei of all are formed…
A: by neutron capture during a type II supernova explosion

When helium capture occurs with a carbon 12 nucleus, what results?
A: Oxygen 16

Neutron stars and black holes are formed by…
A: type II supernovae

In a neutron star, the core is…
A: made of compressed neutrons in contact with each other

Two important properties of young neutron stars are…
A: extremely rapid rotation and a strong magnetic field

An object more massive than the Sun, but roughly the size of a city, is a…
A: neutron star

What have astronomers detected in the center of the Crab Nebula?
A: a neutron star

Rank the following steps that lead to a Type I supernova event in order of when they occur from first to last….

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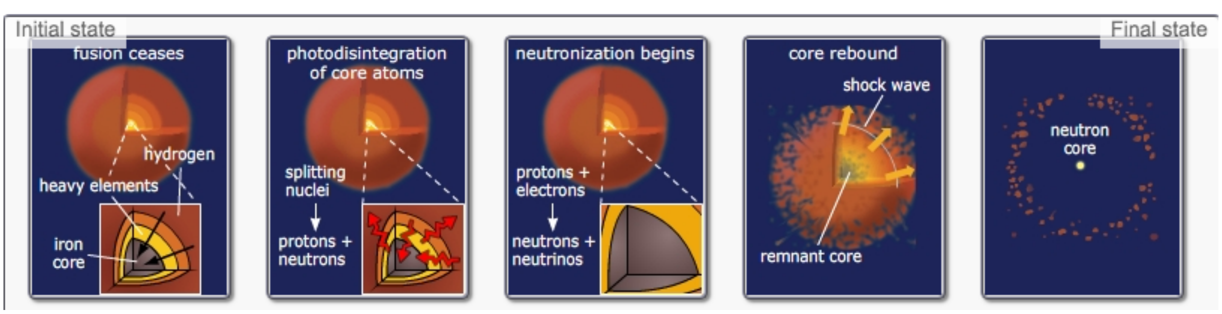
Rank the following steps that lead to a Type II supernova event in order of when they occur from first to last…..



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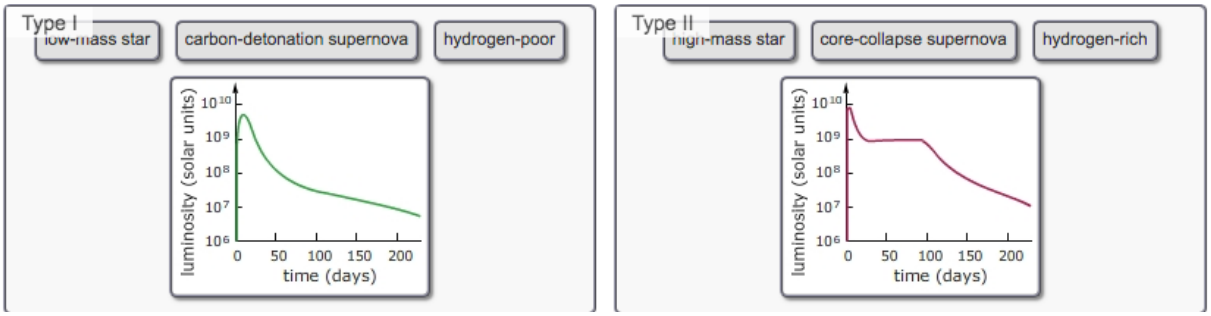
Each supernova type is distinct in initial components, process, and observational properties. Sort the following characteristics as to whether they describe a Type I or Type II supernova.



HW#9

The mass range for neutron stars is
A: 1.4 to 3 solar masses

The Schwartzschild radius for a 12 solar mass star is
A: 36 km

How are the event horizon and Schwarzschild radius related?
A: The Schwarzschild radius is equal to the distance from the singularity of a black hole to the event horizon

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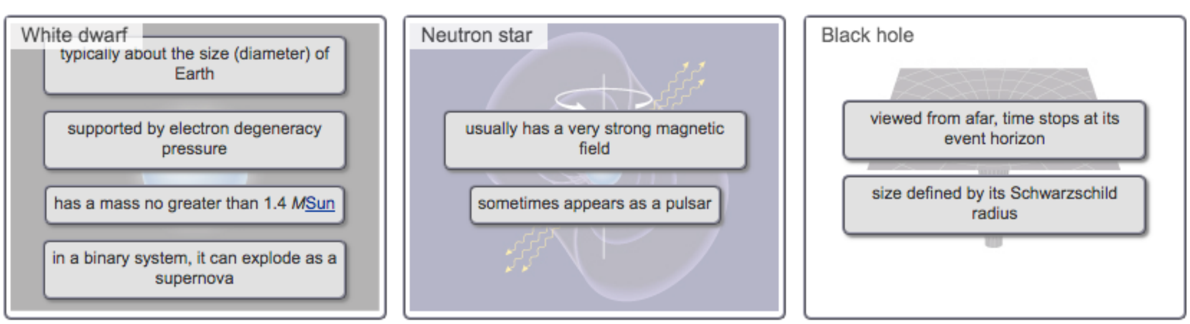
Listed following are distinguishing characteristics of different end states of stars. Match these to the appropriate consequence of stellar death.



What explanation does general relativity provide for gravity?
A: Gravity is the result of curved spacetime

If light from a distant star passes close to a massive body, the light beam will…
A: bend towards the star due to gravity

What is Cygnus X-1?
A: The leading candidate for an observable black hole binary system

The key to identifying a black hole candidate in a binary system is that…
A: the unseen companion in the system must have a sufficiently high mass

Detecting a black hole is a challenging endeavor for astronomers. Why is it so difficult for astronomers to observationally detect black holes?
A: Black holes have an escape speed that is greater than the speed of light

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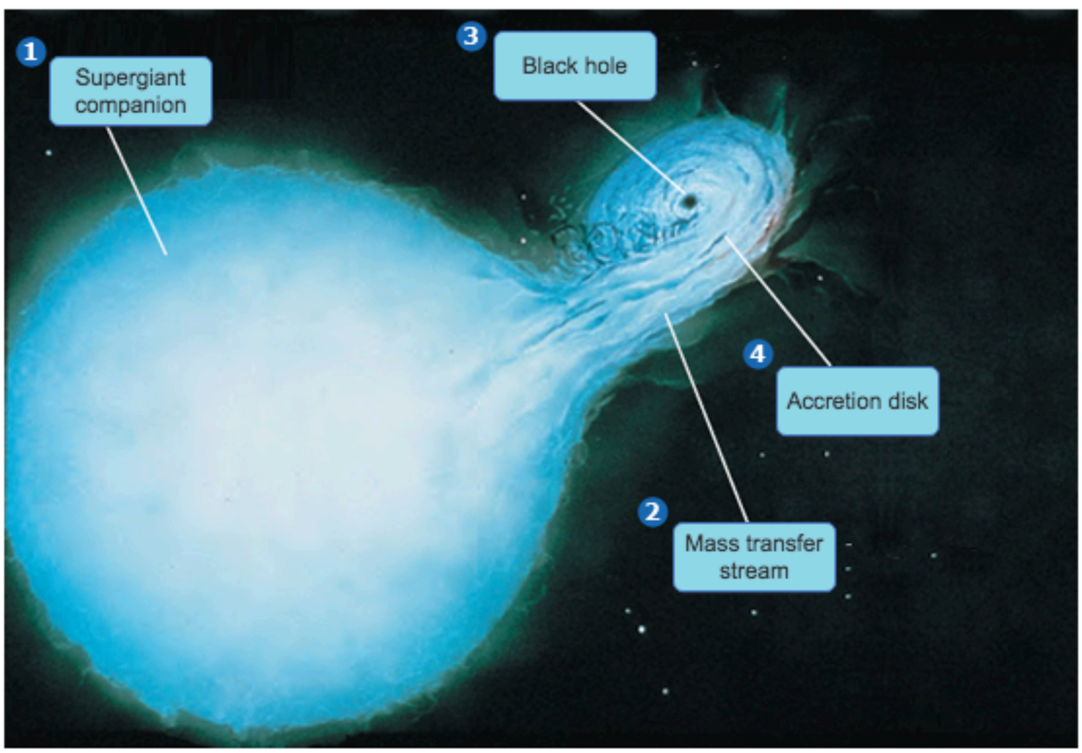
The figure below shows a binary system containing a blue supergiant and a stellar-mass black hole. Label the components of this binary system.



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Black hole candidates

A: -Cygnus X-1 has a diameter less than 300 kilometers
-Cygnus X-1 produces a large amount of X-ray emissions.
-Cygnus X-1 has a mass of 10 solar masses.

Black holes in galaxies
A: -Stars and gas near the center of the galaxy exhibit rapid orbital velocities in a fairly small region of space.
-High-energy jets of gas are observed coming from the galactic center.

From the Sun, the distance to the Galactic center is about…
A: 8,000 pc

In which of the basic regions of the Galaxy is the Sun located?
A: galactic disk

For what type of object is the period-luminosity relation used for determining distances?
A: Cepheids

In variable stars, what is observed to vary?
A: brightness

How do astronomers know the distances to Cepheid variables?
A: By measuring the period of the variable star, we can determine its luminosity. Then, by measuring its apparent brightness, we can use the inverse-square law of light to get its distance

Most of the new star formation in the Galaxy is found in the…
A: spiral arms

The Galactic Year is the time for our solar system to orbit the Galaxy; it is about…
A: 225 million years

Which is the correct description for the Sun's location in the Galaxy?
A: In the disk, and about half way out from the center

From Earth, the view of the Milky Way is a thin band of stars across the night

sky. The part of the Milky Way galaxy that is described here is the
A: disk

In the formation of our Galaxy, the ________ formed first
A: globular clusters

What two observations allow us to calculate the Galaxy's mass?
A: The Sun's orbital velocity and its distance from the Galactic center

Most of the mass of the Milky Way seems to exist in the form of…
A: dark matter out in the Galactic halo

A rotation curve, which plots the rotation speeds of objects as a function of their distance from the center of the Milky Way Galaxy, can be used to determine which property of the Galaxy?
A: mass

We can use Newton's version of Kepler's third law to determine the total mass within any given distance from the center of the Galaxy.

There is a small source of intense radiation at the center of our Galaxy that may have a mass of about how many solar masses?
A: 4,000,000 Suns

The evidence suggests a black hole with a mass of 3.7 million solar masses.

A high-velocity ring or disk of gas just a few parsecs across at the center of the Galaxy suggests that the exact center is occupied by which of the following?
A: supermassive black hole

Why are infrared and radio telescopes the instruments of choice for studying the galactic center?
A: Dust in the plane of the Milky Way obscures observations at other wavelengths

Radio and infrared waves have long wavelengths and can avoid dust grains.