LC GT ... Key 2022

Star in a Box Worksheet Beginning

https://starinabox.lco.global/

☆ *Launch Star in a Box and open the lid. The main plot is a HertzsprungRussell diagram. On the right, the information panel allows comparisons between the radius, surface temperature, luminosity and mass of the star relative to the Sun. The starting parameters are for a star like the Sun.*

A. *Click the play button below the HertzsprungRussell diagram to show the Sun's evolution. Once it is complete, you can click on "Data Table" (upper right) to see the final values for each stage in the lifecycle.*

1. Describe how the Sun changes over its lifetime. will get bigger & brighter & colder as R.G. ⇒ smaller & dimmer & cool as White Dwarf
2. When will the Sun be at its brightest? Red Giant
3. When will the Sun be at its hottest? White Dwarf
4. In which stage of its life does the Sun spend the longest time? Main Sequence
5. In which stage of life will the Sun undergo the most change? Red Giant & White Dwarf
6. What kind of star will the Sun be at the end of its life? White Dwarf
7. How long will the Sun live for? ~12 billion years

B. *By adjusting the mass of the star in the "Star Properties" you can explore the evolution of different stars.*

1. Where do the different mass stars lie on the main sequence?
2. List the different final stages of a star's life.

C. *Follow the evolution for five stars with different masses. Complete the table below filling in a row for each mass (you will need to watch the evolution not just look at the Data Table summary).*

Mass of star (M_{Sun})	Time on main sequence (Myr)	Number of stages		Final state (elem. symbol)	Total lifespan (Myr)	Maximum radius (R_{Sun})	Maximum luminosity (L_{Sun})	Maximum temperature (K)
		Norm	Adv.					
0.2	868,300	3	4	He W.D.	1,039,300	.33	87.78	119,316
.65	57,610	3	4	He W.D.	62,450	1.45	422.47	191,117
1	8992.81	3	7	C/O W.D.	10,210	200.26	3910.21	194,312
2	1163.03	3	7	C/O W.D.	1491.92	204.31	4656.93	233,346
4	178.91	3	7	C/O W.D.	214.64	353.02	14,154.68	322,701
	"Data Table"	DT		DT Ad	DT Add #'s	DT Ad. Greatest #	DT Ad Greatest #	Graph - move cursor to left

Data Tab | DT | DT Adv | Add dur. Column | Greatest # | Great # | Graph-move cursor to left

Mass of star (M_{sun})	Time on main sequence (Myr)	Number of stages: Norm	Number of stages: Adv	Final state	Total lifespan (Myr)	Maximum radius (R_{sun})	Maximum luminosity (L_{sun})	Maximum temperature (K)
6	65.96	3	7	c/o W.D.	76.2	444.02	23,621.09	434,410
10	24.46	3	6	Neutron *	27.44	748.00	69,520.84	1,942,227
20	8.82	3	5	Neutron *	9.84	1501.39	191,029.31	2,123,244
30	5.95		6	Black Hole	6.66	1142.68	266,317.68	~129,000
40	4.87		6	Black Hole	5.48	1433.51	425,402.46	~131,000

D. *Compare the data table for a range of stars.*

1. Are more massive stars the brightest and hottest types of star for their whole lives?
   NO - Red Giant phase is cooler
2. Which mass star gets the hottest?
   20 mass * reaches max temp @ Neutron * Stage (40sm * reaches max temp at supergiant Stage before exploding as supernova & ending as a Black Hole w/very low temps)
3. Which mass star gets the coolest?
   2 solar mass -
4. Which mass star becomes the most luminous?
   40 solar mass → 425,402 solar luminosities

E. *Deneb and Betelgeuse are both 20x the mass of the Sun, but look very different. Deneb has 100 times the radius of the Sun and its temperature is about 8000 K. Betelgeuse has 1000 times the radius of the Sun and its temperature is about 3500 K.*

Select a star with 20x the mass of the Sun and run the animation, use this to find:

1. What stages of their lives the two stars are in. Deneb → blue white supergiant (between MS & Red Supergiant)
   Betelgeuse → red supergiant nearing end of its life
2. How long each star has to live.
   Deneb - ~1 million years - a few million yrs
   Betelgeuse - ~100,000 years