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The Hertzsprung-Russell Diagram

The Hertzsprung-Russell Diagram is critical to understanding the lives and deaths of stars. This lab is designed to make you more familiar with this diagram and to use it to learn about the average characteristics of stars.

In this activity, you will plot two Hertzsprung-Russell diagrams, one for the brightest stars in the sky and one for the stars that are closest to us. The data for these plots are in the two tables at the end of this lab.

A Hertzsprung-Russell diagram is a scatter plot of the surface temperature vs. the luminosity of a group of stars. However, you will notice that appendices 4 and 5 do not give the temperature of our two groups of stars. Fortunately, the temperature of a star is directly related to its spectral type. So, if we plot the Luminosity versus Spectral Type, it is a simple matter to convert the spectral class to temperature. Use the following instructions to make your plots.

Step 1: Plot the two Hertzsprung-Russell diagrams on the graph sheets provided using the data in two tables at the end of this lab. ***PLOT ALL THE STARS OF BOTH TABLES.*** Be sure to label one diagram as **Brightest Stars** and the other as **Nearest Stars**. Also, label at least ten stars with their names or catalog numbers on each plot.
Note on the spectral type white dwarf: For the Star Sirius B, plot it as if it is spectral type A5. For Procyon B, plot it as if it is spectral type F0.
Also note : the subclass (the first number after the class letter) goes from 0 (hottest) to 9 (coolest) so that the very hottest star (an O0) is to the far left and the very coolest star (an M9) is to the far right

Step 2: Label the temperature on each diagram. Use Table 13.3 on page 396 of the text to get the temperature for each spectral type. Mark these labels on your diagrams.

Step 3: Label the Main Sequence and circle and label the supergiants, the giants and the white dwarfs on each of your diagrams. You may need to do a web search to see where each of these types of stars are located on a Hertzsprung-Russell Diagram.

Step 4: Answer the following questions in the space provided. Use complete sentences. Be sure to explain how you arrived at your answer for numerical results.

1) Sirius is the brightest star in the sky. Why isn't Rigel the brightest since its luminosity is 120,000 times that of the sun while Sirius is only 21 times more luminous than the sun?

2) What percentage of the brightest stars in the sky are more luminous than the sun?

3) What percentage of the brightest stars are giants?

4) What percentage of the brightest stars are supergiants?

5) What percentage of the brightest stars are white dwarfs?

6) What percentage of the closest stars are more luminous than the sun?

7) What percentage of the closest stars are giants?

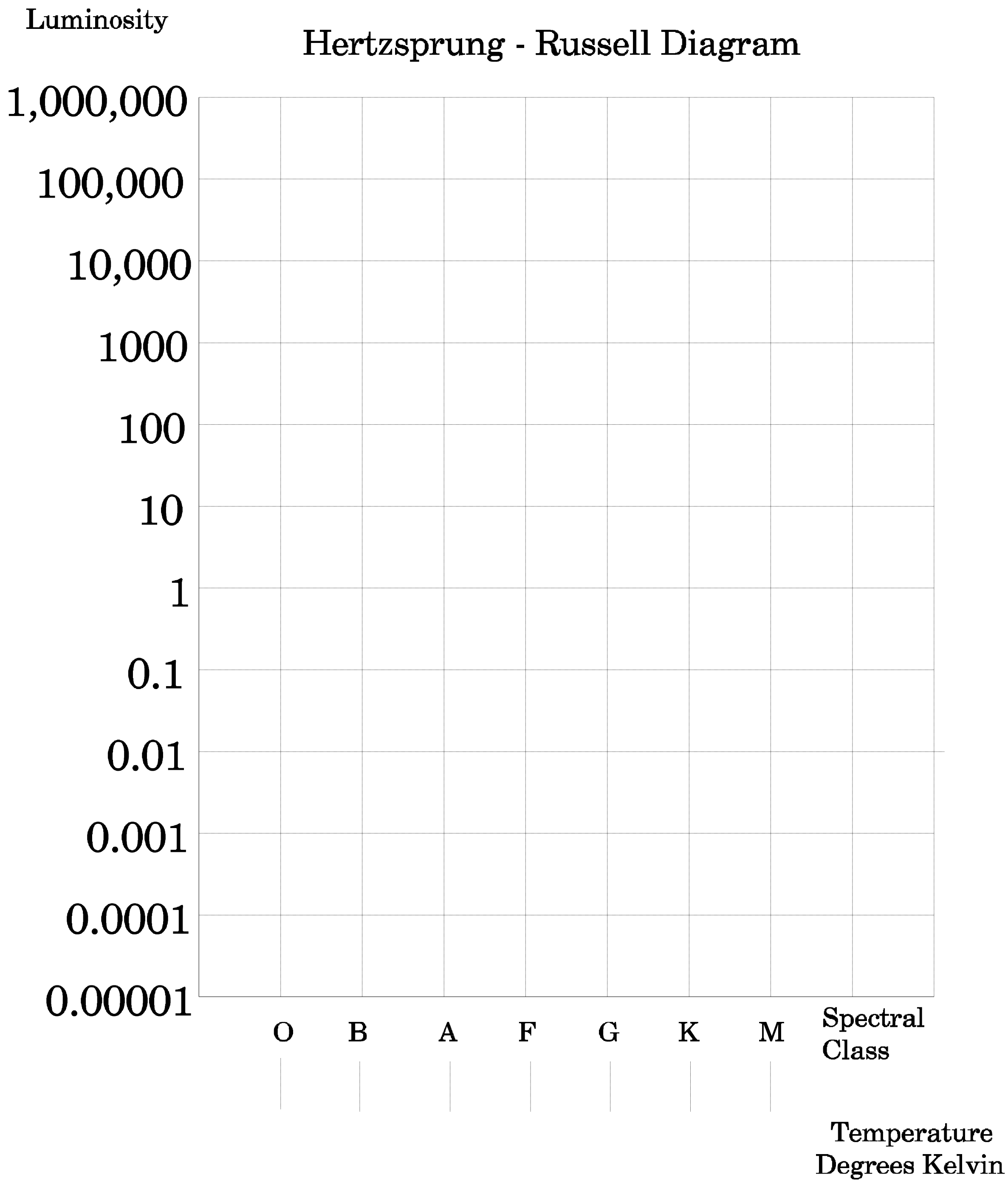
8) What percentage of the closest stars are supergiants?

9) What percentage of the closest stars are white dwarfs?

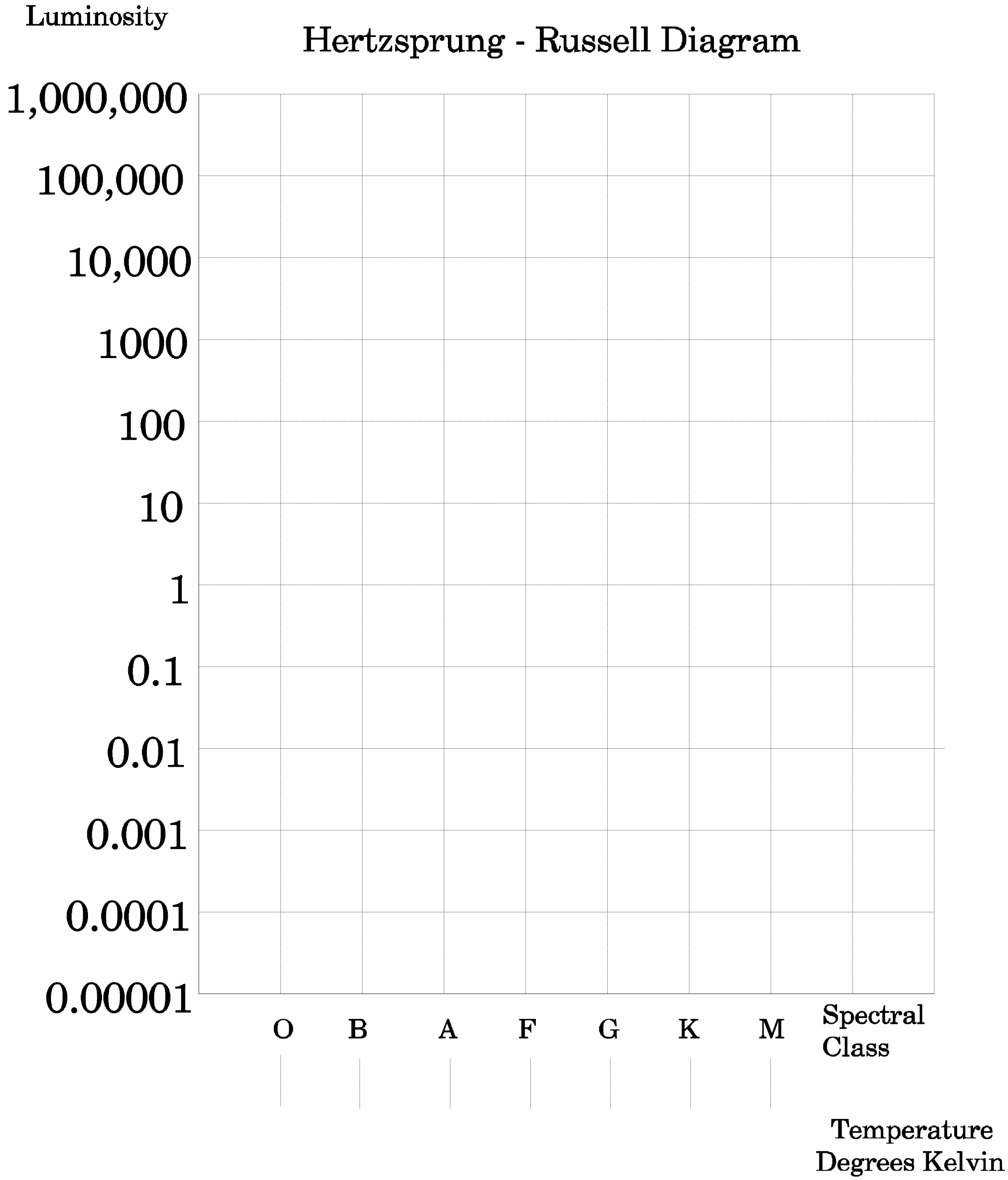
10) Which group of stars (nearest or brightest) is most representative of all the stars? Why?

11) About what percentage of all stars (not just those in the two tables) are more luminous than the sun? Explain how you arrived at your answer using your answers to questions 2 through 10.

12) About what percentage of all stars are giants or supergiants? white dwarfs? Explain how you arrived at your answer using your answers to questions 2 through 10.


Luminosity
Hertzsprung - Russell Diagram
1,000,000
100,000
10,000
1000
100
10
1
0.1
0.01
0.001
0.0001
0.00001
O
B
A
F
G
K
M
Spectral Class
Temperature Degrees Kelvin

Hertzsprung - Russell Diagram



The Visually Brightest Stars

Name	Spectral Class	Luminosity
Sirius A	A1 V	26.1
Canopus	F0 I	$8.2x10^{+4}$
Arcturus	K2 III	190
Alpha Centauri A	G2 V	1.77
Vega	A0 V	61.9
Capella	G8 III	180
Rigel	B8 Ia	$7.0x10^{+5}$
Procyon A	F5 IV-V	7.73
Achernar	B3 IV	5250
Betelgeuse	M2 Iab	$4.1x10^{+4}$
Hadar	B1 II	$8.6x10^{+4}$
Altair	A7 IV-V	11.8
Aldebaran	K5 III	370
Spica	B1 V	$2.5x10^{+4}$
Antares	M1 Ib	$3.7x10^{+4}$
Pollux	K0 III	46.6
Fomalhaut	A3 V	18.9
Deneb	A2 Ia	$3.2x10^{+5}$
Mimosa	B0.5 III	$3.4x10^{+4}$
Regulus	B7 V	331

The Nearest Stars

Name	Spectral Class	Luminosity
Sun	G2 V	1.00
Proxima Centauri	M5.5 V	8.2×10^{-4}
Alpha Centauri A	G2 V	1.77
Alpha Centauri B	K0 V	0.55
Bernard's Star	M4 V	3.6×10^{-3}
Wolf 359	M6 V	3.5×10^{-4}
Lalande 21185	M2 V	0.023
L 726-8 A	M5.5 V	9.4×10^{-4}
L 726-8 B	M6 V	5.6×10^{-4}
Sirius A	A1 V	26.1
Sirius B	White dwarf	2.4×10^{-3}
Ross 154	M3.5 V	4.1×10^{-3}
Ross 248	M5.5 V	1.5×10^{-3}
Epsilon Eridani	K2 V	0.40
Lacaille 9352	M1.5 V	0.051
Ross 128	M4 V	2.9×10^{-3}
L 786-6	M5 V	1.3×10^{-3}
61 Cygni A	K5 V	0.16
61 Cygni B	K7 V	0.095
Procyon A	F5 VI-V	7.73
Procyon B	White dwarf	5.5×10^{-4}
BD +59° 1915 A	M3 V	0.020
BD +59° 1915 B	M3.5 V	0.010
Groombridge 34 A	M1.5 V	0.030
Groombridge 34 B	M3.5 V	3.1×10^{-3}
Epsilon Indi	K5 V	0.27
GJ 1111	M6.5 V	2.7×10^{-4}
Tau Ceti	G8 V	0.62
GJ 1061	M5.5 V	1.0×10^{-3}
L 725-32	M4.5 V	1.7×10^{-3}
BD +05° 1668	M3.5 V	0.011
Kapteyn's Star	M0 V	0.013
Lacaille 8760	M0 V	0.094
Krüger 60 A	M3 V	0.010
Krüger 60 B	M4 V	3.4×10^{-3}