Name: ____________________

Date: ____________________

Section: ____________________

Astron 104 Laboratory #9
The H-R Diagram
Section 10.1, 10.5

If we know the temperature of a star (or its Spectral Type) and the stars intrinsic brightness (or luminosity), a great deal more can be learned about the star. These two pieces of information can be plotted against each other on a graph known as a Hertzsprung-Russell (or H-R) Diagram.

In this exercise, we will be expressing the luminosity of a star in terms of its Absolute Visual Magnitude M_V. This is a scale based on how bright the star would appear if it were at a standard distance of 10 parsecs (about 32.6 light-years) from us. A difference of 1 magnitude is equivalent to a change of about 2.5× in brightness. For historical reasons, the scale runs "backwards," with higher numbers indicating fainter stars. Since the scale is originally based on the apparent brightness of stars, extending it to the absolute brightnesses (luminosity) meant extending the scale into negative numbers for bright stars.

On the attached tables, both the Apparent Visual Magnitude (m_V) and the Absolute Visual Magnitude (M_V) are given. The Apparent Visual Magnitude is how bright the star appears in the sky. The human eye can usually only see stars that are brighter than about 6th magnitude. In the city, light pollution usually raises this limit to stars brighter than about 2nd magnitude.

One the blank H-R Diagram provided, plot the Absolute Magnitude of each star versus its spectral type for the two sets of stars in the Tables. To distinguish between the data sets, use a different color or symbol for each set. The distinction between the luminous and nearest stars will be important when we analyze the diagrams. [**50 pts**]

Notes:

- The diagram is plotted with the most luminous stars (most negative magnitudes) at the top and the hottest stars on the left. Each division of the magnitude scale is 0.5 magnitudes. Estimate the best position for each data point within that range.
- Each division of the spectral class scale is 2 sub-classes. A star will therefore either be plotted on or halfway between the grid lines.
- Be sure to plot the **Absolute Magnitude** M_V for each star.
- You do not need to label the stars on the H-R diagram.

Questions [5 pts each]

1. Where on the HR diagram are most of the nearby stars located in terms of luminosity and temperature?

2. Where on the HR diagram are most of the apparently brightest stars located in terms of luminosity and temperature?

3. Only 3 of the nearby stars are also on the brightest star list. (a) With respect to the Sun, where in space would you expect bright stars to be located (near or far)? (b) With respect to the Sun, where in space would you expect dim stars to be located (near or far)? Why?

4. (a) Which of the two groups of stars gives a more accurate picture of a true stellar population? (b) How would you make it more accurate?

5. What can we conclude about the number of cool stars in the Universe (types K and M)?

6. What can we conclude about the number of hot stars in the Universe (types O and B)?

Look at:

http://astro.unl.edu/classaction/animations/stellarprops/hrexplorer.html

To explore a similar HR diagram. Here you can change the properties of a star and make it move in the HR diagram, and then compare it to the nearest and brightest stars.

Questions [5 pts each]

1. Using the sliders on the left, drag the *temperature* left and right. Which way does the *red cross* move, horizontally, vertically, or diagonally?

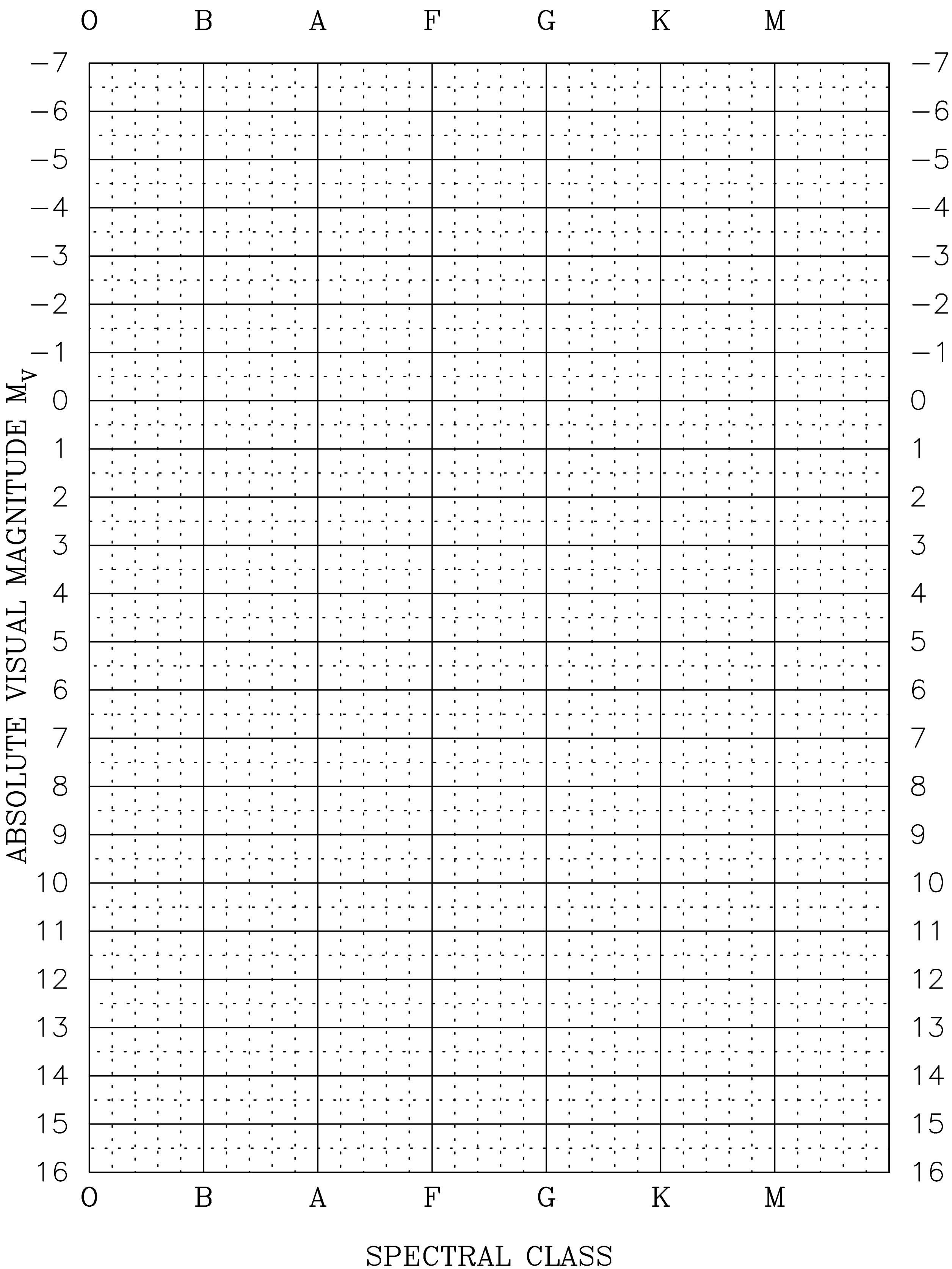
2. Using the sliders on the left, drag the *luminosity* left and right. Which way does the *red cross* move, horizontally, vertically, or diagonally?

3. Our Sun has temperature of 5800 K and luminosity of 1.00. Set the sliders at these values. The red cross should now fall on the red line, which is the *main sequence*. Now try to get the red cross to fall on the main sequence at temperatures of 3000 K, 10,000 K, and 20,000 K. Record the luminosities necessary below. Also record the radii, which is given in the left panel below the sliders.

4. What can you conclude about how the luminosity and radius change as you move to hotter and cooler stars on the main sequence? Which changes faster, temperature, radius, or luminosity?

The Brightest Stars			
Star	**Apparent magnitude** m_V	**Absolute magnitude** M_V	**Spectral Type**
Sirius	−1.4	1.5	A1
Canopus	−0.7	−4.0	F0
α Centauri	−0.1	4.4	G2
Arcturus	−0.1	−0.3	K2
Vega	0.0	0.5	A0
Capella	0.1	0.0	G2
Rigel	0.1	−7.1	B8
Procyon	0.4	2.7	F5
Betelgeuse	0.4	−5.6	M2
Archernar	0.5	−3.0	B5
Hadar	0.6	−3.0	B1
Altair	0.8	2.3	A7
Acrux	0.8	−3.9	B1
Aldebaran	0.9	−0.7	K5
Antares	0.9	−3.0	M1
Spica	0.9	−2.0	B1
Pollux	1.2	1.0	K0
Fomalhaut	1.2	2.0	A3
Deneb	1.3	−7.1	A2
β Crucis	1.3	−4.6	B0
Regulus	1.4	−0.6	B7
Adhara	1.5	−5.1	B2
Castor	1.6	0.9	A1
Shaula	1.6	−3.3	B1
Bellatrix	1.6	−2.0	B2
Elnath	1.7	−3.2	B7
Miaplacidus	1.7	−0.4	A0
Alnilam	1.7	−6.8	B0

The Nearest Stars			
Star	**Apparent magnitude** m_V	**Absolute magnitude** M_V	**Spectral Type**
Sun	−26.8	4.8	G2
Proxima Centauri	11.0	15.4	M5
α Centauri A*	0.1	4.4	G2
α Centauri B	1.5	5.8	K5
Barnard's Star	9.5	13.2	M5
Wolf 359	13.5	16.7	M6
Lalande 21185	7.5	10.5	M2
Sirius A*	−1.4	1.5	A1
Sirius B	7.2	10.1	wd (B1)
Luyten 726-8A	12.5	15.3	M6
Luyten 726-8B	13.0	15.8	M6
Ross 154	10.6	13.3	M5
ϵ Eridani	3.7	6.1	K2
Luyten 789-6	12.2	14.6	M6
Ross 128	11.1	14.6	M5
61 Cygni A	5.2	13.5	K5
61 Cygni B	6.0	7.5	K7
ϵ Indi	4.7	8.3	K5
Procyon A*	0.4	7.0	F5
Procyon B	10.8	2.7	wd (A8)
Cincinnati 2456A	8.9	13.1	M4
Cincinnati 2456B	9.7	11.2	M4
Groombridge 34A	8.1	12.0	M1
Groombridge 34B	11.0	10.4	M6
Lacaille 9352	7.4	13.3	M2
τ Ceti	3.5	9.6	G8
Luyten's Star	9.8	5.7	M4
Lacaille 8760	6.7	11.9	M1
Kapteyn's Star	8.8	8.8	M0
Kruger 60A	9.7	10.8	M4
Kruger 60B	11.2	13.2	M6


O B A F G K M
−7 −6 −5 −4 −3 −2 −1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
ABSOLUTE VISUAL MAGNITUDE M_V
SPECTRAL CLASS