**Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Lab Night \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**HR DIAGRAM AND PROPERTIES OF STARS (CLEA Version 6/12)**

PART I DETERMINE AGE AND DISTANCE TO CLUSTER USING CLEA PROGRAM

1. After you have logged on select All Programs>COSAM Software>Astronomy>CLEA>Manuals Read pages 4-7 from the students manual for HR Diagram of Cluster.
2. Then select All Programs>COSAM Software>Astronomy>CLEA>VIREO.
3. Select File>Login. Make up a table number.
4. Select File> Run Exercise>HR Diagram of Cluster.
5. Under Tools choose HR Diagram Analysis.
6. Then select File>Load Plot>Select Cluster Data. Start with the intermediate age NGC 752. Double click to load graph. Under tools choose Zero Age Main Sequence. Adjust the V-Mv scroll bar to get the best fit between the ZAMS (green line) and the data. The older the cluster the fewer the stars left on the upper left part of the ZAMS. See pages 9-11 in manual for additional information about matching ZAMS to data. Record V-Mv and E(B-V) below.
7. The point where no stars are left on the ZAMS can be used to estimate the age of the cluster. Under Tools choose Isochrones. Adjust Age, B-V, and metallicity to get best fit between the isochrones (purple) and the ZAMS (green). Look at pages 11-13 for additional details on how to match curves and meaning of B-V and metallicity. Record age (in Gyr), B-V adjustment value and metallicity.
8. Compare your results for NGC with data given at end of writeup. If way off check for errors.
9. Go through the step 6 procedure again using M45 (younger cluster)
10. Go thought step 7 procedure again using M45.
11. Go through procedure again using M67 (older cluster).
12. Compute the distances in parsecs. See page 7 of manual for formula (use V-Mv value for m-M). D = 10 logD . Compare your distance values to those given in the Voyager data panel for these clusters. For M45 & M67, compare your age values to those given in description part of the Voyager data panel. There is a lot of uncertainty in these eyeball estimates especially for older clusters. However if your values are nowhere near Voyager values check for mistakes.

Name of Cluster V-Mv E(B-V) Age(Gyr) B-V Metal: Z Y Distance(parsecs)

NGC 752

M45

M67

PART II PROPERTIES OF NEARBY STARS

This part uses tables 10.1, 10.2 and 10.3 of an earlier HR Diagram Lab. To find tables go to <http://www.auburn.edu/academic/cosam/departments/physics/intro-courses/ugrad-lab/physics1150/index.htm>. Go down page to #18 HR Diagram and look in background material.

1. Which type of star is most common? Choices are: Main Sequence (V), Giants (combine all I,II,III,IV types), White Dwarfs. Do not count Sun. **Go to the tables to count.**

Table 10.1.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Table 10.2.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Table 10.3 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. In Table 10.1, the brightest stars, how many stars are brighter than the Sun? Brighter means lower magnitude (M) not higher. **If double both must be considered**.

# brighter than the sun: \_\_\_\_\_\_\_\_

In Table 10.2, the closest stars, how many stars are brighter than the sun? Brighter means lower magnitude (M) not higher. **If double both must be considered**.

# brighter than the sun: \_\_\_\_\_\_\_\_

3. How many of the star systems in Table 10.1 (brightest) are also in Table 10.2 (closest)? Do not count the Sun. **If a star is a double star, only count once.**

# = \_\_\_\_\_\_\_\_\_\_\_\_\_

4. How many of the stars in table 10.1 are hotter than the Sun (spectral classes O,B,A,F)? **If double star both must be considered**.

# = \_\_\_\_\_\_\_\_\_\_

How many of the stars in table 10.2 are hotter than the Sun (spectral classes O,B,A,F)? **If double star both must be considered**.

# = \_\_\_\_\_\_\_\_\_\_

5. Based on answers to 1-4 above fill in the blanks using **close, hot or large**. The twenty brightest stars in the night sky are most likely to be bright because they are \_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_ not because they are \_\_\_\_\_\_\_\_\_\_\_\_.

**STELLAR RADIUS**

Use the equation for L to calculate the radius of these stars compared to the Sun. If you solve for ratio of star values to Sun values the 4 pi and sigma drop out.  **L = 4R2 (T4) *See example calculation below.***

Star L(star)/ L(Sun) T (star)/ T(Sun) R(star)/ R(Sun)

Vega 50 1.8

Arcturus 110 0 .7

Antares 1300 0.5

Spica 500 4.0

Deneb 43,000 1.6

**Summary Question**

Using the procedures above astronomers are able to A) determine age of clusters B) determine distance to clusters C) determine radius of stars D) determine metal abundance of stars in a cluster E) all of these

Put letter here \_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*“Book Value” of data for NGC 752*

V-M = 8.3 E(B-V) = 0.035 Age = 1.585 Gyr Metallicity z =.019, y = .273

*Example Calculation using Regulus*

Given T(star)/T(sun) = 2.156 and L(star)/L(sun) = 288 then

Dividing star values by Sun values gives:

(R(star)/R(Sun))2 = L(star)/L(Sun) divided by (T(star)/T(Sun))4 = 288/ 2.1564

Take square root of both sides to get

R(star)/R(sun) = 16.97/2.1562 = 3.65