ASTR1102-002

Potentially useful facts and mathematical relations:

A. A star at a distance of 1 parsec (1 pc = 3.26 light-years) exhibits a parallax of 1 arcsecond. That is, p = 1 arcsec ➔ d = 1 pc. More generally, if "p" is measured in arcseconds, then the distance "d" in parsecs can be calculated using the formula,

$$d = 1/p$$

B. A star's apparent brightness varies as the inverse-square of its distance from us. That is,

$$b/b_0 = (d/d_0)^{-2} = (d_0/d)^2$$

C. Each difference of 5 magnitudes ("m" or "M") corresponds to a factor of 100 in brightness. For example,

$$m_2 - m_1 = +5 \quad \rightarrow \quad b_1/b_2 = 100$$

$$m_2 - m_1 = -5 \quad \rightarrow \quad b_1/b_2 = 1/100 = 0.01$$

$$m_2 - m_1 = +10 \quad \rightarrow \quad b_1/b_2 = 100 \times 100 = 10{,}000 = 10^4$$

D. The distance to a star can be determined straightforwardly from the star's tabulated "distance modulus" (m – M). Examples:

$$m - M = 0 \quad \rightarrow \quad d = 10 \text{ pc}$$
$$m - M = +5 \quad \rightarrow \quad d = 100 \text{ pc}$$
$$m - M = +10 \quad \rightarrow \quad d = 1000 \text{ pc}$$
$$m - M = -5 \quad \rightarrow \quad d = 1 \text{ pc}$$

The more general formula that is used to relate the value of (m – M) to distance is [see "Box 17-3" in the textbook]:

$$m - M = 5 \log(d) - 5$$

Practice Questions for Exam #1

1. A star that is closer to us than 1 pc exhibits a stellar parallax that is (larger or smaller?) than 1 arcsec.

2. Star "Q" is twice as far away from us as star "R". Which of the following statements is true?
   a. The parallax of star "Q" is twice as large as the parallax of star "R".
   b. The parallax of star "R" is twice as large as the parallax of star "Q".
   c. The parallax of star "Q" is 4 times as large as the parallax of star "R".
   d. The parallax of star "R" is 4 times as large as the parallax of star "Q".

3. A star with a measured parallax of 0.01 arcsec is at a distance of _____ pc from us. (Fill in the blank.)

4. Star "Q" has an apparent magnitude of +4.0 and star "R" has an apparent magnitude of +1.0. Which star appears to be the brighter in the night sky?

5. You are told that ($m_A - m_B = +3$). Which star ("A" or "B" ?) appears to be brighter in the night sky?

6. You are told that ($m_A - m_B = -8$). Which star ("A" or "B" ?) appears to be brighter in the night sky?

7. You are told that ($m_A - m_B = 0$). Which star ("A" or "B" ?) appears to be brighter in the night sky?

8. You are told that ($m_A - m_B$) is a negative number. Which star ("A" or "B" ?) appears to be brighter in the night sky?

9. You notice that one particular star in a star catalog has an absolute magnitude "M" that is larger in value than its apparent magnitude "m". Is this star closer to us than 10 pc or farther from us than 10 pc?

10. You are told that a particular star exhibits a distance modulus "m – M" of zero. How far away from us is this star?

11. You are told that a particular star exhibits a distance modulus (m – M) = +5. How far away from us is this star?

12. A star with a measured stellar parallax, p = 0.01 arcsec, has a distance modulus (m – M) = _____.

13. The most direct way for an astronomer to determine the distance to an individual star is to measure its _____. (Fill in the blank.)

14. Which of the 6 stars listed in Table 1 appears to be the brightest in the night sky?

15. Which of the 6 stars listed in Table 1 is intrinsically the brightest?

16. Which of the 6 stars listed in Table 1 is intrinsically the faintest?

17. Which of the 6 stars listed in Table 1 is closest to us?

18. Which of the 6 stars listed in Table 1 is farthest from us?

19. Which of the 6 stars listed in Table 1 has an intrinsic brightness that is most similar to the intrinsic brightness of the Sun?

Table 1

Star Name	Parallax "**p**" (arcsec)	Proper Motion "**μ**" (arcsec/year)	Apparent magnitude "**m**"	Absolute magnitude "**M**"
Sirius A	0.380	1.34	-1.43	+1.46
Alpha Centauri A	0.746	3.71	-0.01	+4.36
61 Cygni A	0.286	5.28	+5.21	+7.49
Rigel	0.00422	0.002	+0.12	-6.75
Regulus	0.0420	0.25	+1.35	-0.53
Vega	0.129	0.35	+0.03	+0.58

20. The most direct way for an astronomer to determine the speed at which a star is moving toward or away from us is to measure the star's _____. (Fill in the blank.)

21. Star "A" and star "B" have exactly the same measured proper motions, μ = 1 arcsec/year, but star "A" exhibits a parallax of 0.25 arcesecs and star "B" has a parallax of 0.15 arcsec/yr. Which star is moving through space with the faster speed?
    a. Star "A" is moving faster than star "B".
    b. Star "B" is moving faster than star "A".
    c. The stars are moving through space at the same speed.
    d. None of the above. (Briefly explain.)

22. How many years will it take the star "Regulus" to move to a coordinate location on the sky that is 1 degree away from its present coordinate location?

23. A hurricane that is in the middle of the Gulf of Mexico (west longitude = 90 degrees; latitude = +24 degrees) is observed to be moving due north, headed for New Orleans (west longitude = 90 degrees; latitude = + 30 degrees). If the hurricane forecasters report that the eye of the hurricane will hit New Orleans in 48 hours, what is the observed proper motion of the hurricane?

24. What "astronomer's technique" does a police officer usually use in order to measure whether or not you are speeding?
    a. The officer measures your car's "proper motion."
    b. The officer relies on a "Doppler shift" measurement.
    c. The officer measures the apparent brightness of your headlights.
    d. The officer measures the color of your car.

25. By measuring the "color" of a star, astronomers are able to determine the star's _____. (Fill in the blank.)

26. A "blue" star has a (hotter or colder?) surface temperature than a "red" star.

27. Star "A" and star "B" are observed to have the same color but different absolute magnitudes. If $M_A = +5$ and $M_B = -3$, which star has the larger diameter?

28. Star "A" and star "B" both lie on the "main sequence" of the H-R diagram, but they have different absolute magnitudes: $M_A = +5$ and $M_B = -3$. Which of the following statements is true?
    a. Star "A" and star "B" have the same intrinsic brightness.
    b. Star "A" and star "B" have the same surface temperature.
    c. The surface of star "A" is hotter than the surface of star "B".
    d. The surface of star "A" is cooler than the surface of star "B".
    e. None of the above. (Briefly explain.)

29. It takes light emitted from the surface of the sun approximately _____ seconds/minutes/hours/years to reach the Earth.

30. It takes light emitted from the surface of the sun approximately _____ seconds/minutes/hours/years to reach the nearest stars, such as Proxima Centauri and Alpha Centauri A & B.

31. Light emitted from a star gets "redshifted" if the star is moving toward us. (True or False?)

32. Light emitted from a star gets "blueshifted" if the star is moving toward us. (True or False?)

33. Star "Q" is not moving with respect to the Sun hence the light emitted from star "Q" exhibits no Doppler effect if it is observed from the Sun. As observed from the Earth, however, light from star "Q" exhibits a variable Doppler shift because of the Earth's own orbital motion around the Sun. Describe the behavior of the Doppler shift throughout one year of observing star "Q" from the Earth.

34. If the star "Alpha Centauri A" (see Table 1) were moved twice as far away from us, how much brighter/fainter would it become as viewed on the night sky?
    a. "Alpha Centauri A" would become half as bright.
    b. "Alpha Centauri A" would become one-fourth as bright.
    c. "Alpha Centauri A" would become twice as bright.
    d. "Alpha Centauri A" would become 4 times brighter.
    e. None of the above. (Briefly explain.)

35. If the star "Alpha Centauri A" (see Table 1) were moved ten times farther away from us, what would its apparent magnitude be?
    a. Approximately m = 0.0
    b. Approximately m = + 5.0
    c. Approximately m = - 5.0
    d. Approximately m = +10.0
    e. None of the above. (Briefly explain.)

Use the information provided in Figure 1 to answer the following six questions.

36. The Sun should be counted among the stars marked type "A" in Figure 1. (True or False?)

37. Stars of type "D" are relatively common in our Galaxy. (True or False?)

38. Stars of type "A" are relatively common in our Galaxy. (True or False?)

39. Stars of type "A" are among the intrinsically brightest stars in our Galaxy. (True or False?)

40. Suppose that in one particular region of our Galaxy you find 10 stars of type "B". Approximately how many stars of type "D" would you expect to find within this same region of the Galaxy?

41. Figure 1 illustrates that most stars in our Galaxy are intrinsically fainter than the Sun. (True or False?)

Figure 2 shows the location of the "main sequence" in the H-R Diagram; also, five separate regions of the H-R Diagram are identified by points labeled G, H, I, J, and K. Refer to this figure when answering the following five questions.

36. The Sun lies nearest to which of the five labeled points in this H-R Diagram?

37. Which of the five labeled points identifies stars that are intrinsically the brightest?

38. Which of the five labeled points identifies stars that are intrinsically the faintest?

39. Which of the five labeled points identifies "giant" stars?

40. Which of the five labeled points identifies the coolest stars?

Figure 3 shows the measured correlation between the mass and intrinsic luminosity of normal, "main sequence" stars. Refer to this figure when answering the following few questions.

41. Stars of low mass tend to be intrinsically very bright. (True or False?)

42. Stars that are intrinsically very bright also tend to be more massive than the Sun. (True or False?)

43. The hottest stars along the main sequence are more massive than the Sun. (True or False?) NOTE: Combine information in Figure 3 with information in Figure 2 to answer this question.

44. The coolest stars along the main sequence are more massive than the Sun. (True or False?) NOTE: Combine information in Figure 3 with information in Figure 2 to answer this question.

Figure 1

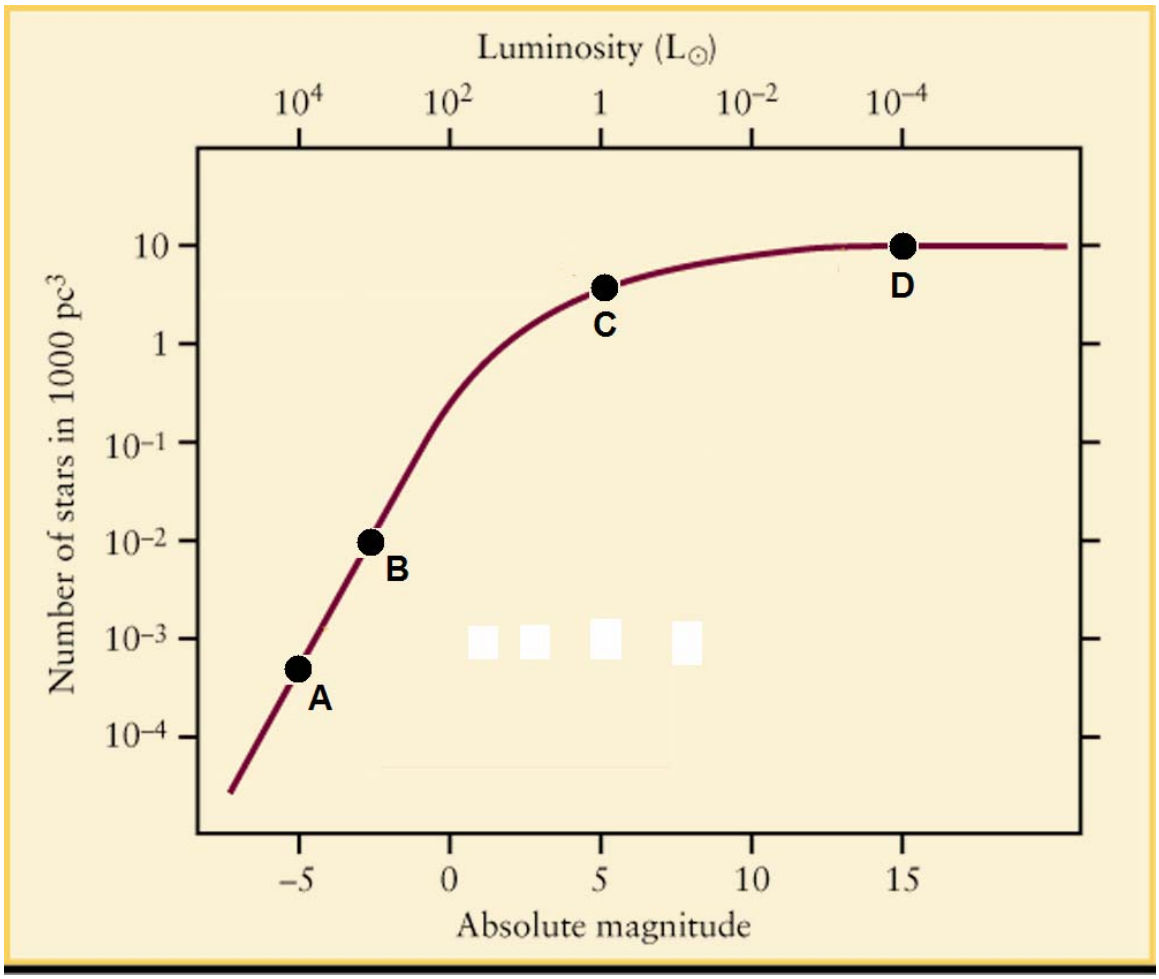

Luminosity ($L_\odot$)
10^4
10^2
1
10^{-2}
10^{-4}
Number of stars in 1000 pc^3
10
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
A
B
C
D
−5
0
5
10
15
Absolute magnitude

Figure 2

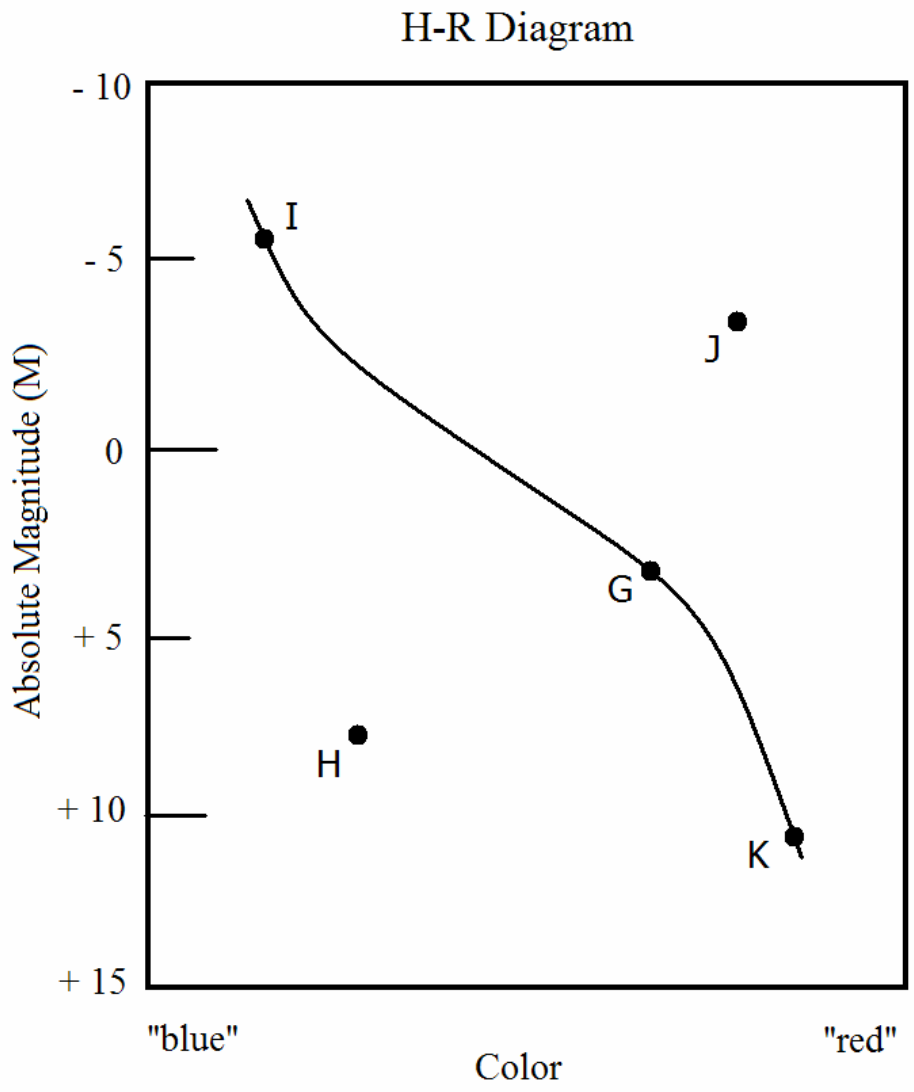
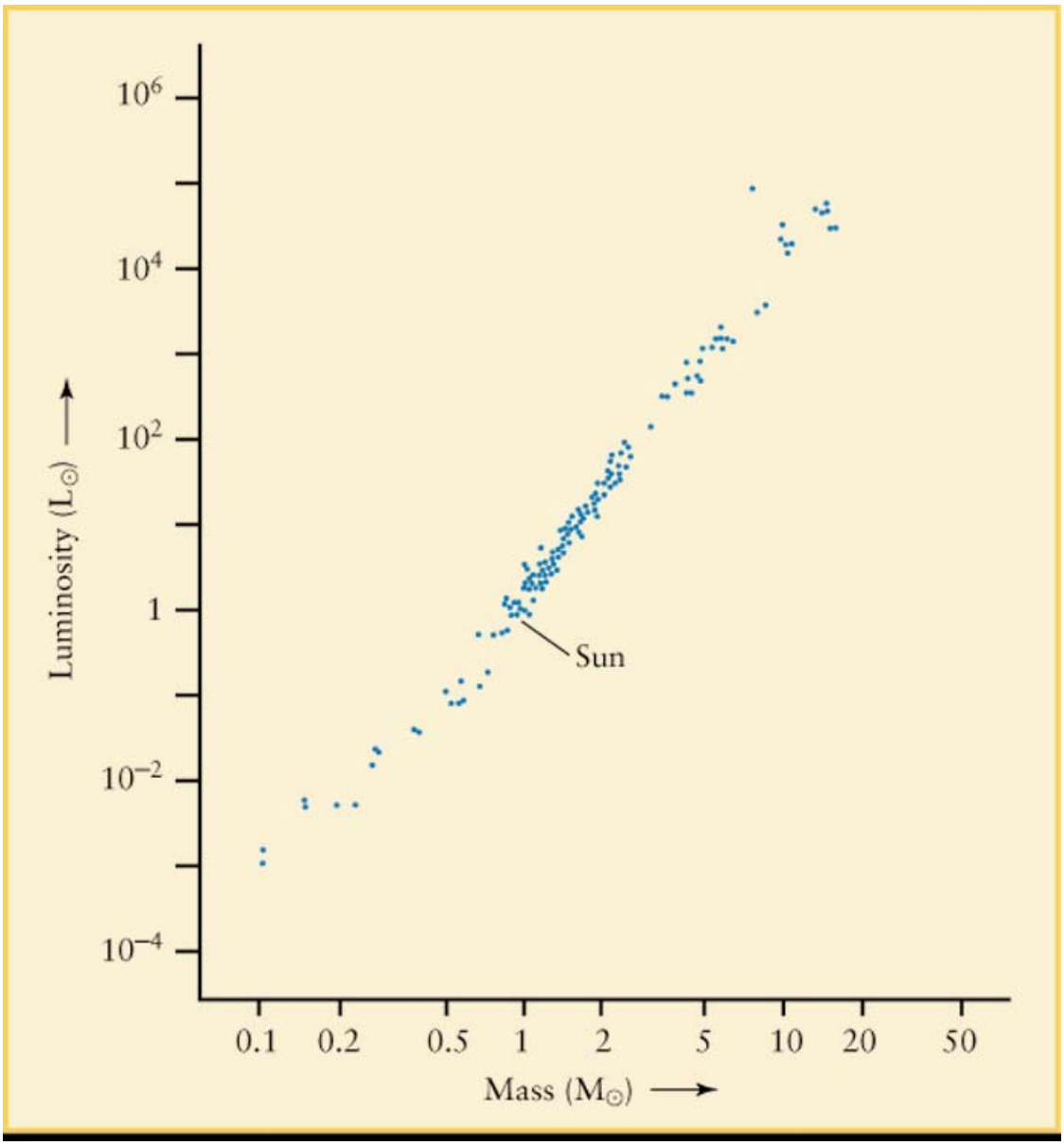

H-R Diagram
- 10
- 5
0
+ 5
+ 10
+ 15
Absolute Magnitude (M)
I
J
G
H
K
"blue"
"red"
Color

Figure 3


10^6
10^4
10^2
1
10^{-2}
10^{-4}
Luminosity ($L_\odot$)
Sun
0.1
0.2
0.5
1
2
5
10
20
50
Mass ($M_\odot$)