You may use one sheet of notes. You may not use books or additional notes.

Name	
PID	
1	/ 18
2	/ 4
3	/ 8
Total	/ 30

Star	App mag	Abs mag	Spectral type	Distance (pc)
Sun	–26.74	4.83	G2	5×10^{-6}
Sirius A	–1.45	1.41	A1	2.7
Sirius B	8.7	11.6	A	2.7
Canopus	–0.73	–4.7	F0	60
Rigel Kent.	–0.1	4.3	G2	1.33
Arcturus	–0.6	–0.2	K0	11
Vega	0.04	0.5	A0	8.1
Capella	0.08	–0.6	G8	14
Rigel	0.11	–7.0	B8	93
Procyon	0.35	2.65	F5	3.5
Betelgeuse	0.8	–6	M2	200
Achernar	0.48	–2.2	B5	39
Hadar	0.60	–5.0	B1	120
Altair	0.77		A7	5.0
Aldebaran	0.85	–0.7	K5	21
Acrux	0.9	–3.5	B2	80
Spica	0.96	–3.4	B1	80
Antares	1.0	–4.7	M1	130
Fomalhaut	1.16	1.9	A3	7.0
Pollux	1.15	0.95	K0	11
Deneb	1.25	–7.3	A2	500
Mimosa	1.26	–4.7	B0	150
61 Cygni	5.2	7.6	K5	3.5

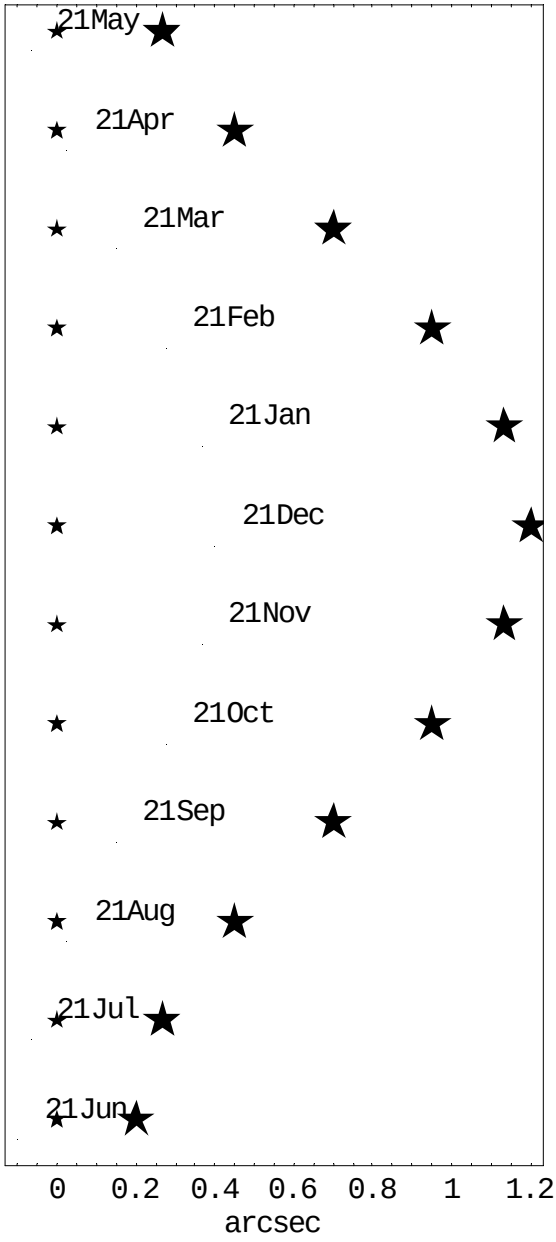

Figure 1 Observations of a nearby star (large symbol) and a distant star (small symbol) over the course of a year. The pictures are offset vertically. The horizontal spacing is shown accurately. East is to the left.

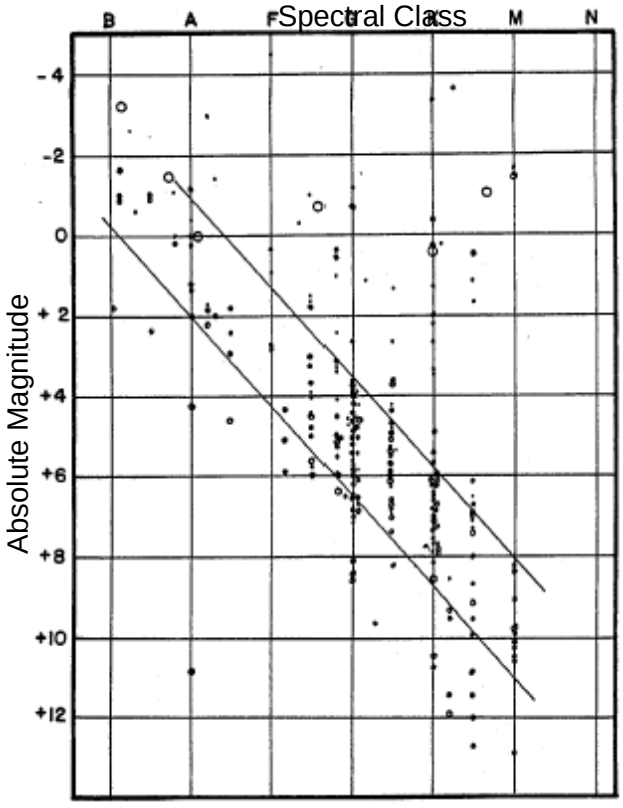

Figure 2 Russell's first Hertzsprung-Russell diagram.

1. Write brief answers using a few complete sentences.
    a. (3 pts.) What prevented Hipparchus from measuring distances to the nearest stars?
    b. (3 pts.) Why was it unnecessary to measure the distance to Jupiter using the method of parallax?
    c. (3 pts.) If we observed on Jupiter, would parallactic shifts of stars be larger or smaller? Explain your reasoning.
    d. (1 pt.) On the H-R diagram in Figure 2, circle a giant and a dwarf that is more luminous than the giant. (2 pts.) How is it possible that a bigger star is less luminous than a smaller one?
    e. (3 pts.) Why was finding Sirius B's temperature crucial to the discovery of white dwarfs?
    f. Suppose a white dwarf having the same mass as the sun replaced the sun, and the earth still orbits at a distance of 1 AU. (1 pt.) Would the period of the orbit be longer, shorter, or the same? (2 pts.) Explain your reasoning.
2. Imagine aliens on a planet that orbits the star 61 Cyg at a distance of 1 AU. The aliens call the star that they orbit Nus.
    a. (1 pt.) Would the aliens observe Nus to be redder or bluer than the Sun?
    b. (3 pts.) For the aliens, how much brighter or fainter would Nus be compared with the Sun as seen by us?
3. We have made observations of a star and a very distant star to measure the distance of the nearby star. On June 21, the nearby star is 0.2 arcsec from the bright one. On July 21, the nearby star is 0.27 arcsec from the bright one. The other observations are shown in Figure 1 on the front sheet.
    a. (5 pts.) Find the distance to the nearby star. Express the distance in parsec.
    b. (1 pt.) What is the right ascension of the star? (2 pts.) Explain your reasoning.

1.

a. Hipparchus did not have a telescope with which to measure the small angles. He did know about the method of parallax, since he used it to measure the distance to the moon.

b. Kepler's 3rd Law and the period of Jupiter gives the distance in AU. Cassini & Richer measured the AU by measuring the distance to Mars with parallax.

c. Using baseline of Jupiter's orbit, the parallactic shift is larger. Parallactic shift = baseline/distance. Although the distance to the star may be slightly larger or smaller, it is negligible (a few AU out of parsecs).

d. A bigger star may be less luminous if it is much cooler.

e. Before Adams found the temperature, there were two possible explanations—size or temperature—for Sirius B's faint luminosity. Adams eliminated temperature.

f. The period is the same, since it depends only on the size of the orbit and mass of the star, according to Newton's extension of Kepler's 3rd Law.

2.

a. Nus is redder, since 61 Cyg is a K star and the sun is a G star.

b. Compare their absolute magnitudes, since the aliens and we both look from the same distance. $m_{Nus}-m_{Sun}=7.6-4.8=2.9$. For the aliens, Nus is 10^(-2.9/2.5) = 0.07 as bright as the sun is for us.

3.

a. Over the course of 12 months from one June to the next June, the angle between the two stars changes by 1.2-0.2=1.0arcsec. Therefore the parallactic shift is 1.0 arcsec. Since the baseline changes by 2AU, the distance to the star is D = 2AU/(1arcsec)=2pc.

b. Star is at 0hr. For the maximum shift to be on 21 June and 21 Dec, the star may be at 0hr or 12hr. (See problem 3 of Homework 4.) If the star is at 12hr, its shift is to the west in June, contrary to Fig 1.