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

 Do the easy questions first. Then go back to the harder ones.

Name	
PID	
1	/ 15
2	/ 7
3	/ 4
4	/ 4
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
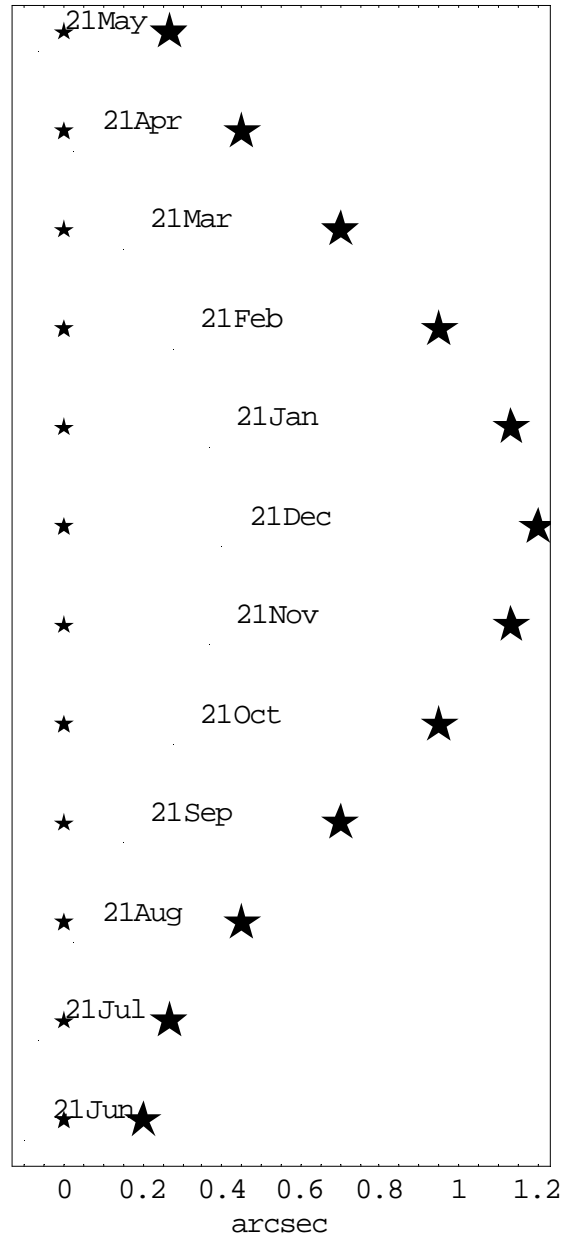
Figure 1 Observations of a nearby star (large
symbol) and a distant star (small symbol) over the
course of a year. The pictures are offset vertically.
The horizontal spacing is shown accurately. East is
to the left.

1. For these questions, you need to separate the key ideas from the details. Extraneous details will count against you. Write brief answers using a few complete sentences.

    a. (3 pts.) What prevented Hipparchus from measuring distances to the nearest stars?

    b. (3 pts.) Suppose we set up a telescope on Mars to measure the distances to stars. Would the parallactic shifts be larger or smaller than they are on Earth? Explain your reasoning.

    c. (3 pts.) How is it possible that a bigger star is less luminous than a smaller one?

    d. (3 pts.) Why was finding Sirius B's temperature crucial to the discovery of white dwarfs?

    e. (3 pts.) Both the apparent and absolute magnitudes of Vega were known in 1900, but only the apparent magnitude was known in 1800. Explain why.

2. Imagine aliens on a planet A that orbits the star Hadar at a distance of 1 AU. (See the table on the front sheet.)

    a. (1 pt.) Would the aliens observe Hadar to be redder or bluer than the Sun?

    b. (3 pts.) For the aliens on planet A, how much brighter or fainter would Hadar be compared with the Sun as seen by us?

    c. (3 pts.) Aliens on another planet B, which also orbits Hadar, see Hadar to be exactly as bright as we see the Sun. What is the distance between planet B and Hadar?

3. A star orbits Sag A in an elliptical orbit with a period of 14 yr. The semi major axis of the orbit is 1000 AU. (3 pts.) Show how to find the mass of Sag A. (1 pt.) Give the numerical answer for the mass. (It is easiest to express the mass in solar mass, rather than in kg.)

4. 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. (3 pts.) Explain how to calculate the distance to the nearby star. (1 pt.) Express the distance in parsec.