1 A star is seen to move by 2 seconds of arc between February 1, 1999 and August 1, 1999 and then back to its starting point on February 1, 2000. What is the parallax angle for this star?
   a. 4 seconds of arc.
   b. 1 seconds of arc.
   c. 5 seconds of arc.
   d. 3 seconds of arc.
   e. 2 seconds of arc.

2 The reason that most SETI programs choose to listen at microwave radio frequencies is that
   a. microwave receivers are easy to build.
   b. microwaves can be beamed in a single direction.
   c. microwaves are the most energy efficient way to send information.
   d. microwaves can get through our atmosphere without being absorbed.

3 The distance modulus of a star at a distance of 10 parsecs would be
   a. 5.
   b. 0.
   c. -5.
   d. 15.
   e. 10.

4 The wavelength of the sound waves that correspond to middle-C is about 4 feet. If you are standing 8 feet away from a piano that is playing that note, then between you and the piano there will usually be
   a. three regions of maximum pressure.
   b. one region of maximum pressure.
   c. maximum pressure every two seconds.
   d. two regions of maximum pressure.
   e. maximum pressure every four seconds.

5 Planets that are in orbit around stars other than our own Sun are most often found by observing
   a. small wobbles in our own Sun.
   b. small wobbles in their primary stars.
   c. small changes in pulsar emissions.
   d. telescope images of the planets.

6 From the broadening of its spectral lines, one can determine a star’s
   a. luminosity class.
   b. radial velocity.
   c. apparent brightness.
   d. spectral type.
7 Which of these is a statement of the Fermi Paradox?
   a. We are never special.
   b. Any long-lasting technological civilization should be obvious and might even be visiting us, so where are they?
   c. Not only do you never get more than you pay for, you never break even.
   d. Because time in a moving reference frame is much slower than in the rest frame, aliens can get anywhere they want to in a very short amount of their own time, so where are they?
   e. The strength of an interstellar signal falls off as the square of the distance but the expected number of such signals increases as the square of the distance, so where are they?

8 The star Wemadeit shows a stellar parallax angle of 0.3 seconds of arc while the star Waytoofar shows a stellar parallax angle of 0.2 seconds of arc. From this, you can conclude that
   a. Waytoofar is closer to our Sun than Wemadeit.
   b. Wemadeit is moving faster than Waytoofar.
   c. Both stars are at the same distance from our Sun.
   d. Wemadeit is closer to our Sun than Waytoofar.
   e. Waytoofar is moving faster than Wemadeit.

9 Which of the following statements qualifies as a falsifiable working hypothesis of the sort that Karl Popper would favor?
   a. Life arises whenever and wherever the conditions are right for it.
   b. Life arose on Earth and exists only there.
   c. Life arose somewhere and spreads from planet to planet through space-born spores.

10 For an eclipsing spectroscopic binary star system, we can determine
   a. only the mass of the smaller star in the system.
   b. the diameters of both stars in the system.
   c. only a minimum mass for each star.
   d. the masses and diameters of both stars in the system.
   e. the masses of both stars in the system.

11 The closest star to Earth (other than the Sun) is part of a multiple star system called
   a. Alpha Centauri.
   b. Albireo.
   c. Epsilon Aurigae.
   d. Procyon.
   e. Sirius.

12 A star is found to have absolute magnitude -1 and apparent magnitude 19. How far away is it?
   a. 10 parsecs.
   b. 10,000 parsecs.
   c. 100,000 parsecs.
   d. 200 parsecs.
   e. 20 parsecs.
13 Cruising far from the Sun, we notice that the Sun’s apparent brightness has dimmed to 0.1 watts per square meter. We know that the apparent brightness at a distance of 1au is 1000 watts per square meter. How far from the Sun are we?
   a. 10au
   b. 1au
   c. 1000au
   d. 1000au

14 A star with an apparent magnitude of 5.7 and an absolute magnitude of –1.2 would appear in our sky as a star
   a. of dazzling brightness.
   b. barely visible to the naked eye.
   c. of average naked-eye brightness.
   d. visible only with a telescope.

15 Spectroscopic Parallax refers to
   a. the shifting of spectral lines due to star motion.
   b. the use of stellar parallax.
   c. the pressure broadening of spectral lines.
   d. a method for finding distances to stars.

16 The problem of stars "twinkling" due to atmospheric turbulence
   a. can only be corrected by putting telescopes in space.
   b. can be corrected by using a more powerful eyepiece.
   c. can be corrected by going to larger telescope mirrors.
   d. can be corrected by using a guide star.
   e. cannot be corrected.

17 Our Sun is a G2V star with absolute magnitude 4.8. Suppose that a star of spectral type G2V is observed to have apparent magnitude 9.8. How far away is it?
   a. 100 parsecs.
   b. 10 parsecs.
   c. 1 parsec.
   d. 1000 parsecs.
   e. 5 parsecs.

18 Which of the following spectral types corresponds to the star with the lowest surface temperature?
   a. K0
   b. K5
   c. G0
   d. G5

19 Which of the following magnitudes corresponds to the brightest star?
   a. +1.2
   b. –1.5.
   c. +2.1.
   d. +3.4.
   e. +5.6.
20 In a Hertzsprung-Russell diagram, the hottest stars are found

   a. at the top.
   b. at the bottom.
   c. on the left side.
   d. on the right side.

21 Think of the ‘front’ of a telescope as the end that light enters. A telescope with Newtonian Focus has the eyepiece

   a. sticking out the side near the front.
   b. at the back of the telescope.
   c. sticking out the side near the back.
   d. inside the telescope barrel.
   e. off to one side in a position that stays fixed when the telescope moves.

22 The star Kruger 60 shows a heliocentric stellar parallax of almost exactly 0.25 seconds of arc. The distance from our Sun to Kruger 60 is

   a. 2 parsecs.
   b. 4 parsecs.
   c. 0.75 parsecs.
   d. 0.25 parsecs.
   e. 8 parsecs.

23 The main reason to suspect that Europa has a subsurface ocean of water is

   a. landmarks that are not rotating with the rest of the moon.
   b. low fluxes of epithermal neutrons.
   c. geysers of water shooting out through cracks in the moon.
   d. patterns of cracks in the ice on its surface.

24 The red line of a spectrum is normally at a wavelength of 656 nm. In the light of a star that is moving away from us, we might expect to see that red line at a wavelength of

   a. 656nm.
   b. 660nm.
   c. 650nm.

25 Of all the things that might go wrong with distances found by using the method that astronomers refer to as the "distance ladder," which of these is the one that an astronomer would say is most likely?

   a. Distant objects are not behaving the same as nearby objects.
   b. The parallax-distance formula is incorrect.
   c. The distance-distance modulus formula is incorrect.
   d. The parallaxes of nearby objects have been measured incorrectly.
   e. The apparent magnitudes of distant objects have been measured incorrectly.
26 Cruising far from the Sun, we notice that the Sun’s apparent brightness has dimmed to 10 watts per square meter. We know that the apparent brightness at a distance of 1au is 1000 watts per square meter. How far from the Sun are we?
   a. 100au
   b. 10au
   c. 1au
   d. 1000au

27 A converging lens will send the light from a distant star through a point
   a. on the side of the lens opposite the star.
   b. at one edge of the lens.
   c. in the center of the lens.
   d. infinitely far away from the lens.
   e. on the same side of the lens as the star.

28 A star whose apparent brightness is $\frac{1}{100}$ that of a first magnitude star would have magnitude
   a. 11.
   b. 1.
   c. 16.
   d. 21.
   e. 6.

29 Spectroscopic parallax uses
   a. annual position shifts of stars to calculate distance.
   b. the doppler shift to find star velocities.
   c. stellar spectra to locate stars in the HR diagram.
   d. timing variations in brightness to estimate mass.

30 A star whose full spectral type is K2V is
   a. a red supergiant star.
   b. a red subgiant star.
   c. a bright blue supergiant star.
   d. a red main sequence star.
   e. a red giant star.
31 In the Hertzsprung-Russell diagram shown, point number 1 could be a

![Hertzsprung-Russell Diagram]

- a. F0 star of absolute magnitude -5.
- c. B0 star of absolute magnitude 10.
- d. F9 star of absolute magnitude 5.
- e. B0 star of absolute magnitude -5.

32 Compared to a magnitude 11 star, a magnitude 1 star would be

- a. 10,000,000 times as bright.
- b. 1,000,000 times as bright.
- c. 1000 times as bright.
- d. 100 times as bright.
- e. 10 times as bright.

33 One of the experiments carried out by the Viking Landers was to use a mass spectrometer to analyze the gas given off from a heated soil sample. The results of that experiment (as interpreted at the time) established that Martian soil contains

- a. no carbon compounds at all.
- b. more carbon compounds than would be expected on a planet with a carbon dioxide atmosphere.
- c. just about the amount of carbon compounds that would be expected on a planet with a carbon dioxide atmosphere.
- d. large organic hydrocarbons.

34 A star of spectral type M should look

- a. orange.
- b. red.
- c. white.
- d. blue.
- e. yellow.

35 The diffraction limit of a telescope refers to the effect of

- a. errors in the lens shape.
- b. the wavelength of light.
- c. its light collection area.
- d. chromatic aberration.
- e. atmospheric turbulence.
36 Which of the following pictures is the most like the main sequence on a Hertzsprung-Russell Diagram?

![Hertzsprung-Russell Diagram options](image)

37 Here is the Drake Equation:

\[ N = R^* \times f_p \times n_e \times f_i \times f_l \times f_c \times L \]

In this equation, \( N \) stands for

a. average number of habitable planets in a planetary system.
b. number of extraterrestrial messages that we might expect to detect in a year.
c. number of communication-capable civilizations in our galaxy.
d. expected lifetime of a communication-capable civilization.

38 The velocity of a wave is defined to be

a. the time taken for a crest to pass.
b. the number of crests that pass multiplied by the time taken.
c. the number of crests that pass divided by the time taken.
d. the distance traveled by a crest divided by the time taken.
e. the distance from one crest to the next.

39 Planets that are in orbit around stars other than our own Sun are **most often** found by observing

a. telescope images of the planets.
b. small wobbles in our own Sun.
c. small changes in starlight due to planetary transits.
d. the microlensing of light from background stars.

40 The velocity of sound waves is roughly the same for all wavelengths. Suppose that a sound wave has a wavelength of one meter and a frequency of 500Hz. The wavelength of a 1000Hz sound wave would then be

a. 1000 m.
b. 1/2 m.
c. 1 m.
d. 500 m.
e. 2 m.

41 Which of these moons could have two levels of oceans, with oceans of liquid hydrocarbons on the surface and oceans of liquid water beneath the surface?

a. Titan.
b. Enceladus.
c. Europa.
d. Ganymede.
42 The star Tau Ceti has moved across the sky by 1922 seconds of arc during the last thousand years, more than a half of a degree of arc. Its proper motion is closest to
   a. 1.9265''/yr.
   b. 1922''/yr.
   c. 3.853''/yr.
   d. 19.22''/yr.
   e. 0.26''/yr.

43 If we detect that a star is sometimes moving toward us and sometimes moving away and also find that this pattern repeats at regular intervals, we know for sure that the star
   a. has at least one object of unknown type orbiting around it.
   b. is part of a binary star system.
   c. has at least one large planet.
   d. is violating the Law of Inertia.

44 A star that is cooler than most other stars will probably look
   a. blue.
   b. yellow.
   c. red.
   d. orange.
   e. peach.

45 A main-sequence star with more mass than our sun will be
   a. cooler and brighter.
   b. hotter and dimmer.
   c. cooler and dimmer.
   d. hotter and brighter.

46 The star Vega is 25 parsecs from our Sun. The light from Vega has been traveling for about
   a. 80 years.
   b. 25 years.
   c. 12.5 years.
   d. 0.04 years.
   e. 7.5 years.

47 Which of the following spectral classes corresponds to the second highest surface temperature (on this list)?
   a. G
   b. B
   c. F
   d. K
   e. A

48 Stellar Parallax
   a. can only be seen with a telescope.
   b. is easily seen with the naked eye.
   c. could have been detected by Tycho Brahe’s angle-measuring instruments.
49 The velocity of sound waves is roughly the same for all wavelengths. Suppose that a sound wave has a wavelength of one meter and a frequency of 1000Hz. The wavelength of a 500Hz sound wave would then be
   a. 500 m.
   b. 2 m.
   c. 1/2 m.
   d. 1 m.
   e. 1000 m.

50 The habitable zone of a planetary system is defined to be the region where
   a. few asteroids can be found.
   b. planetary surfaces permit the existence of liquid water.
   c. the intensity of light from the primary star is enough to support life.
   d. large terrestrial planets might exist.
Answer Key: Exam 4 Preview, Version 1

1 Choice b. (1 seconds of arc.)
2 Choice c. (microwaves are the most energy efficient way to send information.)
3 Choice b. (0.)
4 Choice d. (two regions of maximum pressure.)
5 Choice b. (small wobbles in their primary stars.)
6 Choice a. (luminosity class.)
7 Choice b. (Any long-lasting technological civilization should be obvious and might even be visiting us, so where are they?)
8 Choice d. (We made it is closer to our Sun than Way too far.)
9 Choice b. (Life arose on Earth and exists only there.)
10 Choice d. (the masses and diameters of both stars in the system.)
11 Choice a. (Alpha Centauri.)
12 Choice c. (100,000 parsecs.)
13 Choice c. (100au)
14 Choice b. (barely visible to the naked eye.)
15 Choice d. (a method for finding distances to stars.)
16 Choice d. (can be corrected by using a guide star.)
17 Choice a. (100 parsecs.)
18 Choice b. (K5)
19 Choice b. (−1.5.)
20 Choice c. (on the left side.)
21 Choice a. (sticking out the side near the front.)
22 Choice b. (4 parsecs.)
23 Choice d. (patterns of cracks in the ice on its surface.)
24 Choice b. (660nm.)
25 Choice a. (Distant objects are not behaving the same as nearby objects.)
26 Choice b. (10au)
27 Choice a. (on the side of the lens opposite the star.)
28 Choice e. (6.)
29 Choice c. (stellar spectra to locate stars in the HR diagram.)
30 Choice d. (a red main sequence star.)
31 Choice e. (B0 star of absolute magnitude -5.)
32 Choice b. (10,000 times as bright.)
33 Choice a. (no carbon compounds at all.)
34 Choice b. (red.)
35 Choice b. (the wavelength of light.)
36 Choice a. (A)  
37 Choice c. (number of communication-capable civilizations in our galaxy.)  
38 Choice d. (the distance traveled by a crest divided by the time taken.)  
39 Choice c. (small changes in starlight due to planetary transits.)  
40 Choice b. (1/2 m.)  
41 Choice a. (Titan.)  
42 Choice a. (1.9265°/yr.)  
43 Choice a. (has at least one object of unknown type orbiting around it.)  
44 Choice c. (red.)  
45 Choice d. (hotter and brighter.)  
46 Choice a. (80 years.)  
47 Choice e. (A)  
48 Choice a. (can only be seen with a telescope.)  
49 Choice b. (2 m.)  
50 Choice b. (planetary surfaces permit the existence of liquid water.)
Where to find these questions in the notes

1. Module 020.401 Stellar Parallax and Distance Parallax Angle and Distance
2. Module 019.502 The Search for Life SETI: Search for ExtraTerrestrial Intelligence
3. Module 022.302 Stellar Magnitudes and Distance Luminosity, Apparent and Absolute Magnitudes (50%)
4. Module 021.102 Using the Doppler Shift Describing Waves
5. Module 019.405 The Search for Life Extrasolar Planets
6. Module 024.402 The Hertzsprung-Russell Diagram, Luminosity Class
7. Module 019.507 The Search for Life SETI: Search for ExtraTerrestrial Intelligence (42%)
8. EModule 020.403 Stellar Parallax and Distance Parallax Angle and Distance
9. Module 019.101 The Search for Life The Motivation
10. Module 021.307 Using the Doppler Shift Binary Systems
11. Module 019.410 The Search for Life Extrasolar Planets
12. Module 022.404 Stellar Magnitudes and Distance Luminosity, Finding the distance
13. Module 022.102 Stellar Magnitudes and Distance Luminosity, Brightness and Distance
14. Module 022.303 Stellar Magnitudes and Distance Luminosity, Apparent and Absolute Magnitudes (44%)
15. Module 024.502 The Hertzsprung-Russell Diagram, Spectroscopic Parallax
16. Module 020.205 Stellar Parallax and Distance Telescopes
17. Module 024.503 The Hertzsprung-Russell Diagram, Spectroscopic Parallax
18. Module 023.302 Star Colors and Classes, Spectral Subclasses
19. Module 022.201 Stellar Magnitudes and Distance Luminosity, The Magnitude Scale
20. Module 024.204 The Hertzsprung-Russell Diagram, Interpreting the diagram
21. Module 020.202 Stellar Parallax and Distance Telescopes (42%)
22. EModule 020.405 Stellar Parallax and Distance Parallax Angle and Distance
23. Module 019.305 The Search for Life The Jovian Moons
24. Module 021.203 Using the Doppler Shift The Doppler Shift
25. Module 022.504 Stellar Parallax and Distance Luminosity, Preview of the Distance Ladder
26. ***Module 022.102 Stellar Magnitudes and Distance Luminosity, Brightness and Distance (21%)
27. Module 020.101 Stellar Parallax and Distance Lenses and Mirrors (43%)
28. *Module 022.204 Stellar Magnitudes and Distance Luminosity, The Magnitude Scale (38%)
29. *Module 024.501 The Hertzsprung-Russell Diagram, Spectroscopic Parallax (40%)
30. Module 024.404 The Hertzsprung-Russell Diagram, Luminosity Class
31. Module 024.103 The Hertzsprung-Russell Diagram, A dot for each star
32. Module 022.203 Stellar Magnitudes and Distance Luminosity, The Magnitude Scale
33. Module 019.206 The Search for Life Mars
34. Module 023.203 Star Colors and Classes, Spectral Types
35. *Module 020.203 Stellar Parallax and Distance Telescopes (35%)
Module 024.302A The Hertzsprung-Russell Diagram, The Main Sequence

Module 019.505 The Search for Life SETI: Search for ExtraTerrestrial Intelligence

Module 021.107 Using the Doppler Shift Describing Waves

Module 019.413 The Search for Life Extrasolar Planets

*Module 021.111-g01 Using the Doppler Shift Describing Waves (37%)

**Module 019.302-g01 The Search for Life The Jovian Moons (29%)

Module 020.502-g01 Stellar Parallax and Distance Parallax Angle and Distance

***Module 019.406 The Search for Life Extrasolar Planets (23%)

Module 023.102-g01 Star Colors and Classes, Colors and Temperatures

Module 024.303 The Hertzsprung-Russell Diagram, The Main Sequence

Module 020.407-g01 Stellar Parallax and Distance Parallax Angle and Distance

Module 023.201-g01 Star Colors and Classes, Spectral Types

Module 020.301-g01 Stellar Parallax and Distance What Causes Parallax?

Module 021.111 Using the Doppler Shift Describing Waves

Module 019.401 The Search for Life Extrasolar Planets