

# Astronomy 161 Exam 1

## September 18, 2002

### YELLOW VERSION

Select the single best answer for each question, unless otherwise instructed. No notes or calculators are permitted. Each question is 1 point unless otherwise noted.

1. The ecliptic is

- (a) the path of the Sun across the sky.
- (b) the plane of the Solar System.
- (c) the dividing line between north and south in the heavens.
- (d) the line on the sky directly above Earth's equator.

2. When planets drift backward (compared to their usual direction) against the background of stars, the motion is called

- (a) heliacal rising. (b) retrograde motion. (c) wandering. (d) primum mobile.

3. Which of the following numbers has the same meaning as 8,670?

- (a)  $8.67 \times 10^3$       (b)  $8.67 \times 10^2$       (c)  $8.67 \times 10^1$       (d)  $0.867 \times 10^3$

Remember that  $10^3 = 1000$ .

4. The zero measure of longitude is chosen to be

- (a) the vernal equinox    (b) the equator    (c) the ecliptic    (d) Greenwich, England

This convention is simply a matter of definition. The vernal equinox is the zero measure of right ascension, which is distinct from longitude, an earth measure.

5. Who is responsible for each of the following important developments? Select answers from the following: Galileo, Kepler, Ptolemy, Copernicus, Newton, Brahe, Aristotle, Eratosthenes (Use all answers once. 1 point each)

\_\_\_Copernicus\_\_\_ is credited for the idea that the solar system is heliocentric.

\_\_\_Kepler\_\_\_ first showed that planets move on elliptical orbits.

\_\_\_Ptolemy\_\_\_ introduced epicycles to explain retrograde motion of planets.

\_\_\_Newton\_\_\_ explained planetary motion using the theory of universal gravitation.

\_\_\_Brahe\_\_\_ used giant instruments to measure planets' motion to unprecedented accuracy.

\_\_\_Eratosthenes\_\_\_ first measured the circumference of the earth.

\_\_\_Aristotle\_\_\_ created a cosmological model dominated for 1800 years.

\_\_\_Galileo\_\_\_ made the first use of a refracting telescope in astronomy.

6. A light year is defined as the

- (a) distance from the Sun to the nearest star.
- (b) average distance from the Earth to the Sun.
- (c) length of the Solar Year.
- (d) speed of light in a vacuum.
- (e) distance light travels in one year.

The light year is a measure of astronomical distance, not of time.

7. The solar (tropical) year is decreasing in length relative to the sidereal year because

- (a) the Earth precesses about its axis every 23,000 years.
- (b) the solar year is not an even number of days in length.
- (c) the Earth's rotation speed is slowing down.
- (d) the Earth's orbit is elliptical rather than circular.

While all these are true, only (a) is related to the difference between the tropical and sidereal year. The precession of the earth's pole causes the seasons to shift slightly, moving the position of the equinoxes along the orbit.

8. Where is the greatest collection of large optical and infrared telescopes?

- (a) in Earth orbit  
(c) Kitt Peak, Arizona
- (b) Mauna Kea, Hawaii  
(d) Cerro Tololo,

Mauna Kea is home of the Subaru and twin Keck observatories, and many others. The high, dry location is suitable for both optical and infrared observations.

9. In space, light travels at about

- (a) 3,000,000 km/s. (b) 300,000 km/s (c) 3000 km/s. (d) 3000 m/s.

This can also be expressed as  $3 \times 10^8$  m/s or  $3 \times 10^{10}$  cm/s.

10. The points on the celestial sphere where the ecliptic crosses the equator are called

- (a) asterisms. (b) solstices. (c) meridians. (d) equinoxes.

11. The Earth's atmosphere shields us from most kinds of electromagnetic radiation. The exceptions are

- (a) only visible light frequencies. (b) x-rays and gamma rays.  
(c) visible light and radio waves. (d) x-rays and ultraviolet radiation.

12. Consider the following four stars, with right ascensions and declinations given.

- (a) R.A. 18 hours, declination +2 degrees (b) R.A. 12 hours, declination +10 degrees  
(c) R.A. 0 hours, declination -15 degrees (d) R.A. 5 hours, declination +80 degrees

Select one of the above for each answer. Enter the letters on the lines below. (Use each once, 1 point each.)

\_\_\_c\_\_\_ is in the southern celestial hemisphere.

\_\_\_a\_\_\_ is closest to the equator.

\_\_\_d\_\_\_ is a circumpolar star when viewed from Knoxville.

\_\_\_b\_\_\_ crosses your meridian at noon, sidereal time.

13. A device which separates light into its constituent wavelengths, either using a prism or a diffraction grating, is called a

- (a) bolometer.
- (b) spectrograph.
- (c) refracting telescope
- (d) bolometer.

14. Long baseline interferometry is used to improve the resolution of radio telescopes because

- (a) multiple dishes are needed to reduce interference from radio stations on Earth.
- (b) multiple dishes combine to produce a stereoscopic image of the stars.
- (c) radio waves are very weak on the surface of the earth due to strong absorption in the atmosphere.
- (d) the resolution of individual dishes is limited due to the relatively long wavelength of radio waves compared to the dish size.

Diffraction limits are much worse for radio telescopes than optical telescopes due to the long wavelength of radio waves relative to visible light. Multiple telescopes improve this. Note that (b) is false because all stars are too far away to get any significant parallax effect from having distinct observation points. Only a few stars have enough parallax to be measured across the earth's orbit. Also, (c) is false because visible light and radio waves are the two bands that are transmitted best through the atmosphere.

15. The resolution of large ground-based optical telescopes is presently being significantly improved mostly by

- (a) improved techniques for fabricating the mirror.
- (b) using active optics to correct for atmospheric distortion.
- (c) computer optimization of the telescope's design.
- (d) better reflective coatings.

While everything listed will improve telescopes, the biggest innovation in the new generation of telescopes is active optics, or movable mirrors that can be adjusted rapidly to cancel atmospheric fluctuations.

16. Who's theory of planetary motion **did not** require epicycles to obtain accurate results?

- (a) Aristotle's
- (b) Kepler's
- (c) Copernicus's
- (d) Ptolemy's

Remember that although Copernicus's model was heliocentric, it still had circular orbits, so epicycles were still needed to improve its predictions. Aristotle did not introduce epicycles, but his model needed them to explain retrograde motion, and they were introduced by Ptolemy.

17. An object is moving through space. If all forces are removed from the object, it will

- (a) move in random directions.
- (b) continue in a straight line at constant speed.
- (c) enter a circular orbit.
- (d) continue in a straight line, but slow down and stop.

This is the principle of inertia, which was originally introduced by Galileo. It is also a statement of Newton's First Law, which says that anything moves in a straight line at a constant velocity unless acted upon by an external force.

18. Which of the following **is not** an advantage of reflecting telescopes over refracting telescopes?

- (a) Refracting telescopes cannot view all frequencies of light.
- (b) Reflecting telescopes have no chromatic aberration.
- (c) Reflecting telescopes are not limited by diffraction effects.
- (d) Large mirrors are more easily supported than large lenses.
- (e) Large mirrors are more easily constructed than large lenses.

All optical devices are limited by diffraction. The other choices are all advantages of reflecting telescopes.

19. A 10 meter telescope will collect how many times as much light as a 5 meter telescope?

- (a) 2 times       (b) 4 times      (c) 8 times      (d) the same

The amount of light collected is proportional to the **area** of the aperture (lens or mirror), which is proportional to the square of the diameter. Doubling the aperture lets in 4 times as much light.

20. For the same wavelength of light, a 10 meter telescope will have how many times better resolution than a 5 meter telescope?

- (a) 2 times      (b) 4 times      (c) half      (d) the same

The angular spread of the image due to diffraction is proportional to the wavelength divided by the aperture diameter. Therefore, doubling the diameter (or halving the wavelength) gives twice as good angular resolution.

21. The Hubble Space Telescope is a(n)

- (a) orbiting refracting telescope. (b) orbiting reflecting telescope.  
(c) ground-based refracting telescope. (d) ground-based reflecting telescope.

Like all major modern telescopes, the Hubble Telescope is a reflecting telescope.

22. A spectrum containing dark bands set against a bright background is called a(n)

- (a) emission spectrum (b) continuum spectrum (c) absorption spectrum

23. The age of the universe is most nearly

- (a) 50 million years (b) 4.5 billion years (c) 2 million years (d) 14 billion years

24. Which of the following **is not** a form of electromagnetic radiation?

- (a) gamma rays (b) neutrinos (c) radio waves (d) gamma rays

Neutrinos are (nearly) massless, uncharged weakly-interacting particles created, for example, during nuclear fusion in the interior of stars, including the sun.

25. According to Kepler's Laws, moving a planet's orbit 4 times as far from the sun should make its orbital period how many times as long?

- (a) 8 times (b) 4 times (c) 2.5 times (d) 2 times

Kepler's third law says that the cube of the semimajor axis is proportional to the square of the orbital period. If the planet is 4 times as far away, the cube of its semimajor axis is  $4^3 = 4 \times 4 \times 4 = 64$  times as large. The square root of 64 is 8, so the orbital period is 8 times as long.