

Astronomy 161 Exam 1

September 18, 2002

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

(a) 8.67×10^3

(b) 8.67×10^2

(c) 8.67×10^1

(d) 0.867×10^3

Remember that $10^3 = 1000$.

2. A light year is defined as the

(a) speed of light in a vacuum.

(b) average distance from the Earth to the Sun.

(c) length of the Solar Year.

(d) distance light travels in one year.

(e) distance from the Sun to the nearest star.

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

3. In space, light travels at about

(a) 3000 m/s

(b) 3000 km/s

(c) 300,000 km/s.

(d) 3,000,000 km/s.

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

4. 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.

5. 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.

6. 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.

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

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

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.

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

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

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

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

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

___a___ is in the southern celestial hemisphere.

___c___ is closest to the equator.

___b___ is a circumpolar star when viewed from Knoxville.

___d___ crosses your meridian at noon, sidereal time.

Remember that negative declinations are south of the equator, and larger declinations are closest to the poles. The sidereal time is by definition the time when a star with the same right ascension crosses the meridian.

10. 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.

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

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

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

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

While all these are true, only (c) 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.

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

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

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.

14. The age of the universe is most nearly

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

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

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

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

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

- (a) Aristotle's
- (b) Ptolemy's
- (c) Copernicus's
- (d) Kepler'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. Long baseline interferometry is used to improve the resolution of radio telescopes because

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

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 (a) is false because visible light and radio waves are the two bands that are transmitted best through the atmosphere. Also (d) 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.

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

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

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.

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

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

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.

20. The Hubble Space Telescope is a(n)

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

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

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

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

22. 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) 2 times (b) 2.5 times (c) 4 times (d) 8 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.

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

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

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.

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

- (a) Reflecting telescopes have no chromatic aberration.
(b) Reflecting telescopes are not limited by diffraction effects.
(c) Refracting telescopes cannot view all frequencies of light.
(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.

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

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

