

UNIVERSITY OF CALIFORNIA, SANTA BARBARA
Department of Physics

Astronomy 1
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MIDTERM EXAM
February 9, 2009

VERSION A

Make sure that the person on either side of you has a different colored exam from yours. Answer each question by filling in the appropriate block on your scantron form, using a No. 2 pencil only. For each question give the one best answer. There is no penalty for guessing, so be sure you give an answer for every question.

Be absolutely sure that you print your name on your scantron form. To avoid possible mistakes, we suggest that you don't fill in the scantron form until you have decided on your answers to all questions.

This is a closed book, closed notes exam. You may, however, use a calculator. Do not start until told to do so. **Most importantly, note the version of your exam at the top of the scantron form.**

If you wish to receive your exam back in a publicly accessible place, be sure to **SIGN** your scantron form.

Some formulae of possible interest:

Conversion of mass to energy: $E = mc^2$, where $c = 3 \times 10^8$ m/sec

Doppler effect: $\frac{v}{c} = \frac{\Delta\lambda}{\lambda_0}$

Energy of a photon: $E = h\nu$, where $h \approx 1 \times 10^{-34}$ J \times s

Kepler's Third Law: $P^2 \propto a^3$

Total radiation flux of blackbody per unit area per unit time: $F = \sigma T^4$ ("Stefan-Boltzmann Law")

Peak of blackbody spectrum: $\lambda_{\max} = 2.9 \times 10^{-3} \text{mK} / T$ ("Wien's Law")

Newton's Law of Universal Gravitation: $F_g = G \frac{m_1 m_2}{d^2}$, where $G = 6.67 \times 10^{-11} \text{Nm}^2/\text{kg}^2$ in our "mks" metric units

Surface area of a sphere = $4\pi R^2$; Volume of a sphere $4\pi / 3 R^3$

$1\text{m} = 10^6$ microns = 10^9 nm = 10^{10} Å

$v\lambda = c$

$c = 3 \times 10^8$ m/sec

$F = ma$

One light year $\approx 1.0 \times 10^{16}$ m; One pc $\approx 3 \times 10^{16}$ m

Distance to Moon: 400,000 km or 240,000 mi

1 astronomical unit, the distance from the Sun to Earth, is ~ 93 million miles or 150 million km

$H = 6.62 \times 10^{-34}$ Joule-seconds

Small angle formula: $D \approx \alpha d / 200,000$ for α in arcseconds; d is the distance

$\sigma = 5.7 \times 10^{-8} \text{W/m}^2\text{K}^4$ in our "mks" metric units

Luminosity = (surface area A) \times (Energy Flux per unit area F).

1. Which is characteristic of a terrestrial planet?
 - A. It's large and warm
 - B. It's far from the sun
 - C. It's dense like a rock or metal
 - D. It's made mostly of H and He
 - E. It has no solid surface

2. Which planet changes its angular size as seen from Earth more than any other? Can you figure out which it is?
 - A. Mercury
 - B. Venus
 - C. Jupiter
 - D. Neptune

3. Roughly how far does the Sun move on the Celestial Sphere per day?
 - A. 30 degrees
 - B. 12 degrees
 - C. 3 degrees
 - D. 1 degree
 - E. 50 arcseconds

4. Which planets can never be seen at midnight?
 - A. The Superior planets
 - B. The Inferior planets
 - C. All planets can be seen at midnight if you wait long enough
 - D. No planets can be seen at midnight

5. The greenhouse effect occurs because
 - A. a planetary atmosphere absorbs solar radiation.
 - B. a planetary atmosphere reflects solar radiation.
 - C. a planetary atmosphere absorbs the planet's own radiation.
 - D. vegetation preferentially absorbs green light.

6. We detect Balmer alpha emission from the nucleus of a galaxy, and also from the two edges. In the nuclear spectrum, the wavelength is observed to be 656.30 nm. On one edge, the wavelength is 656.70 nm. Which is true?
 - A. The galaxy and the Earth are getting farther apart
 - B. The galaxy and the Earth are getting closer together
 - C. The gas emitting the emission line is hotter than on Earth
 - D. The gas emitting the emission line is colder than the Earth
 - E. 600 km/sec

7. Which is true about the relative abundance of the elements in interstellar space?
- A. Most matter is in the form of rocky and metallic elements and ices
 - B. The vast majority of the mass is in Hydrogen and Helium
 - C. Hydrogen and Helium are no more abundant than the other elements, but they concentrate in the Sun's atmosphere
 - D. Helium is the most abundant element
8. A spaceship travels through empty space. The Captain wants to change course.
- A. It's possible only using the rocket effect
 - B. It's only necessary to rotate external propellers
 - C. The Captain is out of luck. The ship will coast until it enters a gravitational force field, or at least until it is surrounded by some gas
9. An astronaut on the Moon drops a hammer and a feather simultaneously. What can be said about the force and the acceleration that these objects feel?
- A. Both feel the same force, and the same acceleration
 - B. Both feel the same force, but the hammer has the greater acceleration
 - C. Both have the same acceleration, but the hammer feels the greater force
 - D. The hammer feels greater force and greater acceleration
10. The autumnal equinox is that time of the year when the
- A. Sun crosses the equatorial plane, or celestial equator, moving northward.
 - B. Sun crosses the equatorial plane, or celestial equator, moving southward.
 - C. Sun crosses the ecliptic plane.
 - D. Earth is at the closest point to the Sun in its elliptical orbit.
11. Saturn is at a certain location on the Celestial Sphere. Its orbital period is about 30 years. How far will it move in the next 12 months?
- A. 30 degrees
 - B. 12 degrees
 - C. 6 degrees
 - D. 3 degrees
12. How long does a star at 0 degrees Celestial Latitude stay above the horizon?
- A. It depends on your exact location on Earth
 - B. It depends on the time of year
 - C. Both A and B
 - D. 12 hours, except if you are at one of Earth's poles

13. Io and Europa are big Jovian moons. Io's orbit about Jupiter has a semi-major axis of 422,000 km, and a period of 1.77 days. Europa's orbital semi-major axis is 671,000 km. What is the period of Europa?
- A. Also 1.77 days
 - B. 3.54 days
 - C. 5.31 days
 - D. 7.08 days
 - E. 10.62 days
14. Most of the planets orbit the Sun on or close to the
- A. equatorial plane.
 - B. galactic plane.
 - C. ecliptic plane.
 - D. meridian plan at Greenwich, England.
15. An astronaut is floating freely in space. If she/he were to push on a nearby spaceship, what would happen?
- A. Both the astronaut and the spaceship would move, but in opposite directions
 - B. Both the astronaut and the spaceship would move in the direction of the push
 - C. The astronaut would move, but the spaceship would not
 - D. Insufficient information has been given
16. Which is true regarding the nature of the light?
- A. It has particle-like properties as well as wavelike properties
 - B. The Doppler Effect: Light seems to travel faster or slower depending on the observer's motion
 - C. The higher the frequency, the larger the wavelength
 - D. The photoelectric effect disproves the wave theory for light
17. In the simplified version of Kepler's Third Law as applied to planets orbiting the Sun, the unit of orbital period P and semi-major axis of the ellipse must be, respectively,
- A. years and astronomical units.
 - B. years and light years.
 - C. years and meters.
 - D. seconds and meters.
18. Which is true:
- A. A solare eclipse can only occur at full moon
 - B. A lunar eclipse can only occur at new moon
 - C. A full moon rises nearly at sunrise
 - D. If the moon's orbit were exactly in the ecliptic plane, there would be solar and lunar eclipses every month
 - E. An annular eclipse only happens when the moon is near perigee, that is, relatively close to Earth in its orbit

19. The seasons are caused by
- A. the varying length of the daylight time, which is a result of the tilt of Earth's axis relative to the direction perpendicular to the ecliptic.
 - B. the varying angle at which the Sun's rays strike Earth, a result of the tilt of Earth's axis relative to the direction perpendicular to the ecliptic.
 - C. the changing Sun-Earth distance, which is a result of the ellipticity of Earth's orbit.
 - D. both A and B.
20. How do we determine accurate masses for stars?
- A. Their brightness together with their color
 - B. Their parallax together with the Gravity Law
 - C. Their angular sizes as measured by lunar occultation, plus the distance
 - D. The accelerations of companion stars in binary stars
 - E. Their total luminosities plus temperature
21. Comparison of the Moon's acceleration in its orbit with the acceleration of an apple falling from a tree on Earth confirms
- A. the Action-reaction Law.
 - B. Kepler's 3rd Law.
 - C. all bodies falling towards Earth accelerate at the same rate.
 - D. the acceleration and the force of gravity are proportional to d^2 , where d is the distance between any two bodies.
22. A full moon always rises
- A. around noon.
 - B. around sunrise.
 - C. around sunset.
 - D. around midnight.
 - E. at any time, depending on the season.
23. Astronomers sometimes announce that they have discovered a new solar system beyond our own, or a new galaxy beyond our own. Which choice correctly describes the terms "solar system" and "galaxy"?
- A. A solar system is a large assemblage of stars similar to the Sun, whereas a galaxy is much larger and consists of all different types of stars
 - B. A solar system consists of an immense number of stars (i.e., suns), and a galaxy is a cluster of many such systems
 - C. A galaxy consists of planets and other objects orbiting around a single star, whereas a solar system is a system consisting of an immense number of stars (i.e., suns).
 - D. A solar system consists of planets and other objects orbiting around a star, whereas a galaxy is a system consisting of an immense number of stars

24. At what wavelength do humans emit most of their radiation? Our skin temperature is approximately 300 K.
- A. Visible: 500 nm
 - B. Ultraviolet: 100 nm
 - C. Infrared: 10 μm (10 microns)
 - D. Radio: 6cm
25. A light-year is a measure of
- A. arc length along an orbit.
 - B. expansion rate of the universe.
 - C. time.
 - D. distance.
26. The altitude (distance above the horizon) of the pole star Polaris, visible from Earth's northern hemisphere,
- A. is approximately equal to the observer's longitude.
 - B. is approximately equal to observer's latitude.
 - C. varies greatly, depending on the time of day.
 - D. varies greatly, depending on the time of year.
27. The strength of gravity on Mars is about 40% of that on Earth. If you were to visit Mars, what would happen to your mass and weight compared to when you were on Earth?
- A. Your weight would be the same but your mass would be less
 - B. Your weight and mass would both be unchanged from when you were on Earth
 - C. Your mass would be the same but your weight would be less
 - D. Your weight and mass would both be less than when you were on Earth
28. A scientist reports a measurement that the temperature of the surface of a newly discovered planet is -20 K. What conclusion can you draw from this report?
- A. The scientist measured only the dark side of a planet, away from the Sun
 - B. The planet is a very long way from the Sun
 - C. The planet has no atmosphere
 - D. The result is meaningless and erroneous and the scientist might be crazy
29. Hydrogen gas in a low-density, hot transparent cloud gives off what type of spectrum?
- A. A series of emission lines at uniform wavelength spacing
 - B. A uniform spectrum crossed by numerous dark absorption lines
 - C. A series of emission lines spaced in a mathematical sequence
 - D. A uniform spectrum containing all colors
30. The ecliptic is defined as the
- A. band of constellations through which the Sun and Moon move in our sky.
 - B. line in the sky that is perpendicular to the Earth's spin axis.
 - C. line traced in our sky by the Moon each month against the background stars.
 - D. line traced in our sky by the Sun over one year.

31. Which is false?

- A. Incandescent light bulbs contain glowing wires which behave approximately according to the blackbody laws
- B. Incandescent light bulbs are operated at about the same temperature as the Sun's surface, so that they produce visible light efficiently
- C. Incandescent light bulbs are always operated at a relatively low temperature so that their output is mainly in the infrared part of the spectrum and is thus wasted
- D. Fluorescent light bulbs produce emission lines, so they don't obey the blackbody laws and they can be highly efficient emitters of visible light.

32. Which is false?

- A. Our intuition is not always a good guide to physics
- B. Logic has always worked in the study of physics
- C. A theory is like a law of physics that is speculative
- D. A theory is tested through its implicit predictions