

Name \_\_\_\_\_

Do not forget to write your name on your answer sheet and above as well. You have 45 minutes. For each question, mark the best answer. The formulas you may want are:

$$\sin\left(\frac{\theta}{2}\right) = \frac{\ell}{2d}$$

$$F = \frac{GMm}{d^2}$$

$$P^2 = a^3$$

$$(M + m) P^2 = a^3$$

$$c = \lambda f$$

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

$$\frac{v_r}{c} = \frac{\lambda_1 - \lambda_0}{\lambda_0}$$

$$E = hf$$

$$P = knT$$

$$\lambda_{\text{peak}} T = 2900 \text{ K} \cdot \mu\text{m}$$

- How did Kepler's second law get modified by Newton?
  - It's not equal areas, but equal angles, that get swept out in equal times
  - It's not equal areas, but equal distances, that get swept out in equal times
  - It's not equal areas, but equal volumes, that get swept out in equal times
  - Kepler's second law works for circles, but it is only approximate for ellipses
  - Newton's laws required no modification to Kepler's second law
- If Venus were five times bigger than it is, it would appear about one-arc minute across. The actual size that Venus appears is about
  - 5 degrees
  - 5 arc-minutes
  - 12 arc-minutes
  - 5 arc-seconds
  - 12 arc-seconds
- According to Starry Night, the Moon will be at third quarter roughly on July 17. When, roughly, was it most recently at first quarter?
 

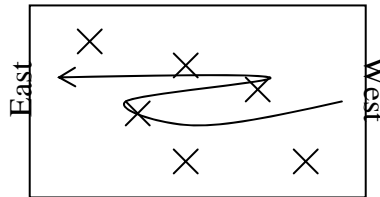
A) April 19      B) June 18      C) July 3      D) July 10      E) July 16
- A set of five atoms each undergoes a transition which emits a photon. The type of photon is different in each case. The one that lost the most energy emitted a
  - red visible light photon
  - violet visible light photon
  - radio photon
  - infrared photon
  - X-ray photon

5. Hot streamers of gas sometimes are shot at an angle from the surface of the Sun. If this gas had no forces on it, it would
  - A) Continue in a straight line away from the Sun, speeding up
  - B) Continue in a straight line away from the Sun, slowing down
  - C) Continue in a straight line away from the Sun, at constant speed
  - D) Curve gradually towards the Sun
  - E) Curve gradually away from the Sun
  
6. Suppose a spacecraft is in a circular orbit around a planet. Suppose I want to change the orbit to make it a hyperbola instead. Which method would work?
  - A) Decrease the mass of the spacecraft by dumping cargo
  - B) Increase the mass of the spacecraft by picking up cargo
  - C) Decrease the speed of the spacecraft
  - D) Increase the speed of the spacecraft
  - E) Keep the speed the same, but change the direction of the spacecraft
  
7. Which of the following is something one can deduce, using naked eye observations, from observing lunar eclipses?
  - A) The Moon is a sphere
  - B) The Earth is bigger than the Moon
  - C) The Sun is bigger than the Earth
  - D) The Sun is farther away than the Moon
  - E) The Sun is a sphere
  
8. The planet Saturn is in an orbit about 9 AU from the Sun. The time it takes to go around the Sun is about
  - A) 1/27 year
  - B) 1/3 year
  - C) 3 years
  - D) 27 years
  - E) 81 years
  
9. What is the significance of the ecliptic?
  - A) It represents the path against the background stars that the Sun appears to take
  - B) It represents the path against the background stars that the Moon appears to take
  - C) It represents the path against the background stars that the planets appear to take
  - D) It represents the directions that are directly above the Earth's equator
  - E) It is the path of the zenith, the points directly above you over the course of one night
  
10. Suppose in the eye of the hurricane, the temperature is higher and the pressure is lower than normal. This implies that the number density of air molecules must be
  - A) higher than normal
  - B) lower than normal
  - C) the same as normal
  - D) it could be higher or lower, depending on how much each change is
  - E) It is impossible for this to happen; if the temperature is higher the pressure must be higher

11. What is the main reason that tides are sometimes especially strong (spring tides) and other times especially weak (neap tides)?
- A) The Sun and Moon both contribute to tides; sometimes they cooperate, and sometimes they oppose each other
  - B) The Moon is sometimes closer to the Earth and sometimes farther away
  - C) The Sun is sometimes closer to the Earth and sometimes farther away
  - D) The Moon is rotating, and sometimes it rotates so that the tidal forces point away from the Earth
  - E) The Sun is rotating, and sometimes it rotates so that the tidal forces point away from the Earth


12. Suppose each of the X's in the picture below represents background stars, and the curved path represents the path over time of some object compared to these stars, as viewed from Earth. Which of the following objects might move as shown?

- A) the star Sirius
- B) the planet Jupiter
- C) the Moon
- D) the Sun
- E) No object follows paths like this.



13. The planet Pluto has a moon Charon that was discovered in 1978. By studying the orbit of Charon around Pluto, scientists were able for the first time to
- A) Estimate the radius of Pluto
  - B) Estimate the composition of Pluto
  - C) Estimate the speed of Pluto
  - D) Estimate the distance to Pluto
  - E) Estimate the mass of Pluto
14. White light consists of
- A) Visible light with very short wavelengths
  - B) Visible light with very long wavelengths
  - C) Visible light with intermediate wavelengths
  - D) Visible light with a wide range of wavelengths, all mixed together
  - E) Since white is not a color, it isn't really made of any type of light
15. Who was the first scientist to speculate that planets move in ellipses, not circles?
- A) Kepler
  - B) Copernicus
  - C) Newton
  - D) Galileo
  - E) Bohr
16. The Moon's distance from the Earth might be which of the following distances?
- A) 4 AU
  - B) 40 AU
  - C) 400 AU
  - D) 4000 AU
  - E) 1/400 AU

17. Why is it so common for moons to always have the same face orbiting their planet, like our Moon facing the Earth?
- A) It's a symbol of universal love of child for parent
  - B) The magnetic fields from the much larger planet hold onto the moon
  - C) Tidal forces have distorted the moon to an oblong shape, which then prefers to always point towards the planet by gravity
  - D) Friction between the moon's atmosphere and the planet have caused the moon to stop rotating
  - E) Electric forces cause these opposite bodies to attract each other
18. The Earth has a mass equal to about 100 times that of the Moon. Where could you put an object between the Earth and the Moon so that their two gravitational forces on the object would be equal?
- A) Half way between them, so the distances are equal
  - B) 10 times closer to the Moon than to the Earth
  - C) 100 times closer to the Moon than to the Earth
  - D) 1000 times closer to the Moon than to the Earth
  - E) 10,000 times closer to the Moon than to the Earth
19. Comet Halley's elliptical orbit has a very high eccentricity. This means
- A) its mass varies in a very eccentric way
  - B) its orbit is very nearly a perfect circle
  - C) its orbit is a very squashed shape, not circular at all
  - D) it rotates very quickly compared to its period going around the Sun
  - E) it rotates very slowly compared to its period going around the Sun
20. Why is it hotter in the summer?
- A) The sunlight beats more straight down in the summer
  - B) There are less clouds to block the Sun in the summer
  - C) The Earth is closer to the Sun in the summer
  - D) The Sun is brighter in the summer
  - E) The Sun is bigger in the summer
21. Clouds of Hydrogen gas in our galaxy produce radiation which has a frequency of about  $1.420 \times 10^9 \text{ s}^{-1}$ , which therefore has a wavelength of about
- A)  $4.26 \times 10^{17} \text{ m}$
  - B)  $2.35 \times 10^{-18} \text{ m}$
  - C) 4.73 m
  - D) 0.211 m
  - E) There is insufficient information to answer this question

22. Surrounding most young stars is a flat disk of gas and dust. What two factors probably cause it to be a disk?
- A) Gravity of the star vs. energy of the gas and dust
  - B) Energy of the star vs. rotation of the gas and dust
  - C) Rotation of the star vs. pressure of the gas and dust
  - D) Gravity of the star vs. rotation of the gas and dust
  - E) Gravity of the star vs. pressure of the gas and dust
23. The reason there are no solar eclipses this month, anywhere on Earth, must be because
- A) The Moon doesn't make a full revolution this month, so it is never lined up right
  - B) The Moon must line up with the Sun only at night, when you can't see the eclipse
  - C) The Moon must be on its more distant part of its orbit, so it looks too small to block the entire Sun
  - D) The Moon must be passing behind the Sun this month, so it won't block the Sun
  - E) The orbit of the Moon is tilted, so even when it is in the direction of the Sun, it is still not lined up for an eclipse
24. The heaviest part of an atom is
- A) The electron, which has positive charge
  - B) The electron, which has negative charge
  - C) The nucleus, which has positive charge
  - D) The nucleus, which has negative charge
  - E) The nucleus, which has no charge
25. Sodium atoms produce a well-known spectral line, whose wavelength and frequency has been carefully measured here on Earth. If a sodium atom were moving swiftly towards the Earth, however, the values we would measure would have
- A) longer wavelength and lower frequency
  - B) shorter wavelength and higher frequency
  - C) longer wavelength and higher frequency
  - D) shorter wavelength and lower frequency
  - E) unchanged wavelength and frequency
26. The sketch of the Earth (E), Sun (S), and Moon (M) shown here might be qualitatively correct when
- A) The Moon is full
  - B) The Moon is new
  - C) The Moon is at first quarter
  - D) There is a solar eclipse
  - E) There is a lunar eclipse
- 

27. There are many moons around other planets. The moon Titan is farther away from us than the moon Io. The moon Titan looks bigger (has a larger angular size) than the moon Io. Therefore
- A) Titan is bigger than Io
  - B) Io is bigger than Titan
  - C) Io and Titan are the same size
  - D) It is impossible to know for sure unless you tell me *how much* bigger they look and how far away each is
  - E) It is impossible to know for sure, even if you know the distances and angular sizes of both
28. What is different about the orbit of Mercury and Venus, as viewed from Earth, compared to the other planets?
- A) These two planets stay near the ecliptic; the others vary far from it
  - B) These two planets vary far from the ecliptic; the others stay near it
  - C) These two planets are never too far from the Sun; the other planets can be far from the Sun, even in the opposite direction
  - D) These two planets can be far from the Sun, even in the opposite direction; the others are never too far from the Sun
  - E) These planets sometimes have retrograde motion; the other planets do not
29. One development of the late 20<sup>th</sup> century that has vastly improved ground-based visible light astronomy is:
- A) The introduction of mirrors, rather than just using lenses
  - B) The use of high quality films
  - C) Giant lights that can illuminate dim astronomical objects
  - D) The use of spectrometers, that study the spectrum of light
  - E) Adaptive optics that can adjust mirrors to compensate for atmospheric blurring
30. Rocket motors shoot hot gasses out their back. Why do they do that?
- A) The hot gasses push on the atmosphere, and the atmosphere pushes on the rocket
  - B) By Newton's third law, if the rocket is pushing on the gasses, the gasses are pushing on the rocket, accelerating it forward
  - C) The hot gasses would damage the rocket if they weren't quickly disposed of
  - D) The large mass of all the fuel is slowing the rocket down, so getting rid of mass speeds it up
  - E) The gravitational force from the gasses then pulls the rocket forward
31. It is very common for two or more widely separated radio telescopes to view the same object simultaneously because
- A) The signals can be combined to produce a much sharper image of the object
  - B) If it is cloudy at one site, it will be clear at another
  - C) Each telescope will typically "listen" at a different frequency
  - D) It allows us to see if sources emit radio waves the same in all directions
  - E) It allows you to use only one guidance system for multiple telescopes, saving money

32. Place the following three colors in order from shortest wavelength to longest:

- A) orange, blue, yellow
- B) blue, orange, yellow
- C) yellow, blue, orange
- D) blue, yellow, orange
- E) yellow, orange, blue

33. Which of the following might give you a clue how hot a star is?

- A) Its radius
- B) Its mass
- C) Its density
- D) Its color
- E) Its distance