

Name _____

Do not forget to write your name and fill in the bubbles with your student number, and fill in test form A on the answer sheet. Write your name above as well. You have 50 minutes. For each question, mark the best answer. The formulas you may want are:

$$F = \frac{GMm}{d^2} \quad F = ma \quad P^2 = a^3 \quad (M + m) P^2 = a^3$$

$$c = \lambda f \quad c = 3 \times 10^8 \text{ m/sec} \quad E = hf \quad P = knT$$

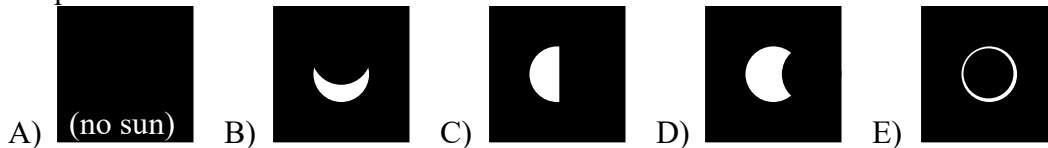
$$\frac{v_{\text{rad}}}{c} = \frac{\lambda_{\text{shift}} - \lambda_{\text{rest}}}{\lambda_{\text{rest}}} \quad \lambda_{\text{max}} T = 2900 \text{ K} \cdot \mu\text{m}$$

- The Sun follows a path against the stars called the *ecliptic*. What path do the planets follow?
 - They always stay exactly on the ecliptic
 - They always stay near, but not generally on the ecliptic
 - They always stay far from the ecliptic, but perpendicular to it
 - They always stay as far as possible from the ecliptic, perpendicular to it
 - None of the above is correct
- Why are Mercury and Venus always in the same general direction as the Sun, according to the Copernicean model?
 - Because they are in closer orbits than Earth; the rest of the planets are farther
 - Because they are the smallest mass planets
 - Because they move the fastest of all the planets
 - Because they feel the Sun's gravity the most
 - Because they are in orbit around the Sun, while other planets orbit Earth
- Which of the following types of energy was not a type that was discussed?
 - Nuclear
 - Gravitational
 - Heat
 - Kinetic
 - Quantum
- Which of the following colors of light has the most energy for a single photon?
 - Red
 - Blue
 - Yellow
 - Green
 - Violet
- It is found that the spectral lines from distant galaxies often have their wavelength shifted to much longer wavelengths than the wavelengths we observe for the same element here on Earth. This very likely is because
 - The galaxies are moving away from us at high velocities
 - The galaxies are moving towards us at high velocities
 - The galaxies are made of heavier atoms than occur here on Earth
 - The galaxies are made of lighter atoms than occur here on Earth
 - The speed of light has been changing since ancient times

6. What is expected to happen to a large moon that gets too close to a planet, inside its Roche limit?
- A) It will break into two, creating exactly two moons
 - B) It will break into pieces over and over, ultimately becoming a ring
 - C) It will get stretched into a solid ring that circles the planet
 - D) It will get pulled into the planet and disappear
 - E) It will get expelled from the planet on a hyperbolic trajectory

7. Which of the following colors of light cannot be made with just one wavelength of light, but must be a mixture
- A) Red
 - B) Blue
 - C) Yellow
 - D) Green
 - E) White

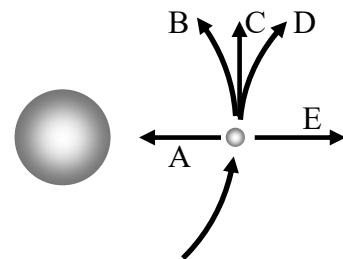
8. Which of the following could not be the shape of the visible Sun during a solar eclipse?



9. What is the effect of the rotation of the Earth on the shape of the Earth?
- A) It causes it to be more spherical
 - B) It causes it to bulge at the equator; an oblate spheroid
 - C) It causes it to bulge at the poles; a prolate spheroid
 - D) It causes it to have tides
 - E) The rotation of the Earth has no substantial effect on its shape
10. According to Newton, which of the following orbits is impossible for objects going around the Sun?
- A) Ellipse
 - B) Straight line
 - C) Hyperbola
 - D) Parabola
 - E) Circle
11. As viewed from here in North America, most stars rise in the east and set in the west. Are there any exceptions?
- A) Yes: stars to the south stand still
 - B) Yes: stars to the south go in a circle that never drops below the horizon
 - C) Yes: stars to the north stand still
 - D) Yes: stars to the north go in a circle that never drops below the horizon
 - E) No

12. When you shine white light containing all frequencies through a relatively cool gas, what sort of spectrum comes out?
- A) An unchanged spectrum, still containing all frequencies
 - B) All the waves with frequency below a special cutoff frequency, that depends on the element
 - C) All the waves with frequency above a special cutoff frequency, that depend on the element
 - D) A bright line spectrum containing only a few special frequencies, that depend on the element
 - E) A dark line spectrum missing only a few special frequencies, that depend on the element
13. Which of the following is one of Kepler's laws?
- A) The gravitational force between two objects is proportional to the product of the masses divided by the separation squared
 - B) Objects without forces on them move at constant speed and direction
 - C) Objects with forces on them accelerate according to $F = ma$
 - D) The wavelength, frequency, and speed of light are related by $c = \lambda f$
 - E) The square of the period of a planet's orbit (in years) equals the cube of the distance (in AU), or $P^2 = a^3$
14. The Earth was first realized to be a sphere by
- A) Christopher Columbus
 - B) Galileo
 - C) Tycho Brahe
 - D) Copernicus
 - E) None of these; the realization that Earth was a sphere came much earlier
15. Two charges repel each other due to electric forces. From this we conclude that the two charges must
- A) Both be positive (only)
 - B) Both be negative (only)
 - C) Both be positive OR both be negative
 - D) One must be positive and one must be negative
 - E) None of the above are correct

16. Suppose the Moon (small sphere) is orbiting the Earth (large sphere) counterclockwise as indicated, but at its current position gravity were suddenly turned off. On which path would it continue?



17. Why does the Moon always face the same side towards the Earth?

- A) Friction has stopped its rotation, so it isn't rotating
 - B) The magnetic fields of the Earth hold it that way
 - C) There is a permanent tidal bulge on the Moon, and gravity wants that bulge to always point along the line joining the Earth and Moon
 - D) The Earth rotates at just the right rate so that we always see the same side of the Moon
 - E) The Moon actually shows us all sides, but only the side facing the Earth ever gets illuminated by the Sun
18. Which of the following is constant for all types of light?
- A) The amount of energy in a single photon
 - B) The wavelength
 - C) The speed
 - D) The frequency
 - E) Actually, all of these vary for different types of light
19. Light is actually made of two types of energy, namely
- A) Electric and gravitational
 - B) Gravitational and nuclear
 - C) Nuclear and magnetic
 - D) Electric and magnetic
 - E) Gravitational and electric
20. Io is a moon that orbits Jupiter, but it is much smaller than Jupiter. How does Jupiter's gravitational pull on Io compare to Io's on Jupiter?¹
- A) Jupiter's pull on Io is stronger
 - B) Io's pull on Jupiter is stronger
 - C) They are exactly the same size
 - D) Insufficient information
 - E) I have no idea; please mark this one wrong
21. Which of the following reintroduced the idea that the Earth orbits the Sun?
- A) Newton
 - B) Brahe
 - C) Galileo
 - D) Copernicus
 - E) Kepler
22. Which determines what element an atom is?
- A) The number of electrons
 - B) The charge of the nucleus
 - C) The mass of the nucleus
 - D) The mass of the entire atom
 - E) What chemical bonds it has
23. Which of the following types of radiation has the longest wavelength?
- A) Microwave
 - B) Radio
 - C) Infrared
 - D) X-rays
 - E) Gamma rays

¹ This question was improperly worded on the actual exam

24. What advantage did Galileo have over previous astronomers, such as Tycho Brahe?
- A) He was a much more careful observer
 - B) He used a telescope
 - C) He had access to brilliant young mathematicians like Kepler
 - D) The planet Uranus had been discovered by his time
 - E) He could use the universal law of gravitation to figure out what was going on
25. Which of the following temperatures could a human feel comfortable in?
- A) 0 K
 - B) 2.73 K
 - C) 77 K
 - D) 295 K
 - E) 517 K
26. Suppose a gas has a pressure P . The gas is then replaced by a gas that has three times the mass, four times the number density, and five times the temperature. What is the final pressure?
- A) $4P$
 - B) $5P$
 - C) $12P$
 - D) $20P$
 - E) $60P$
27. Many astronomical objects tend to be spheres (planets, the Sun, large moons, etc.). This occurs when two competing effects determine the shape. Which two?
- A) Gravity vs. pressure
 - B) Gravity vs. rotation
 - C) Pressure vs. rotation
 - D) Gravity vs. chemical forces
 - E) Pressure vs. chemical forces
28. Which of the following observations of a star could give you an estimate of its surface temperature?
- A) The color
 - B) The total power of the light from the star
 - C) The composition of the star
 - D) The total number of photons per second from the star
 - E) The highest energy photons coming from the star
29. The Moon was full on the night of the lunar eclipse lab, Jan. 20-21. Approximately when was/is the next time the Moon is full?
- A) January 27
 - B) February 3
 - C) February 19
 - D) March 20
 - E) July 16
30. Astronauts in spaceships float around with apparently no gravity. Why don't they fall?
- A) They are above Earth's atmosphere, which blocks the gravity from the Earth
 - B) The spaceship's engines counter the Earth's gravity
 - C) They are so far from Earth that gravity is negligible
 - D) The spaceship is spinning to create artificial gravity that counters the Earth's
 - E) They do fall, and so does the spaceship, at exactly the same rate

31. Which piece of evidence allowed ancient astronomers to conclude that the Moon is a sphere, not a flat disk?
- A) The phases of the Moon
 - B) The shape of the shadow on the Moon during lunar eclipses
 - C) The apparent shape of the Sun during partial solar eclipses
 - D) The appearance of the Sun's atmosphere during total solar eclipses
 - E) The way the planets disappeared behind the Moon
32. On the side of the Earth facing the Moon, high tide occurs. What happens on exactly the other side of the Earth, facing away from the Moon?
- A) High tide
 - B) Low tide
 - C) Intermediate tide
 - D) Solar tide
 - E) Tide with bleach
33. Two stars have masses of $0.20 M_{\text{Sun}}$ and $0.30 M_{\text{Sun}}$ and are orbiting at a separation of 2 AU. How long does it take for them to go around each other?
- A) 2 years
 - B) 2.8 years
 - C) 3.5 years
 - D) 4 years
 - E) 16 years