

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:

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

$$F = ma$$

$$P^2 = a^3$$

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

$$c = \lambda f$$

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

$$E = hf$$

$$P = knT$$

$$\frac{v_{\text{rad}}}{c} = \frac{\lambda_{\text{shift}} - \lambda_{\text{rest}}}{\lambda_{\text{rest}}}$$

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

- Which of the following observations helped ancient astronomers figure out the shape of the Earth?
 - A solar eclipse
 - A lunar eclipse
 - A terrestrial eclipse
 - The angle of the moon at first or third quarter
 - None of the above; ancient astronomers were unable to deduce the shape of the Earth
- Does the Moon rotate as it goes around the Earth?
 - Yes, at the same rate it goes around the Earth
 - Yes, and faster than it is going around the Earth
 - Yes, and slower than it is going around the Earth
 - Yes, and backwards compared to how it orbits the Earth
 - No
- Copernicus's main contribution to understanding the motions of the planets was
 - He argued that you have to use ellipses, not circles, to describe the motions of planets
 - He argued that the motion was due to the universal law of gravitation
 - He invented calculus, which was necessary to solve the equations
 - He argued that the Sun was the center of the solar system, not Earth
 - He discovered that Venus had phases

4. The Earth contains an enormous number of positively charged nuclei. Why does this not cause the entire Earth to expand and explode from electric forces?
 - A) The electromagnetic force between two nuclei is attractive, not repulsive
 - B) The gravitational force is much stronger, and overcomes this force
 - C) The Earth is exploding, very slowly, and this is part of the universal expansion of the Universe
 - D) Nuclei also have magnetic forces, which hold them together
 - E) The positive charge of the nuclei is cancelled by negative charges from the electrons

5. As viewed from here in the northern hemisphere, do the stars rise and set over the course of a day, just as the Sun does?
 - A) Yes, they all do
 - B) Yes, except for some near the equator called ecliptic stars
 - C) Yes, except for some in the north called circumpolar stars
 - D) Yes, except for some in the east and west called morning and evening stars
 - E) No, the stars are stationary as viewed from Earth

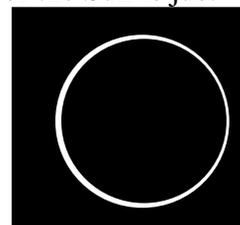
6. In which phase(s) of the Moon listed below would the Sun and Moon combine to cause especially large tides (spring tide)?
 - A) New moon (only)
 - B) First quarter (only)
 - C) Full moon (only)
 - D) New moon and first quarter, but not full moon
 - E) New moon and full moon, but not first quarter

7. Which of the following observations seemed to indicate rather convincingly that the Sun, rather than the Earth, was the center of the Solar System?
 - A) Sunspots on the Sun
 - B) Mountains on the Moon
 - C) Moons around Jupiter
 - D) The phases of Venus
 - E) Retrograde motion of the planets

8. If two stars are separated by a distance of 3 AU, and orbit each other once every 6 years, what must be the combined mass of the two stars, in solar masses?
 - A) $0.0417 M_{Sun}$
 - B) $0.75 M_{Sun}$
 - C) $1.33 M_{Sun}$
 - D) $2.25 M_{Sun}$
 - E) $24 M_{Sun}$

9. How does the position of the Sun principally differ at noon in the summer compared to the winter?
 - A) It is farther east in the summer and farther west in the winter
 - B) It is farther west in the summer and farther east in the winter
 - C) It is lower in the sky in the summer and higher in the winter
 - D) It is higher in the sky in the summer and lower in the winter
 - E) None of the above

10. Astronomers often like to do radio astronomy using widely separated radio telescopes. The advantage of this is that
- A) If one is blocked by clouds, the other might not be
 - B) The images from the two can be combined (interfered) in such a way as to give a much more detailed image
 - C) One can check to make sure it is not just noise from a local source
 - D) One can read the radio waves while the other sends a signal back
 - E) Since designing a radio telescope is most of the expense, you can design once and build twice
11. What would happen to the Moon if it came too close to the Earth, inside the Roche limit?
- A) It would immediately move back out to a larger distance, beyond the Roche limit
 - B) It would be absorbed into the Earth due to the Earth's large gravity
 - C) It would be broken in half by tidal forces, and that would be it
 - D) It would be broken in half over and over, ending up as a lot of tiny moons
 - E) It would be frozen in place, orbiting the Earth exactly once per day
12. Which of the following would reduce the gravitational force between the Earth and the Moon by a factor of four?
- A) Doubling the mass of the Earth
 - B) Halving the mass of the Earth
 - C) Doubling the mass of the Moon
 - D) Halving the mass of the Moon
 - E) Doubling the distance between the Earth and Moon
13. According to Kepler's second law of planetary motion, a planet, as it orbits the Sun
- A) Moves equal angles in equal time
 - B) Moves an equal distance in equal times
 - C) Sweeps out equal areas in equal times
 - D) Moves the same distance as any other planet in the same time
 - E) None of the above
14. Sometimes, solar eclipses are *annular eclipses*, where the rim of the Sun is just visible around the edges of the Moon, as sketched at right. What circumstance allows this to happen sometimes?
- A) The Sun is larger in size than usual
 - B) The Sun is smaller in size than usual
 - C) The Moon is farther away than usual
 - D) The Moon is closer than usual
 - E) The Moon is moving more quickly than usual



15. Which object(s) cause significant (easily noticeable) effects on the tides of Earth?

- A) Sun (only)
 - B) Moon (only)
 - C) Planets (only)
 - D) The Sun and Moon, but not the planets
 - E) The Sun, Moon, and planets
16. The coldest temperature possible is
A) -273 K B) 0 K C) 3 K D) 300 K E) 5800 K
17. The first astronomer who was able to extensively use a telescope was
A) Galileo B) Kepler C) Newton D) Tycho Brahe E) Copernicus
18. How does the gravitational force of Jupiter (a massive planet) on Europa (a small moon) compare to the pull of Europa's force on Jupiter?
A) Jupiter's force is stronger
B) Europa's force is stronger
C) They are exactly the same
D) There is insufficient information to determine the answer
E) I have no idea; please mark this one wrong
19. The amount of time from new moon to first quarter would probably be best approximated as
A) 1 day B) 1 week C) 2 weeks D) 1 month E) 1 year
20. If I have two atoms that are both sodium atoms, what is guaranteed to be the same about both of them?
A) The charge of their nuclei
B) The number of electrons
C) Their mass
D) Their chemical bonds
E) The number of neutrons
21. Which of the following best explains why it is hotter at the equator of the Earth than the poles?
A) The Sun shines almost directly down on the equator, but it shines at an angle at the poles
B) The Sun is closer to the equator than to the poles
C) There are long periods of darkness and only very short days at the poles
D) It is much cloudier at the poles than at the equator
E) There is warm ocean water at the equator, which warms the climate
22. Why is it that eclipses occur roughly only two months out of the year, rather than much more spread out through the year?

- A) The tilt of the Moon's orbit around Earth guarantees that the Sun-Moon-Earth system can only line up at certain times of the year
 - B) It takes about six months for the Moon to go around the Earth, which is required for a new eclipse
 - C) During most months, the Moon is so far away that an eclipse would not be noticeable
 - D) During the other months, the eclipse happens on the far side of the Moon, which we cannot see
 - E) The Earth moves in a way that is synchronized with the Moon's motion, so that they never line up except during these months
23. Which reason makes it useful to have a very large objective (first) mirror or lens?
- A) It allows you to see much wider objects
 - B) It allows you to compensate for atmospheric turbulence
 - C) It allows you to do astronomy with longer wavelengths
 - D) It allows you to see dimmer objects
 - E) It allows you to see around small intervening objects
24. If an object is moving towards us, its light will be:
- A) Blue-shifted, which means shifted to longer wavelengths
 - B) Blue-shifted, which means shifted to shorter wavelengths
 - C) Red-shifted, which means shifted to longer wavelengths
 - D) Red-shifted, which means shifted to shorter wavelengths
 - E) None of the above
25. Suppose the electrons in a thin gas of atoms were put into high energy states. What sort of light would be produced from such an atom?
- A) A continuous spectrum, with light of all frequencies
 - B) A dark-line spectrum, with almost all frequencies, but a few missing
 - C) A bright-line spectrum, with only a few frequencies present
 - D) A white noise spectrum, with the brightness for every frequency proportional to $1/f$
 - E) No light; an isolated atom can't produce light
26. Compared to the stars, how do the planets move?
- A) No, they are stationary
 - B) Yes, they always move west to east
 - C) Yes, they always move east to west
 - D) Yes, they sometimes move north to south and sometimes south to north
 - E) Yes, they sometimes move west to east and sometimes east to west
27. The purpose of a spectrometer is to
- A) Combine all the light from a source into a single beam and measure the total power of the spectrum

- B) Take an image of a large range of space all at once
 - C) Divide light into its component wavelengths/frequencies
 - D) Filter out background light
 - E) Compensate for atmospheric turbulence
28. Which force is it that keeps electrons bound in atoms?
- A) (Strong) nuclear
 - B) Weak nuclear
 - C) Electromagnetic
 - D) Gravity
 - E) Higgs field
29. If we wanted to cut the pressure of an ideal gas in half, which of the following would work?
- A) Double the mass of the particles
 - B) Double the temperature
 - C) Double the number density
 - D) Cut the mass of the particles in half
 - E) Cut the temperature in half
30. Which of the following can not be deduced simply by observing the phases of the Moon?
- A) The Moon goes around the Earth
 - B) The Moon is illuminated by the Sun
 - C) The Moon is a sphere, not a flat disk
 - D) The Moon is much closer than the Sun
 - E) The Moon is much less massive than the Sun
31. Besides visible light, what other type of astronomy can be done from the surface of the Earth?
- A) Infrared B) Ultraviolet C) X-rays D) Radio E) Gamma rays
32. Which of the following has the most energy for a single photon?
- A) Visible B) Infrared C) Radio D) Microwaves E) X-rays
33. In the old TV show Star Trek, when the engines of the Enterprise failed, the ship would stop orbiting and begin slowly spiraling towards whatever planet they were orbiting. What's wrong with this idea?
- A) If the engines failed, the ship should fall immediately into the planet

- B) If the engines failed, the ship should continue following whatever orbit it was on before: an ellipse, parabola, or hyperbola
- C) If the engines failed, the ship should move in a straight line whichever direction it was going before
- D) If the engines failed, the ship should immediately halt wherever it is
- E) Nothing; this is in fact exactly what should happen