

Name \_\_\_\_\_

Do not forget to write your name and fill in the bubbles with your student number, followed by a 0, and fill in test form A on the answer sheet. Write your name above as well. **You will lose points if you don't do this.** You have as much time as you need. For each question, mark the best answer. The formulas you may want are:

$$\frac{\theta}{360^\circ} = \frac{\ell}{2\pi d}$$

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

$$P^2 = a^3$$

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

$$c = \lambda f$$

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

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

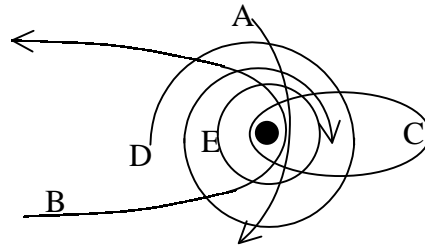
$$E = hf$$

- Which of the following is the best description of an atom?
  - A little plastic sphere with springs sticking out
  - Several positively charged electrons surrounding several negatively charged nuclei
  - Several negatively charged electrons surrounding several positively charged nuclei
  - Several positively charged electrons surrounding one negatively charged nucleus
  - Several negatively charged electrons surrounding one positively charged nucleus
  
- Black holes have so much gravity that they tend to draw gasses from neighboring stars. However, the gas does not fall directly into the black hole, because there is a great deal of angular momentum (rotation). What shape does the gas form before it falls into the black hole?
  - A straight line streamer forming a line pointing towards the black hole
  - A thin circle around the black hole
  - A flat but round disk around the black hole
  - A slightly flattened sphere around the black hole
  - A round spherical shape around the black hole
  
- This month the Moon will be at first quarter on February 9. When, approximately, was the Moon/will the Moon be full?
  - February 1
  - February 6
  - February 12
  - February 16
  - February 23

4. The evil Dr. Vile, floating in space, has just activated the Doomsday Device! Professor Heroic, floating a few meters away, realizes her only chance to save the Earth is to get to Dr. Vile and type in the disable code. Thinking quickly, she draws her reaction pistol and fires directly *away* from Dr. Vile. Why?
- A) Professors are old. They don't think clearly and they don't see very well
  - B) The projectiles from the pistol will orbit the Earth, hitting Dr. Vile from the other side, killing him and perhaps propelling the control panel to her.
  - C) It is probably a "warning shot", fired to convince Dr. Vile to turn off the device or be killed.
  - D) Whatever is propelled out of the reaction pistol is being pushed on, and therefore will push back on Prof. Heroic, propelling her *toward* Dr. Vile.
  - E) The gasses from the reaction pistol will create a sound wave that will hit Dr. Vile and crush the control panel
5. Which of the following was first deduced by Isaac Newton?
- A) The Law of Universal Gravitation is responsible for planetary orbits
  - B) The Earth is actually a sphere
  - C) The planets go around the Sun in elliptical orbits
  - D) The planets go around the Sun, not the Earth
  - E) Compared to the stars, the planets sometimes go East to West and sometimes West to East
6. Which of the following was an innovation introduced by Kepler in attempting to describe the motions of objects in the heavens?
- A) He was the first person to realize that the Earth is actually round
  - B) His was the first model with the Sun at the center of the Solar System
  - C) He was the first person who could actually estimate the distance to the Moon
  - D) He was the first person who suggested that retrograde motion was caused by actual backwards motions of the planets
  - E) He was the first person to use ellipses instead of circles to describe orbits
7. The Sun's mass is greater than the Earth's mass. Nonetheless, the Sun's pull on the Moon is comparable to the Earth's pull on the Moon. How is this possible?
- A) The Sun is made of gas, which has very low density and therefore doesn't produce much gravity.
  - B) The Moon is in orbit around the Earth, not the Sun, and therefore the Earth's pull is more important
  - C) The Earth is much closer to the Moon than the Sun is to the Moon, and gravity's effect increases tremendously at short distances.
  - D) The Sun has approximately equal numbers of protons and electrons, and since it is neutral, the net force is very small
  - E) By Newton's third law, the force of the Sun on the Moon must equal the force of the Earth on the Moon

8. What is the cause of the apparent motion of the Sun compared to the stars as viewed from the Earth?
- A) The Earth rotates on its axis once per day
  - B) The Earth goes around the Sun once per year
  - C) The Earth rotates on its axis once per year
  - D) The Earth goes around the Sun once per day
  - E) It is caused by a wobble of the Earth's axis called precession
9. Venus has a size in the sky which can be as large as one arc-minute. This is about the same as
- A)  $1/3600$  of a degree
  - B)  $1/60$  of a degree
  - C) 60 degrees
  - D)  $1/3600$  of an arc-second
  - E)  $1/60$  of an arc-second

10. According to Newton, which of the orbits sketched at right is impossible?



11. Sodium atoms, when heated, produces a spectrum with two types of yellow light. A sodium lamp is covered by a shutter, then suddenly the shutter is pulled aside. The light goes to a distant hill, is reflected back, and the time of arrival of the two types of light is measured. Which of the two will return to the detector first?
- A) The one with the longer wavelength
  - B) The one with the higher frequency
  - C) The one with the shorter wavelength
  - D) The one with the shorter frequency
  - E) It will be a tie; they will get back at the same time.
12. Roughly how often does eclipse season occur?
- A) Once a year
  - B) Twice a year
  - C) Every two months
  - D) Every month
  - E) Twice every month

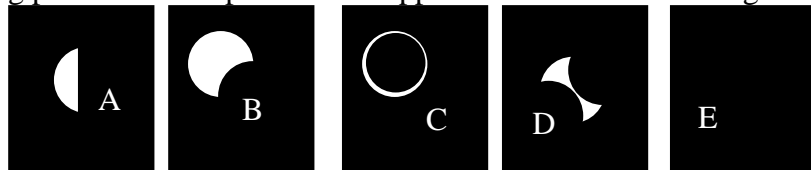
13. Voyager 1 and Voyager 2 are two spacecraft that are leaving the Solar System and never coming back. This implies that their current velocity must be
- A) Less than the velocity needed for a circular orbit
  - B) Exactly equal to the velocity needed for a circular orbit
  - C) Less than escape velocity
  - D) Exactly equal to escape velocity
  - E) Equal to or greater than escape velocity
14. Planet X has two moons, A and B. The gravitational force between X and each of its moons is the same. Moon A is 4 times farther away than planet B. How do the masses of the moons compare?
- A) Moon A is 2 times as massive as moon B
  - B) Moon A is 4 times as massive as moon B
  - C) Moon A is 16 times as massive as moon B
  - D) Moon A is  $\frac{1}{2}$  as massive as moon B
  - E) Moon A is  $\frac{1}{4}$  times as massive as moon B
15. What relationship, if any, is there between the ecliptic and the path the planets seem to follow compared to the stars?
- A) The planets travel along the ecliptic
  - B) The planets travel on a path perpendicular to the ecliptic
  - C) The planets travel on a path that is always far from the ecliptic
  - D) The planets travel on a path that is close to the ecliptic
  - E) There is no relationship between the path of the planets and the ecliptic
16. One photon of each of the following types is detected. Which one has the most energy?
- A) Infrared
  - B) Ultraviolet
  - C) Radio
  - D) They are all the same, since it is one photon
  - E) There is insufficient information to solve the problem
17. A new asteroid has just been discovered which circles the Sun on at a distance of 9 AU. How long does it take to go around the Sun?
- A) 27 years
  - B) 9 years
  - C) 3 years
  - D)  $\frac{1}{3}$  year
  - E)  $\frac{1}{9}$  year

18. From Earth, the moon Titan appears to be smaller than the moon Ganymede. This implies that either
- A) Titan is actually larger than Ganymede or Titan is farther away than Ganymede
  - B) Titan is actually smaller than Ganymede or Titan is farther away than Ganymede
  - C) Titan is actually larger than Ganymede or Titan is closer than Ganymede
  - D) Titan is actually smaller than Ganymede or Titan is closer than Ganymede
  - E) None of the above
19. Arrange the following three wavelengths in order from shortest to longest
- A) red, yellow, blue
  - B) blue, yellow, red
  - C) red, blue, yellow
  - D) yellow, blue, red
  - E) blue, red, yellow
20. I am on the beach at midnight, with a full moon straight overhead. What types of tides would I expect to see?
- A) Very high tides, since the Sun and the Moon would both contribute to the tide
  - B) Medium high tides, since the Moon would create high tide which is partly cancelled by the Sun
  - C) No tide, since the Sun and Moon's effects would cancel.
  - D) Medium low tide, since the Moon would create low tide which is partly cancelled by the Sun
  - E) Very low tides, since the Sun and the Moon would both contribute to the tide
21. The full Moon is about half a degree across. What additional piece of information would allow you to determine how far away the Moon is?
- A) The angular size of the Moon
  - B) The period of the Moon's orbit
  - C) The mass of the Moon
  - D) The combined mass of the Earth and the Moon
  - E) The actual size of the Moon
22. Which of the following is NOT a good reason to put astronomical equipment in orbit around the Earth?
- A) There is no atmospheric absorption in space
  - B) Some wavelengths of electromagnetic radiation cannot make it through the atmosphere
  - C) Clouds and light pollution are not a problem in space
  - D) You are closer to the galaxies and other distant objects from Earth orbit
  - E) Actually, all of these ARE good reasons to put equipment in space

23. Which of the following can be learned by examining lunar eclipses?
- A) The Earth is a sphere
  - B) The Moon is a sphere
  - C) The Sun is a sphere
  - D) The Moon goes around the Earth
  - E) The Earth goes around the Sun
24. New Wave Radio station transmits at a frequency of 100.0 MHz ( $10^8/s$ ) on the FM dial . What is the wavelength of the radio signals?
- A) 3 m
  - B) 30 m
  - C) 300 m
  - D) 0.33 m
  - E) 0.033 m

25. Which of the following is NOT one of the fundamental forces recognized by physicists?
- A) The strong nuclear force
  - B) The weak nuclear force
  - C) The electromagnetic force
  - D) The gravitational force
  - E) The cohesive force

26. Which of the following pictures best represents the appearance of the Sun during an annular Solar eclipse?



27. Two transmitters, one in Russia and one in the U.S., are both beaming messages to a spacecraft using radio waves with a wavelength of 1.000000 m. However, the spacecraft, which is motionless, detects the Russian radio waves at 0.999999 m and the U.S. ones at 1.000001 m. What can account for these curious errors?
- A) The Earth is moving around the Sun, and is moving towards the spacecraft
  - B) The Earth is moving around the Sun, and is moving away from the spacecraft
  - C) The rotation of the Earth is causing the Russian broadcast station to be moving towards the spacecraft, while the U.S. one is moving away
  - D) The rotation of the Earth is causing the Russian broadcast station to be moving away from the spacecraft, while the U.S. one is towards it
  - E) Atoms in the atmosphere are absorbing the broadcasts and reemitting them at a slightly different frequency

28. If a moon comes within the Roche limit of the planet it is orbiting, it can break apart. Why?
- A) Demons from the planet with little hammers come out and break it apart
  - B) Atmospheric drag destroys the planet
  - C) Electromagnetic forces overcome gravity and destroy the moon
  - D) Tidal forces from the planet pull differently on one side and the other of the moon, breaking it apart
  - E) Many planets have rings, and the material in the rings smash into the moon and break it
29. Which of the following is an important aspect of the Bohr model or the quantum mechanical model of the atom?
- A) The atom can only be in certain clearly defined energy states, it can't be in between two energy states
  - B) The atom must have an even number of electrons in it
  - C) The photons emitted and absorbed by the atoms do not move in straight lines, but rather in little squiggles
  - D) The wavelengths of light emitted and absorbed by an atom are identical for all types of atoms
  - E) Atoms can only emit or absorb energy in the infrared or the ultraviolet, never in the visible
30. During a solar eclipse, what is the relative position of the Sun, Earth, and Moon?
- A) In a straight line, with the Sun in the middle
  - B) In a straight line, with the Earth in the middle
  - C) In a straight line, with the Moon in the middle
  - D) Forming a right triangle, with the Earth at the right angle corner
  - E) Forming a right triangle, with the Moon at the right angle corner