

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:

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

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

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

1. In the diagram, at what points would the Moon cause the Earth to have high tide?

- A) Point 1 (only)
 B) Point 2 (only)
 C) Point 3 (only)
 D) Points 1 and 2, but not point 3
 E) Points 1, 2, and 3



2. Which of the following is not a color that can be made with just one wavelength or frequency of light?

- A) Red B) White C) Blue D) Yellow E) Green

3. If I told you that THIS carbon atom has nuclear charge +6, six electrons, and a mass of 12.000 u, what could you conclude about all OTHER carbon atoms?

- A) They would have charge +6 (only)
 B) They would have six electrons (only)
 C) They would have a mass of 12.000 u (only)
 D) A and B are both true, but not C
 E) A, B, and C are all true

4. One month is approximately the time it takes

- A) For the Sun to complete an apparent circle against the stars
 B) For the Earth to actually rotate once on its axis
 C) For the planet Venus to go through its cycle of phases
 D) For the Moon to go through its cycle of phases
 E) For the Sun to go from its highest point in the sky to its lowest point in the sky

5. Which is true about the imaginary circle called the ecliptic?

- A) The Sun follows it exactly, the planets follow it only approximately
 - B) The Sun follows it only approximately, the planets follow it exactly
 - C) The Sun and the planets both follow it exactly
 - D) The Sun and the planets both follow it only approximately
 - E) The Sun follows it exactly, some planets follow it approximately and others do not
6. Why are radio and visible light astronomy the only types that are normally done from the surface of the Earth?
- A) These are the easiest to detect, so we don't have to go up into space to get closer to the source
 - B) These are the only types of electromagnetic radiation that can readily penetrate the Earth's atmosphere
 - C) These are the only types for which there is no background to worry about
 - D) All good radio and visible light telescopes were built before the space age, so it was impossible to send them to space
 - E) These telescopes are so inherently large and expensive that it would be prohibitive to put them in space; other kinds are much cheaper
7. Does the Moon rotate?
- A) Yes, about once per day
 - B) Yes, faster than it goes around the Earth, but slower than once per day
 - C) Yes, at the same rate it goes around the Earth
 - D) Yes, but slower than it goes around the Earth
 - E) No
8. The weather is warmest in the summer because
- A) The Earth is closest to the Sun then
 - B) The Sun is highest in the sky then
 - C) The atmosphere is most transparent then
 - D) The moon blocks the least amount of sunlight
 - E) None of the above
9. The purpose of a spectrometer on a telescope is to
- A) Magnify the source as much as possible, so you can see fine details
 - B) Sharpen the image in a telescope, to minimize blurring
 - C) Add multiple wavelengths of light together to make a spectrum
 - D) Separate the light into its component wavelengths
 - E) Estimate the temperature of an astronomical source
10. Which of the following is true about astrology?
- A) The Sun passes through exactly twelve constellations (only)

- B) The dates used for typical sun-sign astrology are a pretty good match to when the Sun is in each constellation (only)
 - C) Astrology provides accurate predictions (only)
 - D) A and B are true, but not C
 - E) None of the above are true
11. Which of the following would give you a clue about how hot the surface of a star is?
- A) Its color
 - B) Its brightness (how bright it looks)
 - C) Its luminosity (how bright it really is)
 - D) Its distance
 - E) Its radius
12. Which observation by Galileo directly demonstrated that there were objects that went around the Sun, not the Earth?
- A) Mountains on the Moon
 - B) Phases of Venus
 - C) Rings of Saturn
 - D) Moons of Jupiter
 - E) Sunspots on the Sun
13. What clue told ancient astronomers that the Earth was a sphere, and not a flat disk?
- A) The series of phases the Moon went through
 - B) The shape of the Sun during solar eclipses
 - C) The shape of the shadow on the Moon during lunar eclipses
 - D) The Sun shone down on the Earth at different angles throughout the year
 - E) The balance of gravity versus pressure told them it must be a sphere
14. When Mars and Earth are at their closest, they are about 7 times closer than when they are at their farthest. How much does the gravitational force between them change as the distance varies?
- A) It is strongest when they are closest, about 7 times bigger
 - B) It is strongest when they are closest, about 49 times bigger
 - C) It is strongest when they are farthest, about 7 times bigger
 - D) It is strongest when they are farthest, about 49 times bigger
 - E) There is insufficient information to estimate this
15. Neptune and Uranus both orbit the Sun, but Neptune is farther away (greater semi-major axis). Which of the following can be concluded about the period of their orbits (the time it takes to go around the Sun) from this information?
- A) Neptune's period is greater than Uranus's period

- B) Uranus's period is greater than Neptune's period
 - C) We cannot know unless we know the exact mass of each of the planets (only)
 - D) We cannot know unless we know the exact mass of the Sun (only)
 - E) We cannot know unless we know the exact mass of the Sun and both planets
16. For reasons we will discuss much later, visible light from the earliest stars is believed to be shifted to slightly longer wavelengths, so that it is no longer visible. What type of light will it be?
- A) X-rays
 - B) Ultraviolet
 - C) Radio waves
 - D) Infrared
 - E) Gamma rays
17. Under what circumstances could an atom which produces light with a wavelength of 121.6 nm actually have it observed at 135.5 nm?
- A) If it were moving directly towards us (only)
 - B) If it were moving directly away from us (only)
 - C) If it were moving perpendicular to our line of sight (only)
 - D) A and B would work, but not C
 - E) A, B, and C all would work
18. Why do I claim that heat is actually a form of kinetic energy (energy of motion)?
- A) If you look at the individual molecules in a hot gas, for example, it can be seen that they are moving
 - B) Heat always comes about from friction or other forms of motion, and hence it must be in the same category
 - C) Heat can cause motion, such as a hot expanding gas, which shows it must be due to motion
 - D) Moving objects are always hotter than stationary objects, which proves heat is motion
 - E) Heat is just a form of electromagnetic radiation, which is always moving
19. The minimum number of lenses needed to make a telescope (using only lenses) is
- A) 0
 - B) 1
 - C) 2
 - D) 3
 - E) 4 or more
20. When we consider the orbit of the Earth (more massive) and Moon (less massive), which of the following is true?
- A) The Moon stands still and the Earth orbits it
 - B) The Moon and Earth are actually both in orbit, but the Earth moves more
 - C) The Moon and Earth are actually both in orbit, and both move about equally
 - D) The Moon and Earth are actually both in orbit, but the Moon moves more
 - E) The Earth stands still and the Moon orbits it
21. If I push on the Earth with a force of 2000 N, how hard does the Earth push back on me with?
- A) 0 N
 - B) Less than 2000 N
 - C) 2000 N
 - D) More than 2000 N

- E) Insufficient information
22. Why are so many astronomical objects (planets, stars, large moons) approximately spherical in shape?
- A) Because they accreted matter from all directions, they naturally tended to come out spherical
 - B) They are (mostly) rapidly rotating, and a balance of gravity vs. rotation leads to a spherical shape
 - C) Gravity is trying to pull them to a point; pressure is trying to expand them, and the balance of pressure vs. gravity makes them spherical
 - D) Pressure is trying to expand them in all directions, but rotation makes that expansion turn them into spheres
 - E) They started out as all shapes, but rotation caused abrasion that smoothed them into spheres
23. According to the Bohr model, why is it that only specific frequencies of light can be emitted by a particular atom?
- A) The electrons orbit at specific frequencies, and these frequencies correspond to the frequencies that are emitted
 - B) The electrons are orbiting at well-defined velocities, and hence only cross each other's orbits at specific frequencies
 - C) The electrons jump into the nucleus and back out at specified frequencies
 - D) The light is actually emitted by the nucleus, which vibrates at the corresponding frequency
 - E) The electrons can only orbit in specific orbits for each type of atom, and when the electron jumps from one orbit to another, a single photon is emitted with the corresponding energy
24. Which of the following more or less states Kepler's second law of planetary motion?
- A) Planets orbit the Sun such that they have constant velocity
 - B) Planets orbit the Sun such that they sweep out equal angles in equal time
 - C) Planets orbit the Sun such that they sweep out equal areas in equal time
 - D) Planets orbit the Sun so their radial velocity is constant
 - E) Planets orbit the Sun so their transverse velocity is constant
25. An emission nebula is a cloud that produces a spectrum consisting of a set of discrete spectral lines (bright line spectrum). How could we deduce the composition of an emission nebula?
- A) Study the gravitational attraction of the nebula, and deduce the mass of the atoms
 - B) Search for chemical reactions, and search for similar reactions on Earth
 - C) Compare the overall color to the color of different types of atoms on Earth
 - D) Compare the overall brightness to that of different types of atoms on Earth

- E) Compare the wavelengths that result to that from different types of atoms on Earth
26. If you heat up a black body, how does the spectrum change?
- A) The light has a combination of many wavelengths, but the wavelength where the most power is gets shorter
 - B) The light has a combination of many wavelengths, but the wavelength where the most power is gets longer
 - C) The light, which is all at one wavelength, shifts to a longer wavelength
 - D) The light, which is all at one wavelength, shifts to a shorter wavelength
 - E) The combination of light waves remains the same, it just gets uniformly brighter
27. When the space station orbits the Earth, how come it doesn't fall down?
- A) The atmosphere shields it from the effects of gravity
 - B) It is so far away that gravity is very small
 - C) It regularly fires its engines to reverse any falling
 - D) Powerful magnets push against the Earth's magnetic field to keep it up
 - E) It actually is falling, all the time, which is why it goes in a circle around the Earth rather than going in a straight line
28. To double the pressure of an ideal gas, we could
- A) Double the temperature (only)
 - B) Double the number density (only)
 - C) Double the mass of the molecules (only)
 - D) A or B would work, but not C
 - E) A, B, or C would all work
29. According to the models built by Copernicus, why is the planet Mercury always in the same direction as the Sun?
- A) Mercury and the Sun both orbit the Earth on ellipses that have the same semi-major axis, and therefore the same period, though with different eccentricities
 - B) Mercury follows a deferent that goes around Earth at the same rate as the Sun, and any separation is due to the epicycles of its movement
 - C) The Sun goes around Earth, and Mercury orbits the Sun, making it automatically in the same direction as the Sun
 - D) Both Earth and Mercury orbit the Sun, but Mercury is farther away, and therefore it is always in the same direction as the Sun
 - E) Both Earth and Mercury orbit the Sun, but Mercury is closer, and therefore it is always in the same direction as the Sun
30. Which strategy is used by astronomers to improve the viewing they can achieve with a telescope?
- A) Put it on a mountain, so there is less atmosphere to deal with (only)
 - B) Put it away from a city, so there is less light pollution (only)
 - C) Put it in space (only)
 - D) All of the above
 - E) None of the above

31. Suppose a particular frequency of light has a speed of c . What would be the speed if you doubled the frequency?
A) $\frac{1}{4}c$ B) $\frac{1}{2}c$ C) c D) $2c$ E) $4c$
32. Physicists have succeeded in creating extremely cold atoms by a technique called laser cooling. This coldest temperature is in fact about
A) 3000 K B) 300 K C) 0.0000000001 K D) -300 K E) -3000 K
33. The energy of a single photon is greatest if
A) Its source is the brightest
B) Its atoms are the most energetic
C) Its source is the hottest
D) Its wavelength is the longest
E) Its wavelength is the shortest