

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:

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

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

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

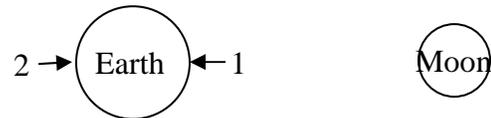
- The brilliant observational astronomer who provided the data that Kepler used to work out the orbits of planets was named
A) Newton B) Carlson C) Galileo D) Copernicus E) Brahe
- In order to experience free fall/weightlessness, you must
A) Travel far enough away that Earth's gravity is negligible
B) Travel far enough away that Earth's gravity is balanced by the Moon
C) Travel far enough away that Earth's gravity is balanced by the Sun
D) Travel above the atmosphere, since the atmosphere blocks gravity
E) Be in a situation where nothing is holding you up
- If you watched a star over time, how long would it take for it to seem to return to approximately the same place in the sky?
A) One hour B) One day C) One week D) One month E) One year
- Which of the following was not part of Kepler's laws of planetary motion
A) Planets orbit in ellipses with one focus at the Sun
B) $P^2 = a^3$
C) $F = \frac{GMm}{d^2}$
D) Equal areas in equal times
E) Actually, all of these were worked out by Kepler

5. The New Horizons spacecraft is currently passing by Pluto. How does the gravitational pull of Pluto on the spacecraft and the pull of the spacecraft on Pluto compare?
- A) Pluto pulls on the spacecraft, but the spacecraft doesn't pull on Pluto
 - B) The spacecraft's pull on Pluto is much larger than Pluto's pull on the spacecraft
 - C) The spacecraft's pull on Pluto is much smaller than Pluto's pull on the spacecraft
 - D) The two pulls are equal, but the spacecraft's smaller mass means that it is more affected by that pull
 - E) The two pulls are equal, but the spacecraft's smaller mass means that it is less affected by that pull
6. The Andromeda Galaxy, if it weren't so dim, would have an angular size of about 180 arc-minutes, which is about the same as
- A) 3 arc-seconds
 - B) 1/3 arc-second
 - C) 3 degrees
 - D) 1/3 degree
 - E) None of these
7. During a solar eclipse, one might experience on the surface of the Earth?
- A) The entire Sun is blocked by the Moon (only)
 - B) One side of the Sun is blocked (only)
 - C) All of the Sun except a thin circle is blocked (only)
 - D) A and B are possible, but not C
 - E) A, B, and C are all possible
8. Which of the following would double the pressure of an ideal gas?
- A) Doubling the number of atoms in each molecule
 - B) Doubling the mass of the molecules
 - C) Doubling the temperature (in Kelvin)
 - D) Doubling the volume in which the molecules are contained
 - E) None of the above
9. According to Newton's Laws, how much force is required to keep an object moving at constant speed in a straight line?
- A) An amount that depends only on the mass and speed
 - B) An amount that depends on the mass, the mass of the thing keeping it moving, and the separation
 - C) An amount that depends on the mass and the distance it is moving
 - D) There is no simple formula, but it must be non-zero
 - E) Zero
10. The fundamental reason the temperature is hotter in the summer is because
- A) The Earth is closer to the Sun
 - B) The Earth is moving faster, so there's more friction
 - C) The Sun is lower in the sky, so it heats the Earth more
 - D) The Sun is higher in the sky, so the light comes more straight down on the Earth
 - E) The atmosphere is more transparent in the summer, letting more light in

11. If I were to calculate the period of the orbit of the Moon around the Earth, should I use the formula $P^2 = a^3$ or $(M + m) P^2 = a^3$, and why?
- A) $(M + m) P^2 = a^3$, because it is more complicated, and therefore better
 - B) $(M + m) P^2 = a^3$, because the sum of the masses is not close to 1, so the other will give the wrong answer
 - C) $P^2 = a^3$, because it requires less information
 - D) $P^2 = a^3$, because the other formula only applies outside the Solar System
 - E) Either will work and give the same answer, though $P^2 = a^3$ is simpler
12. Compared to the stars, what path does the Sun take in the sky?
- A) It follows a circle called the ecliptic, always moving west to east
 - B) It follows a circle called the ecliptic, but sometimes west to east and sometimes east to west
 - C) It follows near but not generally on the ecliptic, always moving west to east
 - D) It follows near but not generally on the ecliptic, sometimes west to east and sometimes east to west
 - E) It follows a complicated path that is not related to the ecliptic
13. Which observation gave strong experimental evidence to Galileo that planets orbited the Sun?
- A) The phases of Venus
 - B) Mountains on the Moon
 - C) Sunspots on the Sun
 - D) The moons of Jupiter
 - E) Rings around Saturn
14. The force that holds atoms together is
- A) Strong Nuclear
 - B) Weak Nuclear
 - C) Quantum Mechanical
 - D) Gravity
 - E) Electromagnetic
15. When light enters a telescope, what surface is the first part the light could reach?
- A) A lens (only)
 - B) A mirror (only)
 - C) A spectrometer (only)
 - D) A lens or mirror, but not a spectrometer
 - E) A lens, mirror, or spectrometer
16. To get white light, what sort of wavelength of light must you use?

- A) Mostly the longest visible wavelengths
- B) Mostly the shortest visible wavelengths
- C) Mostly wavelengths in the middle of the visible spectrum
- D) A combination of a wide variety of visible wavelengths
- E) None, since white is the absence of color and hence the absence of light

17. Suppose the Moon is situated to the right of the Earth, as sketched below. What sort of tides would be experienced at points 1 and 2 on the Earth?



- A) High tide at both
- B) Low tide at both
- C) High tide at 1, low tide at 2
- D) High tide at 2, low tide at 1
- E) High tide at 1, but intermediate value at 2

18. Which of the following measurements could determine the relative temperature of two stars?

- A) Brightness – the brighter star is hotter
- B) Brightness – the dimmer star is hotter
- C) Color – blue stars are hotter than red stars
- D) Color – red stars are hotter than blue stars
- E) None of the above

19. Which of the following is true about the motion of the planets, compared to the background stars?

- A) They always move west to east
- B) They always move east to west
- C) They always stay about the same brightness
- D) Some of them can be the opposite direction compared to the Sun, some cannot
- E) They always stay right on the ecliptic

20. What is the approximate distance from the Earth to the Sun, in AU?

- A) 0.03
- B) 1.00
- C) 30.0
- D) 150,000
- E) 150,000,000

21. What determines whether New Horizons spacecraft returns around the sun in an ellipse or departs it permanently on a hyperbola?

- A) Velocity – if the velocity is large it will remain, but if it's small it leaves
- B) Velocity – if the velocity is small it will remain, but if it's large it leaves
- C) Mass – if the spacecraft is heavy it will remain, but if it's light it leaves
- D) Mass – if the spacecraft is light it will remain, but if it's heavy it leaves
- E) Direction – if it's moving inwards it will remain, but if it's outward it leaves

22. Light wave Long has waves that are twice as long as light wave Short. How do the two frequencies compare?

- A) Long's frequency is twice as big as Short

- B) Short's frequency is twice as big as Long
 - C) They have the same frequency, since all light has the same frequency
 - D) Insufficient information
 - E) I have no idea; please mark this one wrong
23. Which of the following types of electromagnetic radiation are not used for astronomical study?
- A) Ultraviolet
 - B) Radio
 - C) Infrared
 - D) Microwaves
 - E) Actually, all of them are used for astronomical study
24. By watching the various phases of the Moon from Earth, what were ancient people able to figure out about the Moon?
- A) It is much smaller than the Earth
 - B) It has less mass than the Earth
 - C) It is a sphere, not a flat disk
 - D) It shines by light that comes from the Earth
 - E) There is no air on the Moon
25. The Lyman-alpha line of hydrogen, when measured on Earth, has a wavelength of 121.567 nm; however, when measured from distant galaxies, it is often much longer than this. What could possibly explain this increase?
- A) The galaxies must be much hotter than the hydrogen on Earth
 - B) The galaxies must be much colder than the hydrogen on Earth
 - C) The galaxies must be moving towards us
 - D) The galaxies must be moving away from us
 - E) The hydrogen from these distant galaxies must be of a different type than ours
26. Arrange the different types of electromagnetic radiation below in order from longest wavelength to shortest wavelength:
- A) X-rays, Visible, Microwaves
 - B) Visible, Microwaves, X-rays
 - C) Visible, X-rays, Microwaves
 - D) Microwaves, X-rays, Visible
 - E) Microwaves, Visible, X-rays
27. Which of the following types of astronomy can be done from the surface of the Earth?
- A) Radio (only)
 - B) Ultraviolet (only)

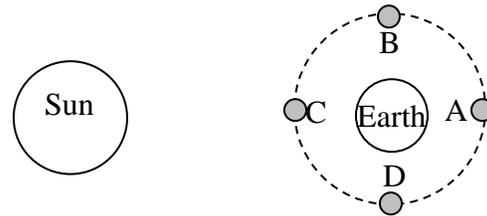
- C) X-rays (only)
- D) All of the above
- E) None of the above

28. We will soon discuss protoplanetary disks, disks of gas and dust that surround a young star. What two effects normally lead to a disk?
- A) Gravity vs. magnetism
 - B) Gravity vs. pressure
 - C) Gravity vs. rotation
 - D) Pressure vs. rotation
 - E) Pressure vs. magnetism

29. The lowest possible temperature in Kelvin is
- A) 0 K
 - B) -273 K
 - C) +273 K
 - D) 300 K
 - E) None of these

30. In which of the positions of the Moon in the diagram below could there be a lunar eclipse?

- A) A
- B) B
- C) C
- D) D
- E) None of these



31. Which of the following is not a fundamental force of nature?
- A) Strong Nuclear
 - B) Weak Nuclear
 - C) Quantum Mechanical
 - D) Gravity
 - E) Electromagnetic
32. Suppose you had a single photon, or particle of light. Which of the following would tell you how much energy is carried by that single photon?
- A) Frequency: lower frequency has more energy
 - B) Frequency: higher frequency has more energy
 - C) Distance: A more distant sources has more energy
 - D) Distance: A closer source has more energy
 - E) None of the above
33. Suppose star A and star B are 4 AU apart and orbit each other every 8 years. What is the combined total mass of the stars in solar masses?
- A) $0.25 M_{\odot}$
 - B) $0.50 M_{\odot}$
 - C) $1.00 M_{\odot}$
 - D) $2.00 M_{\odot}$
 - E) $4.00 M_{\odot}$