

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 1) The fact that Voyager 10 continues to speed out of the solar system, even though its rockets have no fuel, is an example of 1) _____
 - A) Newton's second law of motion.
 - B) Newton's third law of motion.
 - C) Newton's first law of motion.
 - D) the universal law of gravitation.
 - E) none of the above

- 2) What are the main constituents of the jovian planets? 2) _____
 - A) ammonia and water
 - B) ammonia and methane
 - C) hydrogen and helium
 - D) nitrogen and methane
 - E) rocky minerals and water, as on Earth

- 3) What happened during the *accretion* phase of the early solar system? 3) _____
 - A) Earth gained its oceans from icy planetesimal capture.
 - B) Atoms and molecules in the gas bonded together and solidified.
 - C) The solar nebula differentiated into metals inside of the frost line and ices beyond.
 - D) Large planetesimals captured atmospheres from the solar nebula.
 - E) Particles grew by colliding and sticking together.

- 4) Which of the following is an example in which you are traveling at constant speed but not at constant velocity? 4) _____
 - A) jumping up and down, with a period of exactly 60 hops per minute
 - B) rolling freely down a hill in a cart, traveling in a straight line
 - C) driving around in a circle at exactly 100 km/hr
 - D) driving backward at exactly 50 km/hr
 - E) none of the above

- 5) Which of the following methods has led to the most discoveries of massive planets orbiting near their parent stars? 5) _____
 - A) detecting a planet ejected from a binary star system
 - B) detecting the light reflected by the planet
 - C) detecting the shift of the star's position against the sky due to the planet's gravitational pull
 - D) detecting the infrared light emitted by the planet
 - E) detecting the gravitational effect of an orbiting planet by looking for the Doppler shifts in the star's spectrum

- 6) If we observe one edge of a planet to be redshifted and the opposite edge to be blueshifted, what can we conclude about the planet? 6) _____
- A) The planet is actually two bodies, one moving toward us, the other away from us.
 - B) The planet is in the process of falling apart.
 - C) The planet is rotating.
 - D) The planet is in the process of formation.
- 7) What is the primary reason why a Pluto flyby mission would be cheaper than a Pluto orbiter? 7) _____
- A) The fuel needed for an orbiter to slow down when it reaches Pluto is very expensive.
 - B) The flyby is easier to design than the orbiter.
 - C) The question is incorrect; in general, orbiters are cheaper than flybys.
 - D) The fuel needed for an orbiter to slow down when it reaches Pluto adds a lot of weight to the spacecraft.
 - E) The flyby can use less expensive cameras than the orbiter.
- 8) What is the name given to ^2H ? 8) _____
- A) helium B) tritium C) deuterium D) hydrogen
- 9) Which of the following is a form of electrical potential energy? 9) _____
- A) light from a fluorescent bulb
 - B) energy coming to your house from power companies
 - C) coal
 - D) moving blades on an electric mixer
 - E) energy from the Sun
- 10) According to our theory of solar system formation, why do we find some exceptions to the general rules and patterns of the planets? 10) _____
- A) The exceptions probably represent objects that were captured by our solar system from interstellar space.
 - B) The exceptions exist because, even though our theory is as correct as possible, nature never follows rules precisely.
 - C) Most of the exceptions are the result of giant impacts.
 - D) The exceptions probably represent objects that formed recently, rather than early in the history of the solar system.
 - E) Our theory is not quite correct because it cannot explain these exceptions.
- 11) As long as an object is not gaining or losing mass, a net force on the object will cause a change in 11) _____
- A) direction.
 - B) velocity.
 - C) weight.
 - D) speed.
 - E) acceleration.

- 12) When an electron in an atom goes from a higher energy state to a lower energy state, the atom 12) _____
- A) absorbs several photons of a specific frequency.
 - B) can absorb a photon of any frequency.
 - C) can emit a photon of any frequency.
 - D) absorbs a photon of a specific frequency.
 - E) emits a photon of a specific frequency.
- 13) Which of the following statements about constellations is *false*? 13) _____
- A) There are only 88 official constellations.
 - B) Most constellations will be unrecognizable hundreds of years from now.
 - C) Some constellations can be seen in both the winter and summer.
 - D) It is possible to see all the constellations from the earth's equator.
 - E) Some constellations can be seen from both the Northern and Southern hemispheres.
- 14) Spectra from neutral atoms compared with spectra from ionized atoms of the same element 14) _____
- A) are slightly redshifted.
 - B) are slightly blueshifted.
 - C) have the same sets of spectral lines but different widths for those lines.
 - D) have different sets of spectral lines.
 - E) are the same.
- 15) Roughly how many stars are in the Milky Way Galaxy? 15) _____
- A) 100 trillion B) 1 billion C) 100 billion D) 100 million E) 10 billion
- 16) You are standing on a scale in an elevator. Suddenly you notice your weight *decreases*. What do you conclude? 16) _____
- A) The elevator is moving at a constant velocity upwards.
 - B) The elevator is accelerating downwards.
 - C) The elevator is accelerating upwards.
 - D) Your diet is working.
 - E) The elevator is moving at a constant velocity downwards.
- 17) We can learn a lot about the properties of a star by studying its spectrum. All of the following statements are true except one. Which one? 17) _____
- A) The peak of the star's thermal emission tells us its temperature: Hotter stars peak at shorter (bluer) wavelengths.
 - B) We can look at Doppler shifts of spectral lines to determine the star's speed toward or away from us.
 - C) We can identify chemical elements present in the star by recognizing patterns of spectral lines that correspond to particular chemicals.
 - D) The total amount of light in the spectrum tells us the star's radius.

- 18) Which of the following is *not* a characteristic of the inner planets? 18) _____
- A) They have very few, if any, satellites.
 - B) They all have solid, rocky surfaces.
 - C) They all have substantial atmospheres.
 - D) They are relatively smaller than the outer planets.
 - E) Their orbits are relatively closely spaced.
- 19) Which object has the most kinetic energy? 19) _____
- A) a 3-ton truck moving 70 km/hr
 - B) a 1-ton truck moving 110 km/hr
 - C) a 2-ton truck moving 90 km/hr
 - D) a 4-ton truck moving 50 km/hr
 - E) A, B, C, and D all have the same kinetic energy.
- 20) Which of the following statements about electrons is *not* true? 20) _____
- A) Electrons have very little mass compared to protons or neutrons.
 - B) Within an atom, an electron can have only particular energies.
 - C) An electron has a negative electrical charge.
 - D) Electrons orbit the nucleus rather like planets orbiting the Sun.
 - E) Electrons can jump between energy levels in an atom only if they receive or give up an amount of energy equal to the difference in energy between the energy levels.
- 21) Considering Einstein's famous equation, $E = mc^2$, which of the following statements is *true*? 21) _____
- A) A small amount of mass can be turned into a large amount of energy.
 - B) It takes a large amount of mass to produce a small amount of energy.
 - C) One kilogram of mass represents 1 joule of energy.
 - D) You can make mass into energy if you can accelerate the mass to the speed of light.
 - E) Mass can be turned into energy, but energy cannot be turned back into mass.
- 22) Modern telescopes are capable of seeing bright galaxies up to 22) _____
- A) 1 million light years away.
 - B) 10 billion light years away.
 - C) 10 million light years away.
 - D) 1 billion light years away.
 - E) 1 trillion light years away
- 23) If you drop a rock from a great height, about how fast will it be falling after 5 seconds, neglecting air resistance? 23) _____
- A) 50 m/s
 - B) 15 m/s
 - C) It depends on what shape it is.
 - D) It depends on how heavy it is.
 - E) 10 m/s

- 24) What percentage of the mass of the solar nebula consisted of elements other than hydrogen and helium? 24) _____
A) 0.1 percent B) 2 percent C) 20 percent D) 0 percent E) 80 percent
- 25) *Thermal radiation* is defined as 25) _____
A) radiation that is felt as heat.
B) radiation produced by a hot object.
C) radiation that depends only on the emitting object's temperature.
D) radiation in the form of emission lines from an object.
E) radiation in the infrared part of the spectrum.
- 26) When a rock is held above the ground, we say it has some *potential energy*. When we let it go, it falls and we say the potential energy is converted to *kinetic energy*. Finally, the rock hits the ground. What has happened to the energy? 26) _____
A) It is lost forever. Energy does not have to be conserved.
B) The rock keeps the energy inside it (saving it for later use).
C) The energy goes to producing sound and to heating the ground, rock, and surrounding air.
D) The energy goes into the ground and, as a result, the orbit of the earth about the Sun is slightly changed.
E) It is transformed back into gravitational potential energy.
- 27) According to the *universal law of gravitation*, if you double the masses of *both* attracting objects, then the gravitational force between them will 27) _____
A) not change at all.
B) decrease by a factor of 4.
C) increase by a factor of 2.
D) decrease by a factor of 2.
E) increase by a factor of 4.
- 28) Where did the elements heavier than hydrogen and helium come from? 28) _____
A) They were produced in the Big Bang.
B) They were produced inside stars.
C) They evolved from hydrogen and helium shortly after the Big Bang.
D) They were produced inside dense interstellar gas.
E) all of the above
- 29) What does *temperature* measure? 29) _____
A) the average mass of particles in a substance
B) the average kinetic energy of particles in a substance
C) the average size of particles in a substance
D) the total potential energy of particles in a substance
E) the total number of particles in a substance

- 30) When an atom absorbs a photon containing energy, any of the following can happen *except* which? 30) _____
- A) An electron moves from a lower energy level to an upper one.
 - B) The atom becomes excited.
 - C) The atom is ionized.
 - D) An electron moves from an upper energy level to a lower one.
- 31) Which of the following cannot be described by a *field*? 31) _____
- A) gravitational forces
 - B) radiation pressure
 - C) magnetic forces
 - D) electrical forces
- 32) Patterns of stars in constellations hardly change in appearance over times of even a few thousand years. Why? 32) _____
- A) Stars within a constellation move together as a group, which tends to hide their actual motion and prevent the pattern from changing.
 - B) Stars move, but they move very slowly—only a few kilometers in a thousand years.
 - C) Stars are fixed and never move.
 - D) The stars in our sky actually move rapidly relative to us—thousands of kilometers per hour—but are so far away that it takes a long time for this motion to make a noticeable change in the patterns in the sky.
 - E) Although most stars move through the sky, the brightest stars do not, and these are the ones that trace the patterns we see in the constellations.
- 33) If a material is highly *opaque*, then it 33) _____
- A) emits most light.
 - B) scatters most light.
 - C) transmits most light.
 - D) reflects most light.
 - E) absorbs most light.
- 34) What causes the apparent retrograde motion of the planets? 34) _____
- A) As the earth passes another planet, its gravitational pull slows down the other planet so that it appears to be traveling backward.
 - B) Apparent retrograde motion is an illusion created by turbulence in the earth's atmosphere.
 - C) When planets are farther from the Sun, they move slower than when they are nearer the Sun; it is during this slower period that they appear to move backwards.
 - D) The other planets never really appear to move backward; the background stars shift due to the earth's revolution around the Sun.
 - E) As the earth passes another planet, the other planet appears to move backward with respect to the background stars, but the planet's motion does not really change.

- 35) According to the *universal law of gravitation*, the force due to gravity is 35) _____
A) directly proportional to the distance between objects.
B) inversely proportional to the distance between objects.
C) inversely proportional to the square of the distance between objects.
D) not dependent on the distance between objects.
E) directly proportional to the square of the distance between objects.
- 36) When light reflects off an object, what is the relation between the angle of incidence and the angle of reflection? 36) _____
A) angle of incidence + angle of reflection = 180°
B) angle of incidence - angle of reflection = 90°
C) angle of incidence + angle of reflection = 90°
D) it depends on the material that the light reflects off
E) angle of incidence = angle of reflection
- 37) The ultimate source of energy that powers the Sun is 37) _____
A) kinetic energy of the orbital motion of the Sun.
B) chemical potential energy of hydrogen burning into helium.
C) gravitational potential energy of the contraction of the gas cloud that formed the Sun.
D) thermal energy of the hydrogen atoms in the Sun.
E) mass energy of hydrogen fusing into helium.
- 38) What is an *astronomical unit*? 38) _____
A) the length of time it takes the earth to revolve around the Sun
B) any basic unit used in astronomy
C) the average distance from the earth to the Sun
D) the diameter of the earth's orbit around the Sun
E) the average speed of the earth around the Sun
- 39) Based on our current theory of the earth's formation, the water we drink comes from 39) _____
A) chemical reactions that occurred in the earth's crust after the earth formed.
B) comets that impacted the earth.
C) ice that condensed in the solar nebula in the region where the earth formed.
D) material left behind during the giant impact that formed the Moon.
E) chemical reactions that occurred in the earth's core after the earth formed.
- 40) Which is the densest planet in the solar system? 40) _____
A) Venus B) Mercury C) Earth D) Jupiter E) Mars

- 41) Changing the orbit of a spacecraft by firing thrusters is an example of 41) _____
- A) Newton's first law of motion.
 - B) Newton's second law of motion.
 - C) the universal law of gravitation.
 - D) Newton's third law of motion.
 - E) none of the above
- 42) How are wavelength, frequency, and energy related for photons of light? 42) _____
- A) Longer wavelength means higher frequency and lower energy.
 - B) Longer wavelength means lower frequency and lower energy.
 - C) Longer wavelength means lower frequency and higher energy.
 - D) Longer wavelength means higher frequency and higher energy.
 - E) There is no simple relationship because different photons travel at different speeds.
- 43) Why do we see essentially the same face of the Moon at all times? 43) _____
- A) because the other face points toward us only at new moon, when we can't see the Moon
 - B) because the Moon does not rotate
 - C) because the Moon has a nearly circular orbit around the earth
 - D) because the Moon's rotational and orbital periods are equal
 - E) because the Sun illuminates only one half at a time
- 44) Suppose a lone asteroid happens to be passing relatively near Jupiter (but not near any of its moons), following a hyperbolic orbit as it approaches Jupiter. Which of the following statements would be *true*? 44) _____
- A) The asteroid would slowly spiral into Jupiter until it crashed into the atmosphere.
 - B) The asteroid's orbit around Jupiter would not change, and it would go out on the same hyperbolic orbit that it came in on.
 - C) Jupiter's gravity would capture the asteroid, making it a new moon of Jupiter.
 - D) Jupiter would probably expel the asteroid far out into the solar system.
 - E) Any of these scenarios is possible.
- 45) What conditions are required for a solar eclipse? 45) _____
- A) The phase of the Moon can be new or full, and the nodes of the Moon's orbit must be nearly aligned with the earth and the Sun.
 - B) The phase of the Moon must be new, and the nodes of the Moon's orbit must be nearly aligned with the earth and the Sun.
 - C) The phase of the Moon must be full, and the Moon's orbital plane must lie in the ecliptic.
 - D) The phase of the Moon must be new, and the Moon's orbital plane must lie in the ecliptic.
 - E) The phase of the Moon must be full, and the nodes of the Moon's orbit must be nearly aligned with the earth and the Sun.

- 46) Radiative energy is 46) _____
A) energy carried by light.
B) energy of motion.
C) energy used in home radiators.
D) energy from nuclear power plants.
E) heat energy.
- 47) Which of the following statements about thermal radiation is *always true*? 47) _____
A) A hot object emits more X rays than a cool object.
B) A hot object emits photons with a higher average energy than a cool object.
C) A hot object emits more radio waves than a cool object.
D) A hot object emits photons with a longer wavelength than a cool object.
- 48) According to what we now know from Newton's laws, which of the following *best* explains why Kepler's second law is true? 48) _____
A) Orbits must be elliptical in shape.
B) A planet's angular momentum must be conserved as it moves around its orbit.
C) This effect happens because of the influence of other planets on a particular planet's orbit.
D) Gravity is an inverse cube law.
- 49) Observations of young stars (as well as theory) tell us that when the Sun was young the solar wind 49) _____
A) was stronger than it is today.
B) was about the same strength as it is today.
C) was nonexistent.
D) blew outward only along the Sun's poles.
E) was weaker than it is today.
- 50) Why are the inner planets made of denser materials than the outer planets? 50) _____
A) The Sun's gravity pulled denser materials toward the inner part of the solar nebula, while lighter gases escaped more easily.
B) Denser materials were heavier and sank to the center of the nebula.
C) In the inner part of the nebula only metals and rocks were able to condense because of the high temperatures, whereas hydrogen compounds, although more abundant, were only able to condense in the cooler outer regions.
D) In the beginning, when the protoplanetary disk was spinning faster, centrifugal forces flung the lighter materials toward the outer parts of the solar nebula.
E) When the solar nebula formed a disk, materials naturally segregated into bands, and in our particular solar system the denser materials settled nearer the Sun while lighter materials are found in the outer part.

Answer Key

Testname: UNTITLED1

- 1) C
- 2) C
- 3) E
- 4) C
- 5) E
- 6) C
- 7) D
- 8) C
- 9) B
- 10) C
- 11) B
- 12) E
- 13) B
- 14) D
- 15) C
- 16) B
- 17) D
- 18) C
- 19) C
- 20) D
- 21) A
- 22) B
- 23) A
- 24) B
- 25) C
- 26) C
- 27) E
- 28) B
- 29) B
- 30) D
- 31) B
- 32) D
- 33) E
- 34) E
- 35) C
- 36) E
- 37) E
- 38) C
- 39) B
- 40) C
- 41) D
- 42) B
- 43) D
- 44) B
- 45) B
- 46) A
- 47) B
- 48) B
- 49) A
- 50) C