



**The 58th Annual
Merck State Science Day Competition
May 20, 2008
Integrated Science**

Directions:

PLEASE DO NOT OPEN THE EXAM BOOKLET UNTIL DIRECTED.

Be sure to fill in your name on the answer sheet both by printing it in the correct space and by filling in the corresponding letter in the spaces provided.

Use a #2 pencil only.

Carefully erase any errors, and do not make any extraneous marks on the answer sheet. Do NOT use *White-Out* on any portion of the answer sheet.

The test has **100 items** that will be scored. You have **90** minutes in which to answer all the questions.

There is only one correct answer per question. Do not spend too much time on any one question. Do the items you find easier first, and then go back to those you find more difficult or time consuming during the time you have remaining. Your individual score will be computed on the basis of the number of correctly answered items. (There is no penalty for guessing.)

In addition to the periodic table, there are several subject-specific items below that you may find useful in answering certain questions. Be sure to read them immediately after you are told to begin. You may refer to them at any time during the test.

INFORMATION THAT MAY BE USEFUL IN SOLVING SOME PROBLEMS

$$1 \text{ calorie} = 4.184 \text{ joules}$$

$$1/f = 1/d_o + 1/d_i$$

$$C = 2f$$

$$h_i/h_o = d_i/d_o$$

$$E = hf$$

$$\text{speed of light in vacuum} = 3.0 \times 10^8 \text{ m/sec}$$

$$\text{Planck's constant, } h = 6.63 \times 10^{-34} \text{ joule-sec}$$

$$v = c \sqrt{1 - v^2/c^2}$$

$$\text{Avogadro's Number} = 6.02 \times 10^{23}$$

$$Q = mc\Delta T$$

$$KE_{\text{ave}} = 1/2mv^2$$

$$PE_{\text{grav}} = mgh$$

$$W = F \times S$$

$$W = Vq$$

$$v_{\text{avg}} = s/t$$

$$s = v_o t + 1/2at^2$$

$$v_f^2 = v_i^2 + 2as$$

$$v_f = v_i + at$$

$$c = f\lambda$$

$$P_1V_1/T_1 = P_2V_2/T_2$$

$$I = V/R$$

$$1 \text{ C} = 6.25 \times 10^{18} \text{ e}^-$$

$$D = M/V$$

$$v = f \lambda$$

$$P = W/t$$

$$K_f \text{ water} = 1.86 \text{ }^\circ\text{C/m}$$

$$K_b \text{ water} = 0.51 \text{ }^\circ\text{C/m}$$

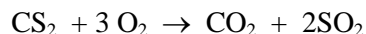
Universal gas constant: $R = 8.31 \text{ kPa-liter}/(\text{mole-K}) = 0.0821 \text{ atm-liter}/(\text{mole-K})$

Multiple Choice

Identify the letter of the choice that best completes the statement or answers the question and place your selection ON THE ANSWER SHEET.

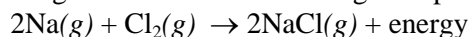
- Calculate and round to the correct number of significant figures for measured numbers:
 $(9.71 \times 10^6) \times (3.446 \times 10^{15})$
A) 3.346×10^{22}
B) 3.35×10^{22}
C) 3.346×10^{24}
D) 3.35×10^{24}
E) 3.350×10^{22}
- The compound containing an ionic bond is
A) H_2O B) KCl C) ClO_3 D) NCl_3 E) HCl
- What volume of argon gas at 100 kPa and 25°C must be added to a 1.00-Litre glass flask containing nitrogen gas at 70 kPa and 25°C to give a mixture of gases having a total pressure of 210 kPa at 25°C ?
A) 1.40 L B) 1.70 L C) 2.00 L D) 2.86 L E) 3.10 L
- The percentage, by mass, of oxygen in pitchblende, U_3O_8 , is
A) 72.7% B) 35.0% C) 30.4% D) 17.9% E) 15.2%
- By addition to water, 30.0 mL of 6.00 mol/L sulfuric acid is diluted to 150.0 mL. What is the concentration of sulfuric acid after dilution?
A) 1.20 mol/L B) 1.50 mol/L C) 2.40 mol/L D) 3.00 mol/L E) 4.80 mol/L
- If 3.1 g of sodium oxide is dissolved in enough water to make 500 mL of solution, what is the molar concentration of sodium ions in the solution?
A) 0.05 M B) 0.10 M C) 0.20 M D) 0.25 M E) 0.40 M
- Balance the following equation and select the quantity which is the sum of the coefficients of the products.
 $? \text{Cl}_2\text{O}_7 + ? \text{Al}(\text{OH})_3 \rightarrow ? \text{Al}(\text{ClO}_4)_3 + ? \text{H}_2\text{O}$
A) 7
B) 6
C) 5
D) 4
E) 3
- A bronze alloy contains Zn and Cu. The zinc reacts with HCl but copper does not. A 0.5065 g sample of an alloy reacts with excess HCl to produce 0.0985 g ZnCl_2 . What is the percent of zinc in the alloy?
 $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$
A) 10.1 %
B) 9.33 %
C) 8.34 %
D) 8.98 %
E) 8.75 %

- 9) What is the total mass of products formed when 19.0 g of carbon disulfide is burned in air?



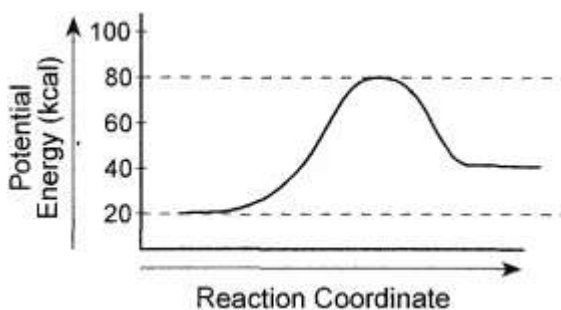
- A) 29.0
B) 35.0
C) 37.0
D) 39.0
E) 43.0
- 10) What is the molar concentration of a barium hydroxide, $\text{Ba}(\text{OH})_2$, solution that was formed by the reaction of 0.34 g of barium with enough water to give 200.0 mL of solution?
- $$\text{Ba}(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow \text{Ba}(\text{OH})_2(\text{aq}) + \text{H}_2(\text{g})$$
- A) $1.2 \times 10^{-2}\text{M}$
B) $1.9 \times 10^{-2}\text{M}$
C) $9.2 \times 10^{-1}\text{M}$
D) $6.2 \times 10^{-1}\text{M}$
E) $2.5 \times 10^{-2}\text{M}$
- 11) Which term best describes the shape of the molecule PF_3 ?
- A) T-shaped
B) trigonal planar
C) trigonal pyramidal
D) square planar
E) tetragonal pyramid
- 12) Consider the following elements and select the one which has the largest number of electrons shown in an electron dot symbol. **S P Ba Al Rb**
- A) Al
B) Ba
C) P
D) Rb
E) S
- 13) If 0.200 L of 0.15 M $\text{HCl}(\text{aq})$ is mixed with 0.300 L of 0.090 M $\text{NaOH}(\text{aq})$, what is the pH of the solution that results?
- A) 0.52
B) 1.22
C) 2.22
D) 2.52
E) 7.00
- 14) When a 25.0 g sample of a metal is heated from 20.0 °C to 50.0 °C, 178 J of energy is absorbed from the surroundings. The specific heat capacity of the metal is
- A) $7.12 \text{ J/g}\cdot^\circ\text{C}$
B) $0.356 \text{ J/g}\cdot^\circ\text{C}$
C) $0.237 \text{ J/g}\cdot^\circ\text{C}$
D) $0.142 \text{ J/g}\cdot^\circ\text{C}$
E) $7.85 \text{ J/g}\cdot^\circ\text{C}$

- 15) The following reaction will occur at high temperatures.



The half-reaction for the reduction that occurs in this reaction is

- A) $\text{Na}(g) \rightarrow \text{Na}^+(g) + e^-$
B) $\text{Na}(g) + e^- \rightarrow \text{Na}^+(g)$
C) $\text{Cl}_2(g) + 2e^- \rightarrow 2\text{Cl}^-(g)$
D) $\text{Cl}_2(g) \rightarrow 2\text{Cl}^-(g) + 2e^-$
- 16) At what temperature do the molecules of an ideal gas have twice the average kinetic energy that they have at 100°C?
A) 200 K
B) 373 K
C) 473 K
D) 546 K
E) 746 K
- 17) A potential energy diagram of a chemical reaction is shown below.

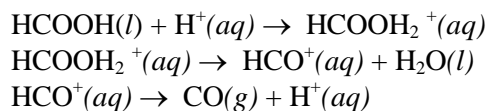


What is the difference between the potential energy of the reactants and the potential energy of the products?

- A) 20. kcal B) 40. kcal C) 50. kcal D) 60. kcal E) 80. kcal
- 18) What is the net ionic equation for the reaction that occurs between nitrous acid, HNO_2 , and potassium hydroxide, KOH ?
A) $\text{HNO}_2(\text{aq}) + \text{KOH}(\text{aq}) \rightarrow \text{KNO}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$
B) $\text{HNO}_2(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{NO}_2^-(\text{aq}) + \text{H}_2\text{O}(\text{l})$
C) $\text{K}^+(\text{aq}) + \text{NO}_2^-(\text{aq}) \rightarrow \text{KNO}_2(\text{s})$
D) $\text{H}^+(\text{aq}) + \text{NO}_2^-(\text{aq}) + \text{K}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{KNO}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$
E) $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$
- 19) Which atom in the ground state has three half filled orbitals?
A) Li B) Al C) Si D) P E) S
- 20) The *strongest* van der Waals forces of attraction exist between molecules of
A) I_2 B) Br_2 C) Cl_2 D) F_2 E) H_2
- 21) In which reaction does high pressure favor the formation of the products?
A) $2\text{H}_2\text{O}(g) \rightleftharpoons 2\text{H}_2(g) + \text{O}_2(g)$
B) $\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)$

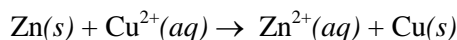
- C) $\text{CaCO}_3(s) \rightleftharpoons \text{CaO}(s) + \text{CO}_2(g)$
 D) $\text{CO}(g) + \text{H}_2\text{O}(g) \rightleftharpoons \text{CO}_2(g) + \text{H}_2(g)$

22) In the reaction mechanism for the decomposition of formic acid, HCOOH ,



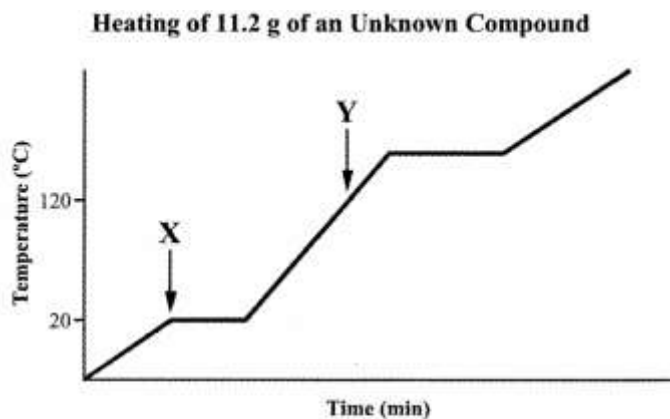
which species acts as a catalyst?

- A) $\text{H}^+(aq)$
 B) $\text{CO}(l)$
 C) $\text{H}_2\text{O}(l)$
 D) $\text{HCO}^+(aq)$
 E) $\text{HCOOH}_2^+(aq)$
- 23) Given the net ionic equation



for an electrochemical cell, which is the equation for the reaction at the anode of this cell?

- A) $\text{Zn}(s) \rightarrow \text{Zn}^{2+}(aq) + 2e^-$
 B) $\text{Cu}(s) \rightarrow \text{Cu}^{2+}(aq) + 2e^-$
 C) $\text{Zn}^{2+}(aq) + 2e^- \rightarrow \text{Zn}(s)$
 D) $\text{Cu}^{2+}(aq) + 2e^- \rightarrow \text{Cu}(s)$



Characteristic Properties

- 1 Melting point
- 2 Boiling point
- 3 Specific heat capacity of liquid
- 4 Molar heat of fusion
- 5 Molar heat of vaporization

24)

A student wishes to calculate the amount of energy required to heat the unknown compound represented in the graph above, from point X to point Y. Along with the information in the graph, which of the characteristic properties listed above must the student know to carry out the calculations?

- A) 1 and 4

- B) 2 and 5
 C) 3 and 4
 D) 3 and 5
 E) 4 and 5
- 25) Sucrose, $C_{12}H_{22}O_{11}$, is a nonvolatile nonelectrolyte. What is the freezing point of a solution of 3.50 g of sucrose in 20.0 g of water?
 A) -0.750 B) -1.15 C) -0.951 D) -0.800 E) -1.30
- 26) Strontium-90 has a half-life of 28 years. What fraction of a sample remains as strontium-90 after 84 years?
 A) 1/28 B) 1/8 C) 1/4 D) 1/3 E) 1/2
- 27) Which mineral family is by far the most common on the Earth's crust?
 A) Carbonates D) Oxides
 B) Halides E) Silicates
 C) Native
- 28) What identification property is used to easily identify mica?
 A) color D) hardness
 B) streak E) luster
 C) cleavage
- 29) The Moh's scale is used to identify a mineral's:
 A) color D) hardness
 B) streak E) luster
 C) cleavage
- 30) Which gas is converted into a useful form for plants by bacteria in the soil (fixation)?
 A) hydrogen D) carbon dioxide
 B) nitrogen E) water vapor
 C) oxygen
- 31) Buildings, pavement and other development tend to make flooding at flood plains occur:
 A) later D) lower
 B) sooner E) b & c
 C) higher
- 32) The high point between two watersheds is called a:
 A) saltation D) levee
 B) meander E) divide
 C) contour
- 33) Toward which direction is the North American plate moving?
 A) North D) West
 B) South E) It is not moving
 C) East
- 34) Plate movement is caused by convection currents in the:
 A) crust D) outer core
 B) lithosphere E) ocean floor
 C) asthenosphere

- 35) The youngest part of the ocean floor is found at the:
- A) trenches
 - B) abyssal plain
 - C) guyouts
 - D) ridges
 - E) slope
- 36) The Himalayan Mountains are an example of which type of zone:
- A) Continental Divergent
 - B) Continental Convergent
 - C) Transform
 - D) Oceanic Convergent
 - E) Oceanic Divergent
- 37) Which of the following is **NOT** associated with oceanic convergent zones?
- A) rifts
 - B) earthquakes
 - C) island arcs
 - D) volcanoes
 - E) trenches
- 38) Which geologic time era was known for the dinosaurs that existed at that time?
- A) Cenozoic
 - B) Mesozoic
 - C) Paleozoic
 - D) Precambrian
 - E) Proterozoic
- 39) Which type of rock has the best chance of being an oil reservoir?
- A) granite
 - B) sandstone
 - C) conglomerate
 - D) basalt
 - E) igneous
- 40) The actual location of energy release of an earthquake is called the:
- A) magnitude
 - B) epicenter
 - C) Richter point
 - D) foreshock
 - E) focus
- 41) The seismic intensity scale used to measure the amount of damage caused by an earthquake is called the:
- A) Moh's
 - B) Richter
 - C) Magnitude
 - D) Mercalli
 - E) Mercator
- 42) What is the minimum number of seismograph instruments are needed to properly locate the epicenter an earthquake?
- A) one
 - B) two
 - C) three
 - D) four
 - E) five
- 43) Approximately what percentage of the Earth's surface area is represented by oceans?
- A) fifty
 - B) sixty
 - C) seventy
 - D) eighty
 - E) ninety
- 44) Which ocean has the greatest number of trenches?
- A) Atlantic
 - D) Pacific

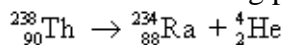
- B) Antarctic
C) Indian
- E) Arctic
- 45) What is the name for high altitude puffy clouds?
A) cumulus
B) cumulonimbus
C) stratocumulus
D) cirrocumulus
E) altocumulus
- 46) The most abundant gas in clean dry air is:
A) hydrogen
B) helium
C) oxygen
D) nitrogen
E) carbon dioxide
- 47) Ozone is an efficient absorber of incoming _____ radiation.
A) radio
B) infrared
C) visible
D) ultraviolet
E) x-ray
- 48) The Earth loses its heat to space in the form of _____ radiation.
A) radio
B) infrared
C) visible
D) ultraviolet
E) x-ray
- 49) Which of the following is associated with a high-pressure zone?
A) warm front
B) clockwise circulation
C) rain
D) rising air
E) occluded front
- 50) Which type of spectra is formed by a hot and ionized gas?
A) continuous
B) bright-line
C) dark-line
D) absorption
E) doppler shifted
- 51) A car travels in a straight line covering a total distance of 90.0 miles in 60.0 minutes. Which one of the following statements concerning this situation is *necessarily* true?
A) The velocity of the car is constant.
B) The acceleration of the car must be non-zero.
C) The first 45 miles must have been covered in 30.0 minutes.
D) The speed of the car must be 90.0 miles per hour throughout the entire trip.
E) The average velocity of the car is 90.0 miles per hour in the direction of motion.
- 52) A jogger, traveling at constant speed, makes one lap around a circular track of radius r in a time t . When the jogger has traveled halfway around the track, what is the magnitude of his/her *displacement* from the starting point?
A) r B) $2r$ C) πr D) $2\pi r$ E) zero
- 53) A football is kicked at an angle θ with respect to the horizontal. Which one of the following statements best describes the *acceleration* of the football after it has been kicked if air resistance is neglected?
A) The acceleration is zero at all times.

- B) The acceleration is 9.8 m/s^2 at all times.
 C) The acceleration is zero when the football has reached the highest point in its trajectory.
 D) The acceleration is positive as the football rises, and its is negative as the football falls.
 E) The acceleration starts at 9.8 m/s^2 and drops to some constant lower value as the ball approaches the ground.
- 54) A potato is fired from a spud-gun with initial horizontal and vertical components of velocity equal to 30 m/s and 40 m/s , respectively. What is the magnitude of the potato's velocity just before it strikes the ground?
 A) zero B) 9.8 m/s C) 30 m/s D) 40 m/s E) 50 m/s
- 55) Wile E Coyote runs with a horizontal velocity in the positive x direction from the top of an 80 m high cliff. Following the true laws of physics, Wile strikes the ground 1330 m from the base of the cliff. What is the magnitude of the acceleration of Wile just before it strikes the ground?
 A) 4.0 m/s^2 B) 9.8 m/s^2 C) 82 m/s^2 D) 170 m/s^2 E) 330 m/s^2
- 56) Two masses m and M are separated by a distance d . If the distance between the masses is increased to $3d$, how does the gravitational force between them change?
 A) The force will be one-third as great.
 B) The force will be one-ninth as great.
 C) The force will be three times as great.
 D) The force will be nine times as great.
 E) It is impossible to determine without knowing the numerical values of m , M , and d .
- 57) Which force is responsible for holding a car in a *frictionless* banked curve?
 A) the reaction force to the car's weight
 B) the vertical component of the car's weight
 C) the vertical component of the normal force
 D) the horizontal component of the car's weight
 E) the horizontal component of the normal force
- 58) Which force is responsible for holding a car in an *unbanked* curve?
 A) the car's weight
 B) the force of friction
 C) the reaction force to the car's weight
 D) the vertical component of the normal force
 E) the horizontal component of the normal force
- 59) A car with kinetic energy $8 \times 10^6 \text{ J}$ travels along a horizontal road. How much work is required to stop the car in 10 s ?
 A) zero B) $8 \times 10^4 \text{ J}$ C) $8 \times 10^5 \text{ J}$ D) $8 \times 10^6 \text{ J}$ E) $8 \times 10^7 \text{ J}$
- 60) A helicopter of $m = 1250 \text{ kg}$ is cruising at a speed of 25 m/s at an altitude of 185 m . What is the total mechanical energy of the helicopter?
 A) $3.91 \times 10^5 \text{ J}$
 B) $2.66 \times 10^6 \text{ J}$

- C) 2.27×10^6 J
D) 6.18×10^5 J
E) 1.88×10^6 J
- 61) The Starship Enterprise has mass m has a speed v . At some instant, it separates into two pieces, each of mass $0.5m$. One of the pieces is at rest just after the separation. Which one of the following statements concerning this situation is true?
A) The moving piece has speed $2v$.
B) This process conserves kinetic energy.
C) The piece at rest possesses kinetic energy.
D) The process does not conserve total energy.
E) This process does not conserve momentum.
- 62) A car travels in a circular path with constant speed. Which one of the following quantities is constant and *non-zero* for this car?
A) linear velocity
B) angular velocity
C) centripetal acceleration
D) angular acceleration
E) total acceleration
- 63) A spinning star begins to collapse under its own gravitational pull. Which one of the following occurs as the star becomes smaller?
A) Its angular velocity decreases.
B) Its angular momentum increases.
C) Its angular velocity remains constant.
D) Its angular momentum remains constant.
E) Both its angular momentum and its angular velocity remain constant.
- 64) Complete the following statement: *Bimetallic strips* used as adjustable switches in electric appliances consist of metallic strips that must have different
A) mass
B) length
C) volume
D) expansion coefficients
E) specific heat capacities
- 65) The space between the inner walls of a thermos bottle is close to a vacuum to minimize heat transfer by
A) radiation.
B) conduction.
C) conduction and convection.
D) conduction and radiation.
E) conduction, convection, and radiation.

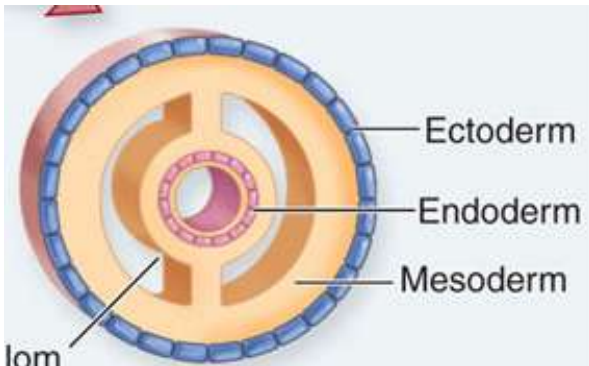
- 66) A sample of neon gas at $20\text{ }^{\circ}\text{C}$ is confined to a cylinder with a movable piston. It is then heated until its pressure is doubled. What is the final temperature of the gas?
- A) $10\text{ }^{\circ}\text{C}$
 B) $40\text{ }^{\circ}\text{C}$
 C) $313\text{ }^{\circ}\text{C}$
 D) $586\text{ }^{\circ}\text{C}$
 E) This cannot be found since the final and initial volumes are unknown.
- 67) An *isobaric* process is represented on a *pressure-volume* graph by which one of the following curves?
- A) a parabola
 B) a hyperbola
 C) a vertical line
 D) a horizontal line
 E) a circle
- 68) A guitar string of length L is clamped at both ends. Which one of the following is not a possible wavelength for standing waves on this string?
- A) $L/2$
 B) $2L/3$
 C) L
 D) $2L$
 E) $4L$
- 69) Two positive point charges Q_a and Q_b are separated by a distance R . If the charge Q_a experiences a force of magnitude F when the separation is R , what is the magnitude of the force on the charge Q_b when the separation is $2R$?
- A) $F/4$
 B) $F/2$
 C) F
 D) $2F$
 E) $4F$
- 70) What is the correct order, shortest to longest wavelength, of the following colors in the visible light spectrum: blue, green, red, violet, and yellow?
- A) red, yellow, blue, green, violet
 B) violet, blue, yellow, red, green
 C) red, yellow, green, blue, violet
 D) violet, blue, green, yellow, red
 E) red, blue, violet, green, yellow
- 71) A beam of light passes from air into water. Which is necessarily true?
- A) The frequency is unchanged and the *wavelength increases*.
 B) The frequency is unchanged and the *wavelength decreases*.
 C) The wavelength is unchanged and the *frequency decreases*.
 D) Both the wavelength and frequency *increase*.
 E) Both the wavelength and frequency *decrease*.
- 72) A diffraction grating which has 4500 lines/cm is illuminated by light which has a single wavelength. If a second order maximum is observed at an angle of 42° with respect to the central maximum, what is the wavelength of this light?
- A) 1500 nm
 B) 370 nm
 C) 930 nm
 D) 1100 nm
 E) 740 nm
- 73) Complete the following statement: The results of special relativity indicate that
- A) Newtonian mechanics is a valid approximation at low speeds ($v \ll c$).
 B) the laws of electromagnetism are invalid at speeds that are comparable to that of light.
 C) Newtonian mechanics is an incorrect theory under all conditions.
 D) moving clocks run fast compared to when they are at rest.
 E) moving objects appear to be longer than when they are at rest.

74) Which one of the following processes is illustrated by the reaction:



- A) beta decay
B) alpha decay
C) gamma decay
D) neutrino emission
E) positron emission
- 75) Which one of the following types of nuclear radiation is not affected by a magnetic field?
A) alpha particles
B) β^- particles
C) gamma rays
D) β^+ particles
E) helium nuclei
- 76) An agent would make a good antibiotic if it affected a structure or process only found in bacterial cells and not in our (eukaryotic) cells. Which of the following actions would theoretically make a good candidate antibiotic?
A) prevents repair of the peptidoglycan cell wall
B) damages the nuclear membrane
C) damages DNA
D) prevents ribosomes from producing proteins
E) stops cellular respiration
- 77) The endosymbiotic hypothesis argues that prokaryotes became some of the organelles of early eukaryotic cells. This would be supported by what evidence?
A) The vacuoles can "come and go" across the plasma membrane.
B) The mitochondria and chloroplasts have their own DNA.
C) Mitochondria and chloroplasts are nearly identical to some free living prokaryotes.
D) The mitochondria and chloroplasts have their own DNA AND are nearly identical to some free living prokaryotes.
E) Prokaryotes lack a nucleus.
- 78) Radioactive isotopes are used to tag proteins in the cell membranes of mouse cells. These cells are then fused with human cells in cultures. What is the likely consequence of the tagged mouse proteins?
A) The tagged proteins remain in the mouse cells and keep their position on the membrane.
B) The tagged proteins remain in mouse cells but move anywhere across the mouse cell membrane.
C) The tagged proteins drift across cell membranes and are soon found dispersed across both human and mouse cell membranes.
D) None of these will occur since mouse cell membranes are unlike human cell membranes.
E) None of these will occur since radioactive cells will soon die.
- 79) Which is a correct example of tonicity?
A) Water is hypertonic to red blood cells.
B) Turgor pressure is created when a plant cell swells in a hypotonic solution.

- C) Plasmolysis results from plant cells in hypotonic solutions.
- D) Crenated red blood cells result when they are placed in a hypotonic solution.
- E) If a cell is placed in a hypertonic solution, water enters the cell.



80) lcm

The body cavity seen in the diagram above would be referred to as:

- A) acoelomate
- B) pseudocoelomate
- C) epicoelomate
- D) coelomate
- E) none of the above

Use the following information for questions #81 and 82.

A problem facing many lakes is eutrophication. In this process plant growth increases dramatically and leads to lakes filling in and becoming marshes and bogs prematurely. You wish to design an experiment to test eutrophication. You obtain four aquaria, add some plants to both and some clean well water. To the first aquarium you add no fertilizer. To the other three aquaria you add 1 g/L, 5 g/L and 10 g/L fertilizer. You place the four aquaria under some lights and measure the mass of the plants in the aquaria every week for three weeks.

- 81) What is the dependent variable in your experiment.
 - A) the fertilizer
 - B) the light
 - C) the aquarium with no fertilizer added
 - D) the mass of the plants
 - E) the well water
- 82) What is the independent variable in your experiment.
 - A) the fertilizer
 - B) the light
 - C) the aquarium with no fertilizer added
 - D) the mass of the plants
 - E) the well water
- 83) The Golgi apparatus apparently directs its protein products to the correct location in the cell based on
 - A) which sugar chain is added and the sugar chain determines the destination in the cell.

- B) the DNA extending its long molecular helix to direct the protein through the Golgi apparatus and on to the final destination.
 - C) vesicles that constantly shuttle back-and-forth from the various cell destinations and these vesicles determine which protein in the Golgi apparatus to pick up and deliver.
 - D) proteins drifting away in all directions and are only used at the cell sites that need them.
- 84) The *lac* operon in *E. coli*
- A) regulates the rate of binary fission
 - B) coordinates the production of tryptophan-utilizing enzymes when it is present
 - C) uses activators to initiate the production of enzymes that break down lactose
 - D) prevents lactose-utilizing enzymes from being expressed when lactose is absent from the environment
 - E) allows the bacterium to resist antibiotics in the penicillin family
- 85) Some herbicides inhibit the electron transport chain in the thylakoid membrane. How would this affect the Calvin cycle reactions?
- A) ATP would not be produced and as a result, the Calvin cycle reactions would not occur.
 - B) CO₂ would not enter the cell as a result and the Calvin cycle reactions would not occur.
 - C) RuBP carboxylase would not function properly so CO₂ fixation would not occur.
 - D) Sunlight could no longer be used by the chloroplast, but this would have no effect on the Calvin cycle reactions because they do not require light.
 - E) Since the Calvin cycle reactions occur in a different part of the chloroplast, there would be no effect.
- 86) You need to identify a plant but it is winter and the leaves have fallen to the ground mixed with others. The parts of flowers, fruits, and seed leaves of germinating seeds are not available either. Your best clue to whether it is a monocot or a eudicot is to
- A) inspect the stem for woody bark since only eudicots have woody tissue.
 - B) determine if there are parallel xylem tubes in the stem which indicates it is a monocot.
 - C) determine if the roots lack phloem and xylem which indicates a monocot.
 - D) cut the stem and if the vascular bundles are in a distinct ring, it is a monocot.
 - E) cut the stem and if the vascular bundles are scattered in the stem, it is a monocot.
- 87) Apoptosis involves
- A) normal internal enzymes that must be held in check by inhibitors.
 - B) the protein *p53* which brings about apoptosis in mammalian cells if DNA is not

- repaired.
- C) executioner enzymes that tear apart the cytoskeleton and chop up DNA.
 - D) caspase enzymes that act as initiators.
 - E) All of the choices are correct.
- 88) Considering the compounds $\text{Cu}^{2+}\text{O}^{2-}$, $\text{Al}^{3+}\text{Cl}_3^-$, and CO_2 , which elements have been oxidized?
- A) copper (Cu), aluminum (Al), and carbon (C)
 - B) only those with a charge sign
 - C) only Cu^{2+} and Al^{3+}
 - D) only oxygen
 - E) only carbon
- 89) You collect a protist from a rotting log and grow it in a petri dish containing *E. coli*, which it engulfs. For a while the protists multiply as single cells. Then the protists aggregate to form a clump, which rises up to become a stalked structure with a globular head. What kind of protist have you got?
- A) a cellular slime mold
 - B) an actinomycete
 - C) a water mold
 - D) an oomycete
 - E) a free-living amoeba
- 90) You work for a company that manufactures food products. A new “wonder food” is being distributed by a rival company. The researchers in your company determine that the “wonder food” contains only carbon, oxygen, and hydrogen. At this point, your researchers can say with certainty that the food
- A) includes proteins
 - B) includes nucleic acids
 - C) could only be made of carbohydrates
 - D) does not include proteins or nucleic acids
 - E) could only be made of triglycerides
- 91) Which reaction actually uses NADPH and ATP from the light reactions?
- A) $\text{PGAL} \rightarrow \text{RuBP}$
 - B) $\text{CO}_2 + \text{RuBP} \rightarrow \text{6 carbon molecule}$
 - C) $\text{PGAL} \rightarrow \text{glucose phosphate}$
 - D) $\text{PGAL} \rightarrow \text{PGA}$
 - E) $\text{PGA} \rightarrow \text{PGAL}$
- 92) In the 1920's, Frederick Griffith conducted an experiment in which he mixed the dead cells of a bacterial strain that can cause pneumonia with live cells of a bacterial strain that cannot. When he cultured the live cells, some of the daughter colonies proved able to cause pneumonia. Which of the following processes of bacterial DNA transfer does this experiment demonstrate?
- A) transduction
 - B) crossing over
 - C) conjugation
 - D) transformation
 - E) transposition
- 93) Which of the following statements regarding DNA packing is *false*?
- A) DNA packing tends to promote gene expression.
 - B) A nucleosome consists of DNA wound around a protein core of eight histone molecules.

- C) Histones account for about half the mass of eukaryotic chromosomes.
 D) Prokaryotes have proteins analogous to histones.
 E) Highly compacted chromatin is generally not expressed at all.
- 94) Which of the following is primarily responsible for limiting the number of trophic levels in most ecosystems?
 A) Many primary and higher-order consumers are opportunistic feeders.
 B) Most predators require large home ranges.
 C) Nutrient cycles involve both abiotic and biotic components of ecosystems
 D) Nutrient cycling rates tend to be limited by decomposition.
 E) Each energy transfer is less than 100% efficient.
- 95) During chordate evolution, what is the sequence (from earliest to most recent) in which the following structures arose?
 1. amniotic egg
 2. paired fins
 3. jaws
 4. swim bladder
 5. four-chambered heart
 A) 2, 3, 4, 1, 5
 B) 3, 2, 4, 1, 5
 C) 3, 2, 1, 4, 5
 D) 2, 1, 4, 3, 5
 E) 2, 4, 3, 1, 5
- 96) During glycolysis, when glucose is catabolized to pyruvate, most of the energy of glucose is
 A) transferred to ADP, forming ATP.
 B) transferred directly to ATP.
 C) retained in the pyruvate.
 D) stored in the NADH produced.
 E) used to phosphorylate fructose to form fructose-6-phosphate.
- 97) Measurements of the amount of DNA per nucleus were taken on a large number of cells from a growing fungus. The measured DNA levels ranged from 3 to 6 picograms per nucleus. In which stage of the cell cycle was the nucleus with 6 picograms of DNA?
 A) G₀ B) G₁ C) S D) G₂ E) M
- 98) If the genotype of an organism is YySsTt, then yST would represent
 A) the genotype of the offspring.

- B) a possible phenotype of the offspring.
 - C) a gamete of the parent.
 - D) a possible zygote.
 - E) the P generation.
- 99) Which plant hormone will act as an inhibitor of growth and maintains dormancy?
- A) auxin
 - B) indoleacetic acid
 - C) gibberellin
 - D) cytokinin
 - E) abscisic acid
- 100) Which statement is NOT true about the founder effect?
- A) It is a form of genetic drift.
 - B) It produces a high frequency of some rare alleles in a small isolated population.
 - C) Founding members contain a tiny fraction of the alleles found in the original population.
 - D) The founder effect occurs when a population is subjected to near extinction and then recovers, so that only a few alleles are left in survivors.

The End