

Question Source:

Indiana Core Assessments Physical Science Sample Test

As scientists in the twentieth century worked to develop a model of the atom, which of the following best describes a common strategy they employed?

- a. They disregarded the work of previous researchers in developing their own unique ideas.
- b. They used mathematical analysis in place of empirical methods to develop their theories.
- c. They compared the data generated by their experiments against the predicted results.
- d. They proposed ideas from outside the field of physics to challenge conventional perspectives.

Correct Response: C.

This question requires the examinee to demonstrate knowledge of the formulation of testable hypotheses and the principles and procedures for designing and conducting scientific investigations. Like scientists in many other fields, the scientists investigating the nature of matter during the twentieth century evaluated their ideas by comparing the results of their experiments to the experimental outcomes predicted by their various models.

Question Source:

Indiana Core Assessments Physical Science Sample Test

While studying the reactants and products of chemical reactions such as combustion, the eighteenth-century scientist Antoine Lavoisier conducted pioneering studies in stoichiometry. His efforts to quantify the reactants and products of chemical reactions led Lavoisier to prove which of the following?

- a. Matter is conserved in chemical reactions.
- b. Energy is produced during combustion reactions.
- c. Chemical reactions produce new compounds.
- d. Combustion increases the entropy of a system.

Correct Response: A.

This question requires the examinee to demonstrate knowledge of the historical development of important ideas in science from different periods and cultures. Antoine Lavoisier is one of the first chemists to precisely measure the reactants and products in combustion reactions and publish his work. This work provided evidence that although some substances may not be easily accounted for (e.g., a gas given off during a combustion reaction), matter is always conserved in chemical reactions.

Question Source:

Indiana Core Assessments Physical Science Sample Test

Which of the following best describes how the quantum mechanical model of the atom differs from the Bohr model of the atom?

- a. It takes into account the wave properties of electrons.
- b. It focuses primarily on the movement of electrons in the hydrogen atom.
- c. It proves that electrons can both absorb and emit energy.
- d. It reveals that different energy levels contain a defined amount of energy.

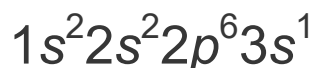
Correct Response: A.

This question requires the examinee to demonstrate knowledge of the characteristics and arrangement of subatomic particles and historical and contemporary models of the atom. Although the Bohr model of the atom accounted for the stability of atoms and the quantization of energy in discrete packets, the quantum mechanical model of the atom introduced the idea that particles with mass, such as electrons, can have both wave and particle properties.

Question Source:

Indiana Core Assessments Physical Science Sample Test

Use the configuration below to answer the question that follows.



The ground state electron configuration for sodium is shown. Given this information, which of the following can be concluded about the distribution of electrons in the sodium atom?

- a. Five electrons are unpaired electrons.
- b. More electrons are located in p orbitals than in s orbitals.
- c. All of the electrons are located far from the nucleus.
- d. Twelve electrons are located in p orbitals.

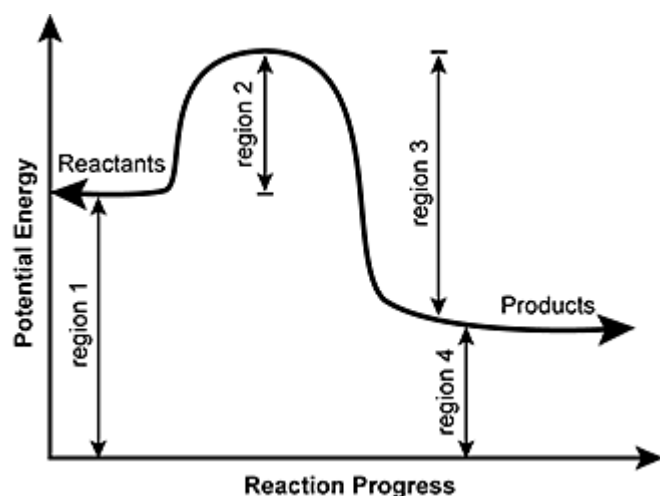
Correct Response: B.

This question requires the examinee to demonstrate knowledge of atomic orbitals and the electron configuration of atoms and ions. In quantum mechanics, electron configurations are used to represent the distribution of electrons. The number of electrons in a particular orbital is designated by the superscripted number to the right of the letter designating the particular orbital. In the example given in the question, there are 5 electrons in s orbitals and 6 electrons in the p orbital.

Question Source:

Indiana Core Assessments Physical Science Sample Test

Use the diagram below to answer the question that follows.



The potential energy diagram for a reaction is shown. Which of the following regions of the curve would be most affected by the addition of a catalyst to the reaction mixture?

- a. region 1
- b. region 2
- c. region 3
- d. region 4

Correct Response: B.

This question requires the examinee to demonstrate knowledge of the principles of chemical kinetics and chemical equilibrium. A catalyst is a substance that increases the rate of a chemical reaction. Region 2 shown in the diagram depicts the activation energy required for the reaction to occur. By introducing a catalyst to the reaction mixture, the activation energy required for the reaction to proceed is lowered.

Question Source:

Indiana Core Assessments Physical Science Sample Test

Use the equation below to answer the question that follows.



How many grams of H_2 will be produced when 5.00 g of Na are reacted according to the chemical equation shown?

- a. 0.109 g
- b. 0.220 g
- c. 1.24 g
- d. 2.50 g

Correct Response: B.

This question requires the examinee to demonstrate knowledge of the mole concept and its use in chemical calculations. To calculate the grams of H_2 that will be produced when 5.00 grams of Na are reacted, the following calculations are carried out.

First the number of moles of Na reacted is calculated:

$$5.00 \text{ g Na} \times \frac{1 \text{ mol Na}}{23.0 \text{ g Na}} = 0.217 \text{ mol Na.}$$

Next, the stoichiometric relationship between Na and H_2 is used to calculate the moles of H_2 produced when 0.217 moles of Na reacts completely:

$$0.217 \text{ mol Na} \times \frac{1 \text{ mol H}_2}{2 \text{ mol Na}} = 0.109 \text{ mol H}_2$$

Finally, the number of grams of H_2 produced is calculated:

$$0.109 \text{ mol H}_2 \times \frac{2.02 \text{ g H}_2}{1 \text{ mol H}_2} = 0.220 \text{ g H}_2.$$

Question Source:

Indiana Core Assessments Physical Science Sample Test

Use the table below to answer the question that follows.

Thermodynamic Property	Value
heat of fusion of water	334 J/g
heat of vaporization of water	2260 J/g
specific heat of liquid water	4.184 J/g•K

How much heat is absorbed by a 41 g sample of H₂O when its temperature is raised from 15°C to 25°C?

- a. 1.7 kJ
- b. 2.5 kJ
- c. 4.3 kJ
- d. 6.9 kJ

Correct Response: A.

This question requires the examinee to demonstrate knowledge of the concepts of heat and temperature and the principles of calorimetry. Raising the temperature of water from 15°C to 25°C does not involve a phase change. As a result, the formula $q = mS\Delta T$ can be used to calculate the amount of heat absorbed by the 41 g of H₂O. In this example, the mass of

$$\frac{4.184 \text{ J}}{\text{g} \cdot \text{K}}$$

water (m) is 41 g, the specific heat of liquid water (S) is

and the change in the sample's temperature (ΔT) is 10°C. The temperature difference in kelvins is equivalent to the temperature difference in degrees Celsius because the two scales have units of equal magnitude. The amount of heat absorbed by the sample is

$$41 \text{ g H}_2\text{O} \times \frac{4.184 \text{ J}}{\text{g} \cdot \text{K}} \times 10 \text{ K} = 1.7 \text{ kJ.}$$

calculated as follows:

Question Source:

Indiana Core Assessments Physical Science Sample Test

Use the equation below to answer the question that follows.

$$\Delta G^{\circ} = \Delta H^{\circ} - T\Delta S^{\circ}$$

The equation shown can be used to calculate the free energy change for a chemical reaction. Chemical reactions with positive ΔG° values are nonspontaneous, while those with negative ΔG° values are spontaneous. Given this information, which of the following best describes the spontaneity of a reaction with the values $\Delta H^{\circ} = 178 \text{ kJ/mol}$ and $\Delta S^{\circ} = 161 \text{ J/K}\cdot\text{mol}$?

- a. The reaction is nonspontaneous only at high temperatures.
- b. The reaction is spontaneous at all temperatures.
- c. The reaction is nonspontaneous at all temperatures.
- d. The reaction is spontaneous only at high temperatures.

Correct Response: D.

This question requires the examinee to demonstrate knowledge of free energy and the spontaneity of chemical reactions. The spontaneity of the reaction can be assessed by substituting the values of ΔH° and ΔS° into the equation for free energy change and then evaluating the temperature at which the reaction becomes spontaneous. Before doing this, however, the units for both ΔH° and ΔS° need to be the same. When these values are substituted into the equation, it is determined that temperatures greater than 1,105.6 K are required for the value of ΔG° to be less than zero. This determination indicates that the reaction is spontaneous only at high temperatures.

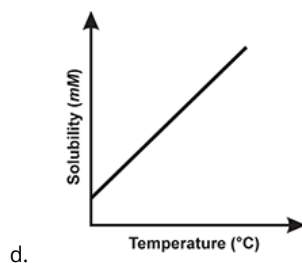
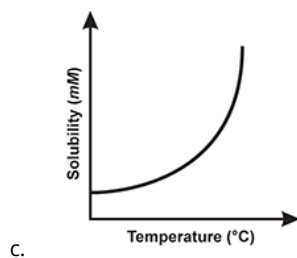
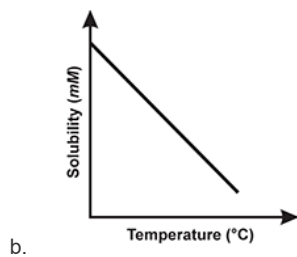
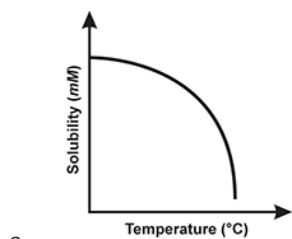
Question Source:

Indiana Core Assessments Chemistry Sample Test

Use the table below to answer the question that follows.

Temperature (°C)	Solubility (mM)
5	5.0
15	4.5
25	4.0
35	3.5
45	3.0
55	2.5

Which of the following line graphs best represents the data shown in the table?



Correct Response: B.

This question requires the examinee to demonstrate knowledge of the analysis, interpretation, and communication of scientific data. The data in the table show that solubility decreases as temperature increases. This decrease in solubility is linear. The graph best representing this trend is the one with a straight line having a negative slope.

Question Source:

Indiana Core Assessments Chemistry Sample Test

Cell theory is based on the fundamental tenets that all living organisms are made up of cells, cells are the fundamental unit of life, and cells arise from preexisting cells. When this theory was first proposed in the mid-1800s, it was met with skepticism. Which of the following statements best explains the source of this skepticism?

- a. Microscopes had not yet been invented.
- b. Many scientists of that time believed in spontaneous generation.
- c. The scientific method was not widely accepted at that time.
- d. Science was still deeply rooted in the principles of alchemy.

Correct Response: B.

This question requires the examinee to demonstrate knowledge of the basic concepts and major principles of life science. Cell theory is widely accepted by scientists today. However, in the mid-1800s, many scientists still believed that living organisms formed spontaneously from nonliving matter. This belief was irreconcilable with the new idea that cells form only from preexisting cells. The conflict between these points of view led to skepticism of cell theory.

Question Source:

Indiana Core Assessments Chemistry Sample Test

Which of the following pairs of ions is arranged in order of increasing ionic radius?

- a. Cl^- , K^+
- b. Fe^{2+} , Fe^{3+}
- c. O^{2-} , S^{2-}
- d. Mg^{2+} , Al^{3+}

Correct Response: C.

This question requires the examinee to demonstrate knowledge of the relationship between subatomic particles and the organization of the periodic table. The size of an ion is determined by its nuclear charge, the total number of electrons, and the principal quantum number of the orbitals occupied by its valence electrons. For ions in the same group of the periodic table that carry the same charge, ionic radius increases from the top of the column to the bottom of the column. This is primarily due to differences in the principal quantum numbers of the valence electron orbitals. Of the ion pairs shown, O^{2-} has a smaller ionic radius than S^{2-} .

Question Source:

Indiana Core Assessments Chemistry Sample Test

Use the equation below to answer the question that follows.



What is the missing product in the nuclear reaction shown?

- a. alpha particle
- b. positron
- c. beta particle
- d. gamma ray

Correct Response: B.

This question requires the examinee to demonstrate knowledge of the types of emissions resulting from radioactive decay. In the nuclear equation shown, the atomic number decreases by 1 and the mass number remains unchanged. The emission of a

positron $\left(\begin{smallmatrix} 0 \\ 1 \end{smallmatrix} e \right)$ is consistent with these changes and it will lead to a balanced nuclear equation.

Question Source:

Indiana Core Assessments Chemistry Sample Test

According to kinetic molecular theory, particles in which of the following gas samples will display the greatest average speed at 300 K?

- a. 1 mol He
- b. 1 mol O₂
- c. 1 mol Kr
- d. 1 mol Cl₂

Correct Response: A.

This question requires the examinee to demonstrate knowledge of the principles of kinetic molecular theory. While all gases at the same temperature have the same average kinetic energy, they all do not have the same average speed. The molar mass of a gas has a considerable effect on its root-mean-square speed (u_{rms}) as shown in the following equation where R is the ideal gas

$$u_{\text{rms}} = \sqrt{\frac{3RT}{\text{molar mass}}}$$

constant and T is temperature in kelvins: . While root-mean-square speed (u_{rms}) is not the average speed, it is a close approximation of it, and it can be used to compare the average speeds of a group of gases at the same temperature. As the equation shows, the gas with the smallest molar mass will have the greatest root-mean-square speed (u_{rms}). The molar mass of helium is less than the molar masses of the other gas samples. As a result, it will have the greatest average speed at 300K.

Question Source:

Indiana Core Assessments Chemistry Sample Test

The pressure of 2.00 mol of Xe in a 0.500 L sealed vessel at -5.00°C predicted by the ideal gas equation is nearly three times greater than the actual gas pressure in the vessel. Which of the following responses best explains this difference between theoretical and actual gas pressures?

- a. The volume of space occupied by the Xe atoms increases at low temperatures.
- b. The interactions between Xe atoms become more elastic at low temperatures.
- c. The speed at which the Xe atoms travel in the vessel increases at low temperatures.
- d. The attractive forces between Xe atoms become significant at low temperatures.

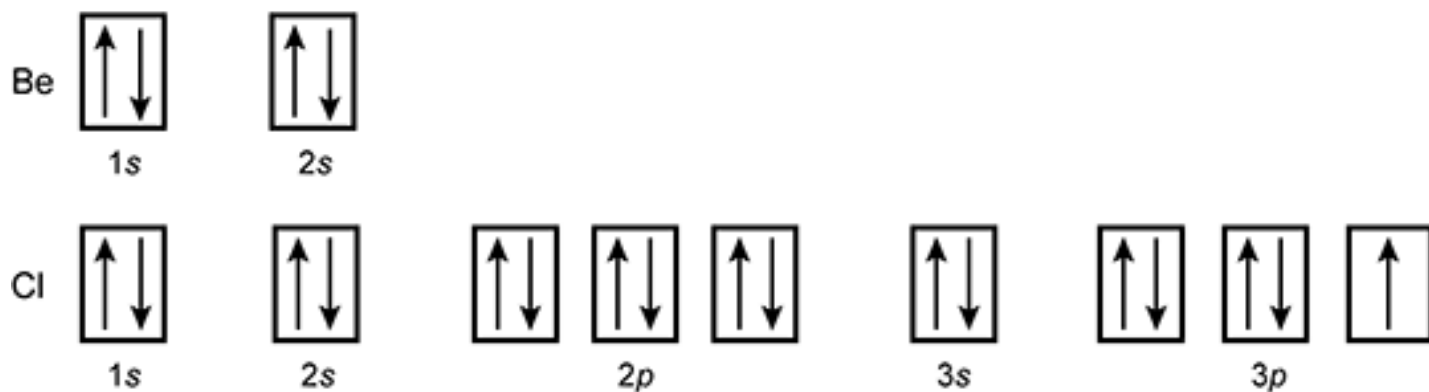
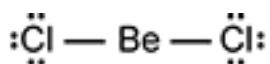
Correct Response: D.

This question requires the examinee to demonstrate knowledge of the application of the gas laws to chemical systems. Pressures calculated using the ideal gas equation are based on the assumption that gas molecules do not interact with one another. This assumption does not always hold true at low temperatures. As the temperature decreases, the kinetic energy of the gas molecules decreases and the attractive forces between molecules become significant. As a result, colliding gas molecules do not bounce off one another with as much force as they do at higher temperatures. This leads to an observed pressure that is less than the pressure predicted by the ideal gas equation.

Question Source:

Indiana Core Assessments Chemistry Sample Test

The Lewis structure for BeCl_2 vapor and the orbital diagrams for Be and Cl are shown below.



This information indicates that each Be–Cl bond in BeCl_2 vapor is formed by the overlap of a $3p$ orbital from Cl and:

- a. a $2p$ orbital from Be.
- b. a $2s$ orbital from Be.
- c. an sp^2 hybridized orbital from Be.
- d. an sp hybridized orbital from Be.

Correct Response: D.

This question requires the examinee to demonstrate knowledge of the application of the valence-shell electron-pair repulsion (VSEPR) model and valence bond theory. The Lewis structure of BeCl_2 shows that Be forms two equivalent covalent bonds with the Cl atoms. Each Cl atom has a partially filled $3p$ orbital that is involved in forming these bonds. However, the Be atom has a filled $2s$ orbital. In order to form two equivalent bonds with the Cl atoms, the $2s$ and a $2p$ orbital of Be hybridize to form two sp hybrid orbitals. Each covalent bond forms when a partially-filled $3p$ orbital of Cl overlaps with a partially-filled sp orbital of Be.

Question Source:

Indiana Core Assessments Chemistry Sample Test

Use the table below to answer the question that follows.

Liquid	Surface Tension (mN/m) at 25°C
C ₈ H ₁₈	21.14
CH ₃ COOH	27.10
Br ₂	40.95
Hg	485.48

The surface tensions for four liquids at 25°C are shown in the table. The significantly greater surface tension of Hg can be attributed to which of the following phenomena?

- a. the lack of hydrogen bonding between atoms in liquid Hg
- b. the low atomic weight of Hg relative to the molecular weights of the other liquids
- c. the presence of metallic bonding between Hg atoms
- d. the compact shape of Hg atoms compared to those in the other liquids

Correct Response: C.

This question requires the examinee to demonstrate knowledge of the relationship between intermolecular forces and the properties of matter. Molecules or atoms at the surface of a liquid are packed more closely together than molecules or atoms within the liquid. This is caused by forces pulling the surface molecules or atoms inward. The effect of this force is a reduction in the surface area of the liquid. Surface tension is a reflection of the strength of this inward force, and it specifically refers to the energy needed to increase the surface area by a specified unit of area. Substances with strong intermolecular attractive forces have a high surface tension. Mercury is a substance whose atoms are held together by strong metallic bonds. It is the presence of these bonds that causes mercury's surface tension to be significantly greater than those of the other substances listed in the table.

Question Source:

Indiana Core Assessments Chemistry Sample Test

Use the chemical equation below to answer the question that follows.



Experimental data have revealed that the chemical reaction shown is first order in Cl_2 and second order in NO . On the basis of this information, which of the following changes to a given set of experimental conditions will double the initial rate of the reaction?

- a. increasing the concentration of Cl_2 by a factor of 2 and holding the NO concentration constant
- b. increasing the concentration of NO by a factor of 2 and holding the Cl_2 constant
- c. increasing the concentrations of both Cl_2 and NO by a factor of 2
- d. increasing the concentration of Cl_2 by a factor of 2 and the concentration of NO by a factor of 4

Correct Response: A.

This question requires the examinee to demonstrate knowledge of chemical kinetics, including reaction rates, rate constants, rate laws, and reaction order. Reaction order refers to the value of the exponents for the reactant concentrations in a rate law expression. On the basis of the information provided, the rate law expression for this reaction is $\text{rate} = k[\text{Cl}_2][\text{NO}]_2$. Given this rate law, the set of conditions that will lead to a doubling of the initial reaction rate is the one in which the concentration of Cl_2 is doubled and the concentration of NO is held constant.

Question Source:

Indiana Core Assessments Chemistry Sample Test

Use the equation below to answer the question that follows.

$$E^{\circ} = \frac{RT}{nF} \ln K$$

Which of the following types of questions can be answered using the equation shown?

- a. How many grams of product are produced in an electrolysis reaction?
- b. What is the length of time an electrochemical cell will operate before reaching equilibrium?
- c. How much electricity is needed to drive a nonspontaneous reaction?
- d. Are products present in greater amounts than reactants when an electrochemical cell reaches equilibrium?

Correct Response: D.

This question requires the examinee to demonstrate knowledge of the principles and applications of electrochemistry, including electrolytic and galvanic cells, cell potentials, and cell equilibrium. The given equation relates the standard cell potential (E°) of an oxidation-reduction reaction to its equilibrium constant (K). The equation can be used to calculate the value of K for an oxidation-reduction reaction by substituting in values for E° , the ideal gas constant (R), temperature in kelvins (T), the number of electrons transferred (n), and Faraday's constant (F). The value of K provides information about the composition of the reaction mixture at equilibrium, such as whether the formation of products is favored over the formation of reactants.

Question Source:

Indiana Core Assessments Chemistry Sample Test

Use the table below to answer the question that follows.

Bond	Bond Enthalpy (kJ/mol)
C-H	413
C-C	348
C=C	614
C≡C	839

On the basis of the bond enthalpies shown in the table, which of the following combustible compounds possesses the greatest amount of potential energy?

- a. CH_4
- b. $\text{HC}\equiv\text{CH}$
- c. C_3H_8
- d. $\text{H}_2\text{C}=\text{CH}_2$

Correct Response: C.

This question requires the examinee to demonstrate knowledge of the energy changes associated with the formation and breaking of chemical bonds. Bond enthalpy values represent the average amount of energy needed to break a given type of bond in a gaseous molecule. Summing the bond enthalpy values for all of the bonds in a compound provides an estimate of the compound's potential energy. When total bond enthalpy values of equivalent molar amounts of each compound are compared, C_3H_8 is found to have the greatest amount of energy stored in its bonds.

Question Source:

Indiana Core Assessments Chemistry Sample Test

A student adds 25.00 g of a pure metal at 85.00°C to a constant-pressure calorimeter containing 100.0 mL of H₂O and records the change in H₂O temperature. If the temperature of the H₂O increases from 25.00°C to 26.55°C and there is negligible heat loss to the surroundings, what is the specific heat of this metal?

- a. 16.74 J/(g•K)
- b. 11.10 J/(g•K)
- c. 0.4438 J/(g•K)
- d. 0.3052 J/(g•K)

Correct Response: C.

This question requires the examinee to demonstrate knowledge of the use of calorimetry to determine the amount of heat absorbed or released in chemical reactions and physical processes. The specific heat of the metal (s) can be calculated using the equation $q = ms \Delta T$ and solving for s . The heat change for the metal (q), the mass of the metal (m), and the change in temperature (ΔT) are known or can be calculated using the information provided. The heat change for the metal can be determined by

$$\frac{4.184 \text{ J}}{\text{g} \cdot \text{K}}$$

calculating the heat change for the water as follows: $q = 100.0 \text{ g H}_2\text{O} \times \frac{4.184 \text{ J}}{\text{g} \cdot \text{K}} \times 1.55 \text{ K} = 648.5 \text{ J}$. Since the heat absorbed by the water is equal to the heat lost by the metal, the value of q_{metal} is -648.5 J . The temperature of the metal changes from 85.00°C to 26.55°C for a difference of -58.45°C . Since the Celsius scale and the Kelvin scale have units of equal value, a decrease in temperature of 58.45°C is equal to a decrease in temperature of 58.45 K . When the values of q , m , and ΔT for the metal are

$$\frac{0.4438 \text{ J}}{\text{g} \cdot \text{K}}$$

substituted into the equation $q = ms\Delta T$, the specific heat of the metal (s) is determined to be $\frac{0.4438 \text{ J}}{\text{g} \cdot \text{K}}$.

Question Source:

Indiana Core Assessments Chemistry Sample Test

Which of the following characteristics of benzene can be attributed to the presence of pi bonds?

- a. its low solubility in water
- b. its rigid stable molecular structure
- c. its physical state at room temperature
- d. its greater density as a solid than as a liquid

Correct Response: B.

This question requires the examinee to demonstrate knowledge of the composition, structure, and properties of organic compounds. The delocalized pi bonds in benzene are formed by the overlap of partially-filled unhybridized $2p$ orbitals on the six carbon atoms. In order for maximum orbital overlap to occur, the six carbon atoms need to be localized in the same plane. This orientation imparts a rigidity and stability to benzene's molecular structure.

Question Source:

Indiana Core Assessments Chemistry Sample Test

When carbohydrates are not readily available, cells use other molecules as substrates for cellular respiration. Which of the following is an example of one of these alternative substrates?

- a. CO_2
- b. RNA molecules
- c. H_2O
- d. amino acids

Correct Response: D. This question requires the examinee to demonstrate knowledge of cellular respiration and major catabolic pathways. Glucose is the primary substrate used to produce energy in the process of cellular respiration. However, it is not the only substrate for this reaction. Amino acids can also serve as substrates for cellular respiration. The partial degradation of amino acids produces carbon compounds that can be used to form pyruvate, acetyl CoA, and other intermediates of glycolysis and the Krebs cycle.

Question Source:

Indiana Core Assessments Chemistry Sample Test

Chemistry students are using molecular modeling software to support molecular geometry content presented in their textbook. Which of the following best explains how this software could be used to enhance students' understanding of this concept?

- a. Students are more likely to collaborate on problems involving challenging concepts when provided with software tools.
- b. The software provides students with a new way to test their knowledge of chemical nomenclature.
- c. Students consistently show a heightened interest in content that is presented in a digital format.
- d. The ability to represent molecules in three dimensions can help make an abstract concept more concrete.

Correct Response: D.

This question requires the examinee to demonstrate knowledge of strategies and skills for using technological resources to enhance teaching and learning in science. Molecular modeling software can be used to produce three-dimensional representations of compounds. Students can use this software to compare the shapes of compounds having different molecular geometries. This type of technological resource can help make an abstract concept such as molecular geometry more concrete.

Question Source:

Indiana Core Assessments MS Science Sample Test

A team of scientists is reviewing a research paper that has been submitted to a professional science journal for publication. Which of the following problems with the paper would most likely cause the team of reviewers to decide that the paper is not appropriate for publication in a professional scientific journal?

- a. The paper's conclusions are not supported by the presented evidence.
- b. The research does not explicitly disprove previously accepted hypotheses related to the topic.
- c. The hypothesis underlying the research was shown to be incorrect.
- d. The author of the paper is working in an area outside her traditional area of expertise.

Correct Response: A.

This question requires the examinee to demonstrate knowledge of the role of peer review and critical evaluation of the results of scientific investigations, models, and explanations. The peer-review process that is used to evaluate scientific papers submitted to professional journals is designed to ensure the veracity and accuracy of the research and conclusions described in the paper. A critical component of a conclusion presented in a scientific paper is that it is supported by the evidence presented in the paper.

Question Source:

Indiana Core Assessments MS Science Sample Test

Which of the following principles of physics would be most useful for a developer of optical lenses?

- a. wave theory of light
- b. law of refraction
- c. diffraction formula
- d. law of reflection

Correct Response: B.

This question requires the examinee to demonstrate knowledge of the interrelationships between science and technology. The law of refraction, also known as Snell's law, concerns the bending of light as it passes from one transparent medium to another. Underlying this phenomenon is the fact that light travels at different speeds in different media. This is the fundamental principle that must be taken into account when designing optical lenses. Light slows as it enters glass and the angle of refraction is determined by the angle at which the light strikes the glass. Unless the light striking a lens is perpendicular to the surface, the light will be bent as it passes from the air into the lens and again as it passes out of the lens.

Question Source:

Indiana Core Assessments MS Science Sample Test

Chemical reactions obey the law of conservation of mass. This means that a balanced chemical equation must have which of the following on both sides of the equation?

- a. the same number of the same types of molecules
- b. the same subscripts following the same types of elements
- c. the same number of the same types of atoms
- d. the same coefficients preceding the same types of compounds

Correct Response: C.

This question requires the examinee to demonstrate knowledge of the law of conservation of mass and the principles of stoichiometry and their application in balancing chemical equations. The law of conservation of mass states that matter is neither created nor destroyed during a chemical reaction. This means that the number of a particular type of atom on one side of a balanced chemical equation must be equal to the number of that type of atom on the other side of the chemical equation.

Question Source:

Indiana Core Assessments MS Science Sample Test

In which of the following reactions is the entropy of the reaction system increasing?

- a. $\text{CaCO}_3(s) \rightarrow \text{CaO}(s) + \text{CO}_2(g)$
- b. $2\text{SO}_2(g) + \text{O}_2(g) \rightarrow 2\text{SO}_3(g)$
- c. $2\text{Mg}(s) + \text{O}_2(g) \rightarrow 2\text{MgO}(s)$
- d. $\text{H}_2\text{O}(g) \rightarrow \text{H}_2\text{O}(l)$

Correct Response: A.

This question requires the examinee to demonstrate knowledge of energy changes associated with physical processes and chemical reactions and principles and applications of the first and second laws of thermodynamics. Entropy is a measure of the dispersal of energy from a system and can be described as the increasing disorder that always occurs in natural systems over time. Chemical reactions that occur on their own are driven by this tendency to greater disorder. In the question one of the reactions moves from a solid to a gas. In the gaseous state the energy is more dispersed; therefore, entropy is increasing as this reaction occurs.

Question Source:

Indiana Core Assessments MS Science Sample Test

A period in the periodic table consists of the elements that are in the same horizontal row. Elements that are in the same period of the periodic table share which of the following characteristics?

- a. similar electron configurations for their outermost electrons
- b. the same atomic weight and charge
- c. similar proportions of neutrons, protons, and electrons
- d. the same number of electron shells

Correct Response: D.

This question requires the examinee to demonstrate knowledge of the organization of the periodic table and periodic trends in the chemical and physical properties of matter. Elements that are in the same period or row of the periodic table have the same number of electron shells. Moving from left to right across a period of the periodic table, the number of electrons and protons in each consecutive element increases by one. This means that group 2 elements will have one more electron and proton than group 1 elements.

Question Source:

Indiana Core Assessments MS Science Sample Test

Use the chemical equation below to answer the question that follows.



A technician working for a chemical company wants to prepare 2 moles of Zn using the reaction represented in the balanced chemical equation shown. The technician combines 81.4 grams of ZnO and 12.01 grams of C, allows them to react completely at 950°C, and determines the amount of Zn produced. The technician's results show that only 1 mole of Zn has been produced. Which of the following statements best explains this result?

- a. There was not enough C available to react with all of the ZnO.
- b. Half of the mass of ZnO was used to form CO₂.
- c. Only 1 mole of ZnO was used in the reaction mixture.
- d. Combining solid reactants reduces the theoretical yield.

Correct Response: C.

This question requires the examinee to demonstrate knowledge of the mole concept and its application in chemical calculations. In the reaction described in the question the technician reacts 12.01 g of carbon with 81.4 g of zinc oxide. Since the molecular weight of zinc oxide is 81.4 g (equivalent to 1 mole of zinc oxide) and 2 moles of zinc oxide are required to produce 2 moles of zinc, the technician would need 162.8 g of zinc oxide to produce 2 moles of zinc.