

Question Source:

CEOE (Oklahoma) Chemistry Sample Test

Competency 2

In the late eighteenth century, Antoine and Marie Lavoisier conducted a series of experiments involving combustion reactions in sealed glass containers. These experiments were significant primarily because they were the first to document that:

- A. atoms of different elements are present in fixed proportions in a given compound.
- B. combustion involves the splitting of molecules and the recombination of the atoms into different molecules.
- C. the total mass of the products of a reaction equals the total mass of the original substances.
- D. the elemental identities of individual atoms are not changed during a chemical reaction.

Correct Response: C. This question requires the examinee to demonstrate knowledge of the significance of key experiments and individuals in the history of chemistry. The experiments of the Lavoisiers demonstrated that the total mass of the products of a reaction equals the mass of the reactants. These experiments were critical in demonstrating the principle of the conservation of matter.

Question Source:

CEOE (Oklahoma) Chemistry Sample Test

Competency 3

In which of the following natural systems is the scale of the system most critical to its proper functioning?

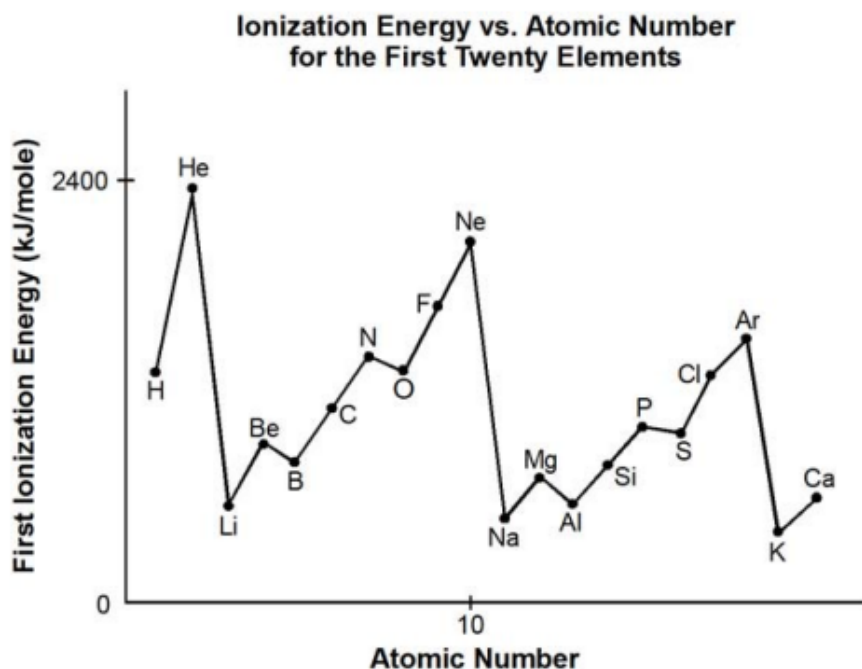
- A. the bones and muscles in the human arm that together operate as a third-class lever
- B. a single-celled organism that uses diffusion to exchange substances with its environment
- C. the side-to-side undulating motion of a snake that allows it to move on land and in water
- D. a turtle's hard upper shell that protects it from predators and environmental stresses

Correct Response: B. This question requires the examinee to demonstrate the ability to apply the concepts of scale to the analysis of scientific phenomena. Diffusion is a spontaneous process in which molecules or ions move from an area of high concentration to one of low concentration. In single-celled organisms, the movement occurs across a semi-permeable membrane. The size of a cell, particularly its surface area to volume ratio, has a significant effect on whether or not diffusion will occur rapidly enough to sustain the metabolic needs of the organism.

Question Source:
CEOE (Oklahoma) Chemistry Sample Test

Competency 5

Use the diagram below to answer the question that follows.



The graph of first ionization energy plotted against atomic number shows that ionization energy is a periodic function. First ionization energy generally increases from alkali metals to noble gases. Exceptions to this general trend can be seen in going from beryllium to boron and from magnesium to aluminum. These two deviations from the line can best be explained by considering each element's:

- A. electron configuration.
- B. atomic radius.
- C. nuclear binding energy.
- D. atomic mass.

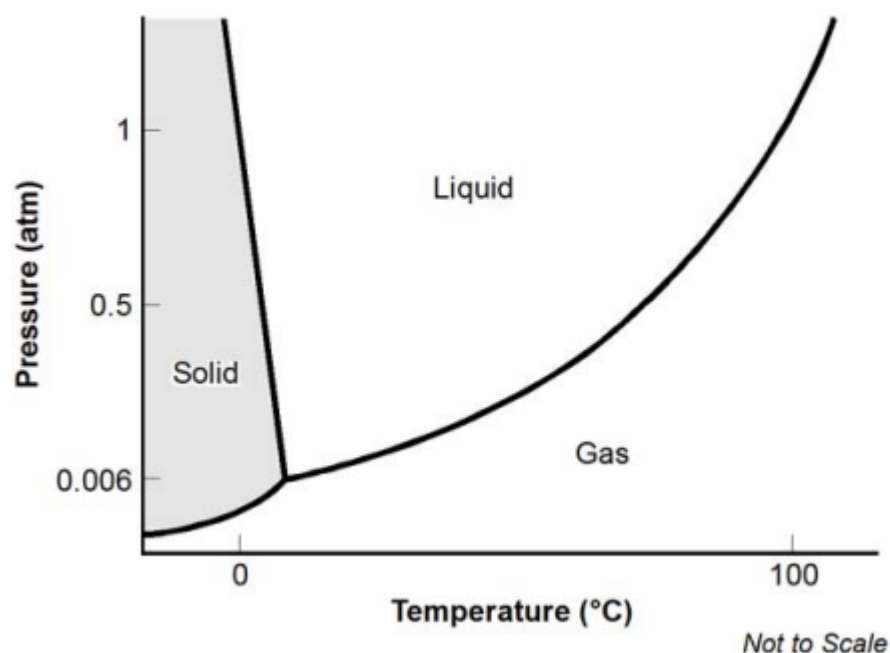
Correct Response: A. This question requires the examinee to demonstrate knowledge of trends within periods and groups in the periodic table. The first ionization energy is the energy required to remove the first electron from an atom in its ground state. In the Group 2 (IIA) elements, which include beryllium and magnesium, the electrons are configured such that there are paired valence electrons in an *s* orbital. Group 13 (IIIA) elements, which include boron and aluminum, have a single electron in the outermost *p* orbital. Less energy is needed to remove a single electron from a *p* orbital than to remove an electron from a filled *s* orbital in the same energy level; therefore, Group 13 (IIIA) elements have lower first ionization energies than Group 2 (IIA) elements.

Question Source:

CEOE (Oklahoma) Chemistry Sample Test

Competency 8

Use the phase diagram below to answer the question that follows.



Which of the following statements is supported by the phase diagram?

- A. The substance sublimates at pressures above 0.006 atm.
- B. The substance's freezing point increases with increasing pressure.
- C. The substance's freezing point is between 0°C and -100°C at pressures below 1 atm.
- D. The substance occurs as a liquid at room temperature and pressure.

Correct Response: D. This question requires the examinee to demonstrate the ability to analyze phase diagrams. In most naturally occurring situations on the earth's surface, the pressure is approximately 1 atmosphere. At a room temperature of approximately 22°C (72°F) and a pressure of 1 atmosphere, the substance will be in a liquid phase.

Question Source:

CEOE (Oklahoma) Chemistry Sample Test

Competency 9

$^{60}_{27}\text{Co}$ has a half-life of 5.27 years. How much of a sample with an original mass of 3.2 μg will remain after 21 years?

- A. 0.03 μg
- B. 0.20 μg
- C. 0.80 μg
- D. 1.60 μg

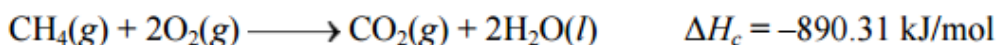
Correct Response: B. This question requires the examinee to demonstrate the ability to solve problems involving the half-life of radioactive materials. Half-life is the length of time it takes half the mass of a sample of radioactive element to decompose. Twenty-one years is equal to approximately four times the half-life of this element. Thus, the sample is reduced first to one-half, then to one-quarter, then to one-eighth, and finally to one-sixteenth its original mass. The mass of sample remaining after 21 years or four half-lives can be calculated by multiplying the original mass by one-sixteenth ($3.2 \mu\text{g} \times \frac{1}{16} = 0.20 \mu\text{g}$).

Question Source:

CEOE (Oklahoma) Chemistry Sample Test

Competency 11

Use the information below to answer the question that follows.



ΔH_f for $\text{CO}_2(g)$ is -393.51 kJ/mol

ΔH_f for $\text{H}_2\text{O}(l)$ is -285.81 kJ/mol

The combustion of methane forms carbon dioxide and water as shown above. Which of the following expressions represents the heat of formation for methane?

- A. $[-393.51 + 2(-285.81) + (-890.31)] \text{ kJ/mol}$
- B. $[-890.31 + (-393.51) - 2(-285.81)] \text{ kJ/mol}$
- C. $[-393.51 + 2(-285.81) - (-890.31)] \text{ kJ/mol}$
- D. $[-890.31 - (-393.51) + 2(-285.81)] \text{ kJ/mol}$

Correct Response: C. This question requires the examinee to demonstrate the ability to solve problems involving energy changes during chemical reactions. The combustion of 1 mole of CH_4 produces 1 mole of CO_2 and 2 moles of H_2O . The heat of formation of methane (CH_4) is equal to the sum of the heats of formation (ΔH_f) of the products minus the heat of combustion (ΔH_c) of methane. Thus the heat of formation of methane is equal to $(\Delta H_f \text{CO}_2(g) + 2\Delta H_f \text{H}_2\text{O}(l) - \Delta H_c \text{CH}_4(g))$. The 2 moles of O_2 gas is omitted from the calculation because elements in their standard states have a heat of formation of zero.

Question Source:

CEOE (Oklahoma) Chemistry Sample Test

Competency 16

Which of the following is an oxidation-reduction reaction?

- A. $\text{HCl}(aq) + \text{H}_2\text{O}(l) \longrightarrow \text{H}_3\text{O}^+(aq) + \text{Cl}^-(aq)$
- B. $\text{NaCl}(aq) + \text{AgNO}_3(aq) \longrightarrow \text{AgCl}(s) + \text{NaNO}_3(aq)$
- C. $2\text{HNO}_3(aq) + \text{MgO}(s) \longrightarrow \text{Mg}(\text{NO}_3)_2(aq) + \text{H}_2\text{O}(l)$
- D. $2\text{H}_2\text{O}_2(aq) \longrightarrow 2\text{H}_2\text{O}(l) + \text{O}_2(g)$

Correct Response: D. This question requires the examinee to demonstrate the ability to analyze processes that occur during oxidation-reduction reactions. An oxidation-reduction reaction is characterized by the transfer of electrons. By assigning oxidation numbers to the elements in the reactions, it can be seen that in the reaction $2\text{H}_2\text{O}_2(aq) \longrightarrow 2\text{H}_2\text{O}(l) + \text{O}_2(g)$ the oxidation number of oxygen changes from -1 in the H_2O_2 molecule to -2 in the H_2O molecule and 0 in the O_2 molecule, indicating a transfer of electrons. This reaction is the only one of those given in which the oxidation numbers of the elements change.

Question Source:

CEOE (Oklahoma) Chemistry Sample Test

Competency 18

Equal molar amounts of NaCl and CaCl_2 are dissolved in two containers containing equal amounts of water. How will the freezing points in the two containers compare?

- A. NaCl and CaCl_2 will lower the freezing point by the same amount.
- B. NaCl will lower the freezing point twice as much as CaCl_2 .
- C. CaCl_2 will lower the freezing point three times as much as NaCl .
- D. CaCl_2 will lower the freezing point one-and-a-half times as much as NaCl .

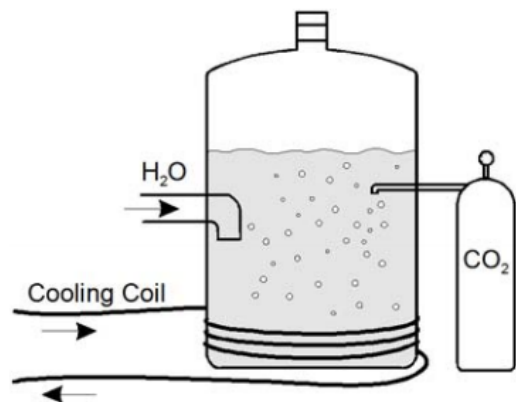
Correct Response: D. This question requires the examinee to demonstrate the ability to analyze the colligative properties of solutions. Freezing point depression in solutions is a colligative property that is dependent on the number of solute particles. In this problem, both NaCl and CaCl₂ are electrolytes that dissociate into ions in solution, but each unit of NaCl dissociates into only two ions (one Na⁺ and one Cl⁻), while CaCl₂ dissociates into three ions (one Ca²⁺ and two Cl⁻). Thus, a solution of CaCl₂ will have one-and-a-half times the number of solute particles as an equal molar solution of NaCl. Since the decrease in freezing point of a solution is directly proportional to the concentration of solute particles, the freezing point of the CaCl₂ solution will be depressed one-and-a-half times more than the freezing point of the NaCl solution.

Question Source:

CEOE (Oklahoma) Chemistry Sample Test

Competency 10

Use the diagram below to answer the two questions that follow.



In the beverage industry, carbon dioxide is introduced into a pressure vessel containing flavored sugar water to give the characteristic fizz associated with soda. After the system has reached equilibrium, the carbonated water is sent through tubing to be bottled.

Which of the following pieces of information is needed in order to calculate the amount of energy required for the cooling coil to bring the contents of the vessel to the desired temperature?

- A. the volume of the vessel
- B. molar concentration of the sugar solution
- C. mass of the sugar water
- D. molecular weight of the sugar

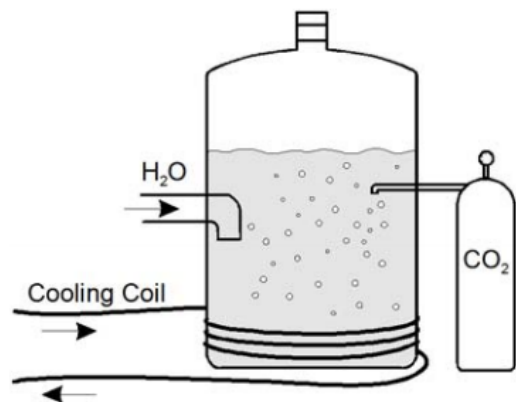
Correct Response: C. This question requires the examinee to demonstrate the ability to analyze the three laws of thermodynamics and their application to chemical systems. The energy required to cool the contents of the vessel to the desired temperature can be calculated using the equation $q = ms\Delta T$. In this equation, q represents the energy needed to cool the sugar water in the vessel, m is the mass of the sugar water, s is the specific heat of the sugar water, and ΔT is the desired change in temperature. Therefore, of the information provided, only the mass of the sugar water will be useful in calculating the energy needed to cool the contents of the vessel to the desired temperature.

Question Source:

CEOE (Oklahoma) Chemistry Sample Test

Competency 14

Use the diagram below to answer the two questions that follow.



In the beverage industry, carbon dioxide is introduced into a pressure vessel containing flavored sugar water to give the characteristic fizz associated with soda. After the system has reached equilibrium, the carbonated water is sent through tubing to be bottled.

During the manufacturing process, which of the following conditions would shift the equilibrium to favor a reduced carbon dioxide concentration in the beverage?

- A. a leak in the pressure vessel
- B. a decrease in the temperature of the cooling coil
- C. an increase in the length of time the carbon dioxide is left in contact with the sugar water
- D. an increase in the level to which the vessel is filled with sugar water

Correct Response: A. This question requires the examinee to demonstrate the ability to analyze the effects of concentration, pressure, temperature, and catalysts on chemical equilibrium. Several factors can affect chemical equilibrium, but in the situation described, temperature and pressure are likely to be of the greatest concern. Either an increased temperature or a decreased pressure would be unfavorable to carbon dioxide going into solution. Therefore, only a leak in the pressure vessel, which would lower the system's pressure, is likely to cause the beverage to have a reduced carbon dioxide concentration.

Question Source:

CEOE (Oklahoma) Chemistry Sample Test

Constructed Response Question

A student is performing a chemistry laboratory investigation to determine the molar mass of an unknown solute from freezing point depression.

The student uses the procedure below to carry out this investigation.

1. Prepare an ice bath by filling a 500 mL beaker about two-thirds full of ice.
2. Pipette 25 mL of cyclohexane into a test tube and lower the test tube into the ice bath.
3. Place a thermometer in the test tube to record the temperature of the cyclohexane.
4. Observe the test tube, noting the temperature at which solid crystals first begin to form.
5. Remove the test tube from the ice bath, and reheat the test tube until all of the cyclohexane has melted.
6. Replenish the ice in the ice bath if necessary.
7. Measure 2.0 g of the unknown solute and transfer the solute to the test tube containing the cyclohexane.
8. Lower the test tube into the ice bath and reinsert the thermometer in the test tube.
9. Observe the test tube, noting the temperature at which solid crystals first begin to form.
10. Compare the freezing points determined in steps 4 and 9.
11. Determine the molar mass of the solute from the freezing point depression.

Using your knowledge of laboratory techniques, prepare a response in which you:

- identify two weaknesses of the procedure described and explain why, from a scientific perspective, they are weaknesses;
- describe modifications that should be made to the procedure to address the identified weaknesses and explain how these changes would enhance the scientific validity of the results; and
- describe safety issues (e.g., safety equipment, safety procedures, safety precautions) that should be considered before performing this investigation.

A Very Good Response

There are several weaknesses in the described procedure. There are a couple of related factors that might call into question the accuracy of the results. First, neither the cyclohexane nor the solute is measured with a high enough degree of accuracy for this experiment. In terms of significant figures, 25 mL of cyclohexane indicates that the measurement could vary by as much as 1 mL above or below 25 mL (25 ± 1 mL). The same reasoning applies to the solute-measuring to a tenth of a gram may not be precise enough to allow for accurate calculations of its molar mass. The second related factor that may affect the accuracy of the results is the volatility of cyclohexane. Cyclohexane tends to evaporate, so by not measuring out a fresh 25.00 mL sample of cyclohexane in step 7, there may actually be less than 25.00 mL left in the test tube after completing steps 2-6. So again, there is some uncertainty in the amount of cyclohexane in the test tube when the unknown is added, and this would undermine the validity of the results.

To address these problems associated with accuracy, a couple of modifications should be made. First, the solvent and solute should be measured out with a higher degree of precision. This may mean using different measuring instruments that allow greater precision. Second, a fresh sample of the solvent should be measured out before adding the unknown in step 7. Both of these modifications will produce more accurate and reliable data, enhancing the validity of the investigation's results.

Another weakness of the described procedure is the lack of information on whether the unknown is an electrolyte or nonelectrolyte, and if it is an electrolyte, how many ions are formed when it ionizes. This information is needed in order to calculate the molality of the solution, which is then used along with the amount of solvent to calculate the molar mass of the unknown. The more particles a solute forms in solution, the greater the freezing point depression. So if the student does not have this information about the unknown, then calculations of molar mass based on how much the freezing point is lowered could be wrong depending on what assumptions the student makes.

For the student to be able to make the appropriate calculations that will lead to an accurate determination of the unknown's molar mass, the number of particles the solute forms in solution must be provided. Providing this information will not give away the identity of the unknown, but it will allow a more certain determination of the unknown's molar mass.

There are several safety precautions that should be considered and taken in performing this investigation. When working with any chemical in the laboratory, safety goggles should be worn to protect against splatters and splashes. Also, more specific to cyclohexane, because it is a volatile chemical, it can cause irritation to the respiratory passages and eyes. It is also highly flammable. For both of these reasons, if cyclohexane is to be used as the solvent, then the investigation should be carried out under a fume hood. Given the purpose of the investigation, determining the molar mass of an unknown solute, the best way to minimize some of these safety risks would be to select a less dangerous solvent in place of cyclohexane.

Page Left Blank Intentionally

Question Source:

MTTC (Michigan) Physical Science Sample Test

A researcher collects data on the structure of the atom by directing alpha particles at a thin sheet of gold foil. After repeated trials, as predicted, most of the alpha particles pass through the gold foil without being significantly deflected from their path. To the surprise of the researcher, a small percentage of the alpha particles are scattered back from the gold foil. Given the small percentage of alpha particles that do not pass through the foil, which of the following should the researcher do?

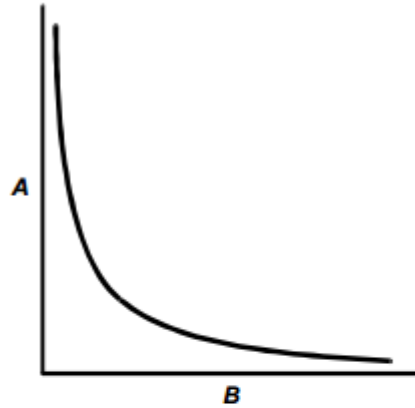
- A. Disregard the anomalous events since they are unrepresentative of the majority of the data.
- B. Develop an explanation for the anomalous events and disregard the results that were predicted.
- C. Continue the experiment until the results match the predictions that were made by the researcher.
- D. Incorporate the anomalous data and the expected results into an explanation that can account for both.

D Understand the principles and procedures of scientific inquiry.

Question Source:

MTTC (Michigan) Physical Science Sample Test

The graph below shows the relationship between two variables, A and B .



Which of the following is most likely to result in a straight-line graph?

- A. Plot $\frac{1}{A}$ versus B .
- B. Plot $\frac{1}{A}$ versus $\frac{1}{B}$.
- C. Plot A^2 versus B .
- D. Plot B versus A .

A Understand the principles and procedures of scientific inquiry.

Question Source:

MTTC (Michigan) Physical Science Sample Test

A chemist is analyzing the concentration of a particular contaminant in a water sample. After running the test repeatedly, the chemist calculates the standard deviation of the concentration data. In this situation, the standard deviation of the data is most useful for:

- A. evaluating the accuracy of the analysis.
- B. determining the cause of variability in the results.
- C. assessing the precision of the measurements.
- D. establishing the average value of the data.

C Apply knowledge of methods and equipment used in scientific investigations.

Question Source:

MTTC (Michigan) Physical Science Sample Test

A researcher announces a major breakthrough in nuclear fusion that could make it a commercially viable energy source. After reviewing the research and evaluating the researcher's claims about fusion, scientists in the same field reject the findings. Which of the following provides an acceptable reason for the scientific community to reject the researcher's findings?

- A. The results do not support the claim that the breakthrough will make fusion commercially viable.
- B. The researcher did not publish the complete data set generated by the investigation.
- C. The results could not be reproduced by independent scientists using the same research procedures.
- D. The researcher was not well known in the field before announcing the breakthrough.

C Understand the development of scientific thought and inquiry.

Question Source:

MTTC (Michigan) Physical Science Sample Test

Which of the following is most important in assessing the credibility of scientific claims?

- A. the researcher's previous work on the same subject
- B. the researcher's results are reproducible
- C. the researcher's affiliation with a major university or institution
- D. the researcher's findings are consistent with earlier work

Understand the relationships of physical science to technological and social issues, both contemporary and historical.

Question Source:

MTTC (Michigan) Physical Science Sample Test

The concept of entropy is most closely associated with which of the following physical laws?

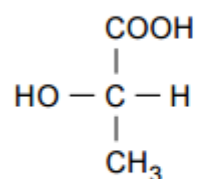
- A. second law of thermodynamics
- B. law of the conservation of energy
- C. Newton's law of inertia
- D. law of universal gravitation

A Understand interrelationships among the physical, life, and earth/space sciences.

Question Source:

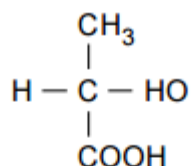
MTTC (Michigan) Physical Science Sample Test

Use the structural formula for lactic acid below to answer the question that follows.

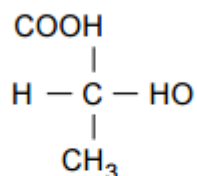


Which of the following is the optical isomer for the lactic acid molecule shown above?

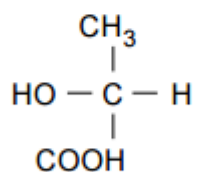
A.



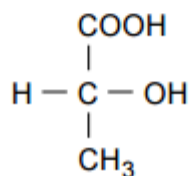
B.



C.



D.

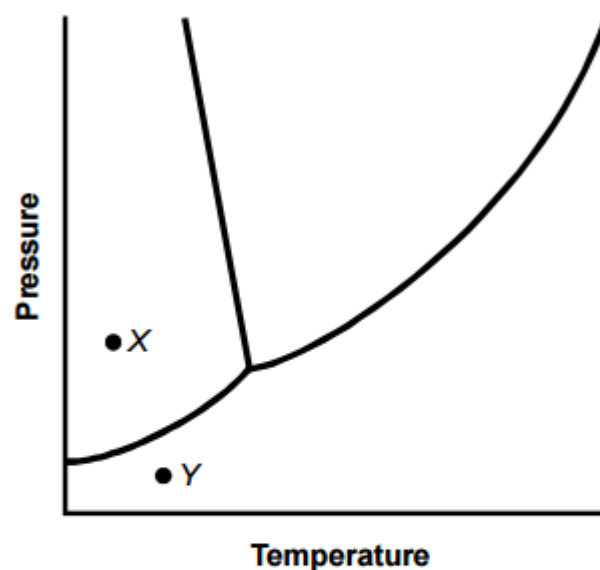


D Understand chemical properties of matter.

Question Source:

MTTC (Michigan) Physical Science Sample Test

Use the phase diagram below to answer the question that follows.



In the phase diagram for water shown above, *X* and *Y* represent different pressure and temperature conditions. Which of the following processes occurs as water makes the transition from the pressure and temperature conditions at point *X* to the conditions at point *Y*?

- A. liquefaction
- B. sublimation
- C. evaporation
- D. condensation

B Understand the physical properties of matter.

Question Source:

MTTC (Michigan) Physical Science Sample Test

Water does not break down into its constituent atoms until its temperature is raised to approximately $2,700^{\circ}\text{C}$. Which of the following is responsible for the great stability of water molecules?

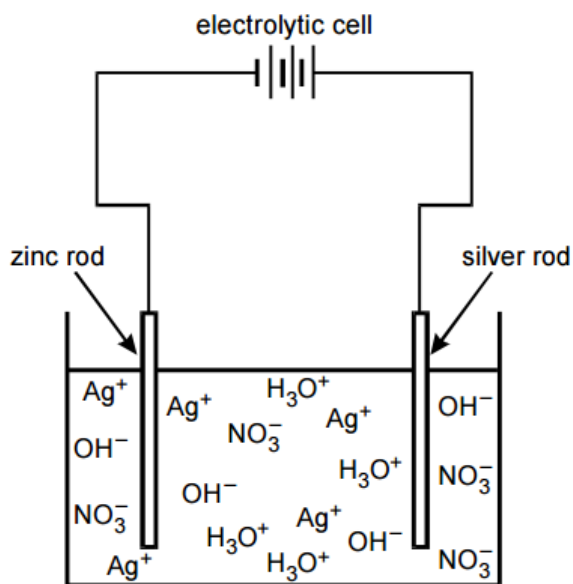
- A. high heat capacity
- B. strong covalent bonds
- C. low chemical reactivity
- D. flexible hydrogen bonds

B Understand the properties and characteristics of chemical bonds.

Question Source:

MTTC (Michigan) Physical Science Sample Test

Use the information below to answer the question that follows.



Two rods, one made of silver and one of zinc, are placed in a solution of silver nitrate, as shown in the diagram above. Which of the following is primarily responsible for the increase in the mass of the zinc rod?

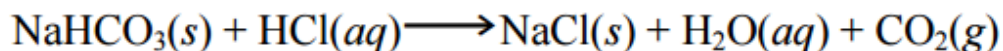
- A. the changing concentration of silver ions in solution caused by the oxidation of the silver rod due to the flow of electrons through the circuit
- B. the changing mass of the silver nitrate solution caused by the oxidation of the nitrate ions and silver ions in solution
- C. the reduction of silver ions in solution that are then deposited on the zinc rod due to the flow of electrons in the circuit
- D. the oxidation of zinc ions at the zinc rod caused by the different reduction potentials of the zinc ions and silver ions in solution

C Understand the types and characteristics of chemical reactions.

Question Source:

MTTC (Michigan) Physical Science Sample Test

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



A scientist puts 4.20 g of NaHCO_3 into an evaporating dish and adds dilute HCl until the production of a gas ceases. The scientist then slowly evaporates water from the evaporating dish and recovers 3.04 g of NaCl . The reaction is depicted in the chemical equation shown above. What is the experimental value for the mole ratio of sodium chloride to sodium bicarbonate?

- A. 1.00 : 1
- B. 1.04 : 1
- C. 1.38 : 1
- D. 1.44 : 1

- B** Apply the principles and methods of stoichiometry and the rules of chemical nomenclature and notation for inorganic and organic substances.

Question Source:

MTTC (Michigan) Physical Science Sample Test

Which of the following provides the best example of qualitative analysis?

- A. identifying the number of moles of a particular compound in a sample
- B. determining the ratio of two specific elements in a compound
- C. identifying the different types of ions present in a sample
- D. determining the average density of a mixture

C Understand analytical techniques.

Question Source:

MTTC (Michigan) Physical Science Sample Test

Which of the following describes a difference between the concepts of mass and weight?

- A. Weight provides a measure of the force acting on an object, while mass does not.
- B. Weight takes volume into account, while mass does not.
- C. Mass takes the gravitational force acting on an object into account, while weight does not.
- D. Mass provides a measure of density, while weight does not.

A Analyze forces and motion in one and two dimensions.

Question Source:

MTTC (Michigan) Physical Science Sample Test

The buoyant force exerted by a fluid on an entirely submerged object is equal to:

- A. the mass of the submerged object.
- B. the gravitational force acting on the submerged object.
- C. the density of the submerged object.
- D. the weight of the fluid displaced by the submerged object.

D Analyze forces and motion in one and two dimensions.

Question Source:

MTTC (Michigan) Physical Science Sample Test

Which of the following best describes the concept of temperature?

- A. the thermal energy transferred between objects as a result of conduction
- B. the total internal energy contained in the atoms or molecules composing a substance
- C. the total heat energy contained within an object or substance per unit volume
- D. the average kinetic energy of the atoms or molecules composing a substance

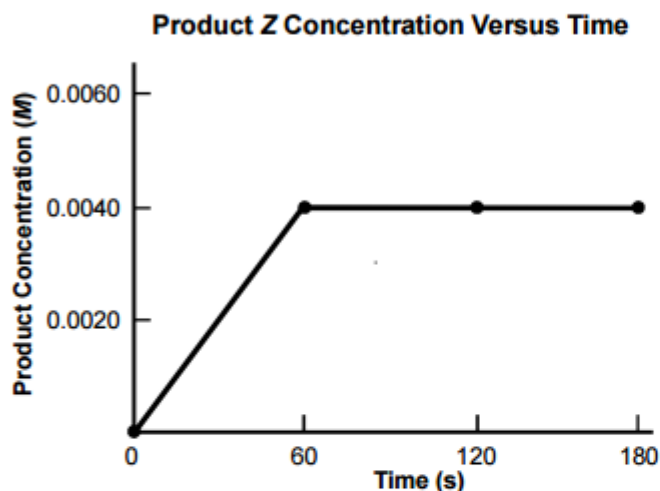
D Understand conservation laws and thermodynamics.

Question Source:

MTTC (Michigan) Chemistry Sample Test

Use the information below to answer the question that follows.

A researcher carried out a reaction between 0.010 *M* reactant *X* and excess reactant *Y*. The researcher measured the concentration of product *Z* at 60-second intervals. The researcher's results are shown in the graph below.



The researcher concludes from these data that the reaction rate was $6.7 \times 10^{-5} \text{ M/s}$. Which of the following is the best evaluation of the validity of the researcher's conclusion?

- A. It is invalid because the chosen time interval of 60 seconds was not short enough to allow for an accurate measurement of the rate of this reaction.
- B. It is valid because the leveling off of the product concentration curve indicates the reaction was complete at 60 seconds.
- C. It is invalid because the rate should have been calculated by dividing the final product concentration by the full 180-second duration of the experiment.
- D. It is valid because reaction rate is an intensive property of the reactants and products involved in the reaction.

A Understand the principles and procedures of scientific inquiry.

Question Source:

MTTC (Michigan) Chemistry Sample Test

A student has to measure out 9.40 mL of a liquid and selects a 100 mL graduated cylinder. To improve the accuracy of the measurement, it would be most effective to:

- A. take the average of multiple measurements using the graduated cylinder.
- B. measure the liquid using a 25 mL graduated cylinder instead.
- C. estimate the measurement obtained from the graduated cylinder to an additional significant figure.
- D. measure the liquid using a 10 mL graduated pipette instead.

D Apply knowledge of methods and equipment used in scientific investigations.

Question Source:

MTTC (Michigan) Chemistry Sample Test

Which of the following is an illustration of the use of verifiable evidence in the practice of science?

- A. Thinkers in ancient India proposed that atoms came in two forms, soft or rough, which caused them to combine in pairs, forming the basis for all matter.
- B. Ernest Rutherford hypothesized that atoms must have dense cores, since some alpha particles, when shot at gold foil, passed through and others were greatly deflected.
- C. Niels Bohr reasoned that an atom's electrons orbiting the nucleus would have to radiate energy in a manner consistent with the law of conservation of energy.
- D. Democritus proposed the idea of the atom when the smell of baking bread caused him to question how the smell traveled to one's nose from a distance.

B Understand the nature of scientific thought, inquiry, and history.

Question Source:

MTTC (Michigan) Chemistry Sample Test

Scientific claims published in professional journals are generally considered more credible than those posed through the mass media. This is true primarily because professional journals:

- A. ensure that every investigation is repeated and the results independently verified before a paper is published.
- B. direct their content to a more narrow readership with highly specialized interests.
- C. maintain their editorial objectivity by refusing to accept paid advertising.
- D. subject researchers' methodologies and conclusions to peer review prior to publication.

- D** Understand the relationship of chemistry to contemporary, historical, technological, and societal issues.

Question Source:

MTTC (Michigan) Chemistry Sample Test

The most important similarity between the mole in chemistry and the light year in astronomy is that these units:

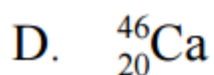
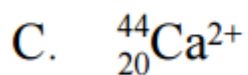
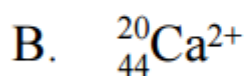
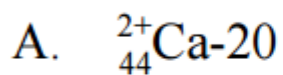
- A. provide accurate physical models of natural phenomena.
- B. have been refined since first being introduced as more data were collected.
- C. represent combined laws worked out by numerous researchers.
- D. convert extremely large- or small-scale phenomena into values that are easier to work with.

- D** Understand interrelationships among the physical, life, and earth/space sciences and their connections to mathematics and technology

Question Source:

MTTC (Michigan) Chemistry Sample Test

Which of the following is the correct notation for the calcium-44 isotope existing as a 2+ ion?

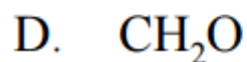
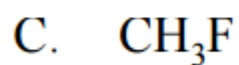
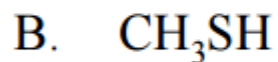
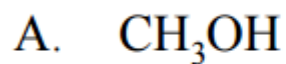


C Apply the rules of chemical nomenclature and notation.

Question Source:

MTTC (Michigan) Chemistry Sample Test

Which of the following substances is likely to exhibit the highest boiling point due to intermolecular forces?



A Understand atomic and molecular structure and bonding.

Question Source:

MTTC (Michigan) Chemistry Sample Test

Which of the following quantities contains the greatest number of moles?

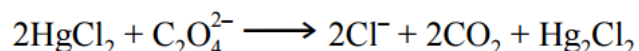
- A. 30 g of N_2
- B. 35 g of NH_3
- C. 60 g of NaCl
- D. 75 g of CaO

B Apply the mole concept and the principles and methods of stoichiometry.

Question Source:

MTTC (Michigan) Chemistry Sample Test

Use the information below to answer the question that follows.



The reaction above was carried out with various starting concentrations of the two reactants, and the initial reaction rate was determined. The experimental results are recorded in the table below.

Trial	$[\text{HgCl}_2](M)$	$[\text{C}_2\text{O}_4^{2-}](M)$	Initial Rate (M/s)
1	0.05	0.15	8.75×10^{-6}
2	0.05	0.30	3.50×10^{-5}
3	0.10	0.15	1.75×10^{-5}
4	0.10	0.30	7.00×10^{-5}

Which of the following rate laws is consistent with the experimental data?

- A. $\text{rate} = k[\text{HgCl}_2][\text{C}_2\text{O}_4^{2-}]$
- B. $\text{rate} = k[\text{HgCl}_2]^2[\text{C}_2\text{O}_4^{2-}]^2$
- C. $\text{rate} = k[\text{HgCl}_2][\text{C}_2\text{O}_4^{2-}]^2$
- D. $\text{rate} = k[\text{HgCl}_2][\text{C}_2\text{O}_4^{2-}]^4$

C Apply knowledge of chemical equilibrium and reaction rates.

Question Source:

MTTC (Michigan) Chemistry Sample Test

Which of the following is a characteristic of methanoic acid (HCOOH) that makes it a suitable component of a buffer?

- A. It changes color when it undergoes ionization.
- B. Its ionization is incomplete.
- C. It has two ionizable hydrogens.
- D. It can ionize to produce both hydrogen and hydroxide ions.

B Understand the principles and applications of acid-base chemistry.

Question Source:

MTTC (Michigan) Chemistry Sample Test

Use the reaction below to answer the question that follows.



The overall reaction of an electrochemical cell is shown above. The cell potential is 1.0 V when the cell is at 25°C and the solution concentrations are 1.0 *M*. Which of the following changes would result in an increase in cell potential?

- A. increasing the concentration of $\text{B}^+(aq)$
- B. increasing the concentration of $\text{A}^+(aq)$
- C. increasing the surface area of the $\text{B}(s)$ electrode
- D. increasing the surface area of the $\text{A}(s)$ electrode

A Understand the principles and applications of electrochemistry.

Question Source:

MTTC (Michigan) Chemistry Sample Test

A soluble ionic compound is thought to contain either sodium or calcium as the cation. Which of the following solutions could be added to an aqueous sample of the compound to determine the identity of the cation?

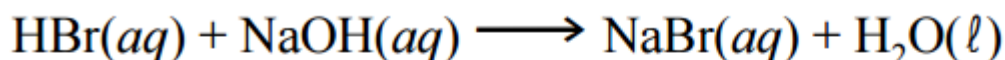
- A. hydrochloric acid
- B. nitric acid
- C. potassium bromide
- D. potassium carbonate

D Understand qualitative analysis.

Question Source:

MTTC (Michigan) Chemistry Sample Test

Use the information below to answer the question that follows.



The reaction shown above is studied in a constant-pressure calorimeter with a heat capacity of $500 \text{ J/}^\circ\text{C}$. In the experiment, 100 mL of 0.10 M HBr and 100 mL of 0.10 M NaOH are mixed.

The entire system, including both solutions, started at 20.00°C , and the final temperature was 20.42°C .

Assuming additive volumes, no heat loss to the surroundings, solution densities of 1.00 g/mL , and solution specific heats of $4.184 \text{ J/g}\cdot^\circ\text{C}$, what is the approximate value of ΔH for the reaction?

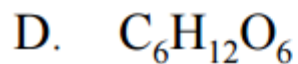
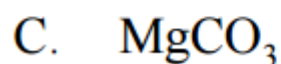
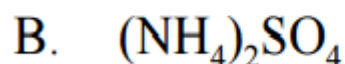
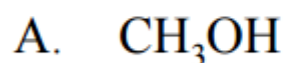
- A. -35 kJ/mol
- B. -40 kJ/mol
- C. -56 kJ/mol
- D. -123 kJ/mol

C Understand chemical thermodynamics and thermochemistry.

Question Source:

MTTC (Michigan) Chemistry Sample Test

An unknown substance is a solid at room temperature. The substance is soluble in water, but the aqueous solution does not conduct electricity. Attempts to measure the melting point of the substance are unsuccessful, as a chemical reaction occurs prior to melting. Which of the following substances is most consistent with this description of physical properties?



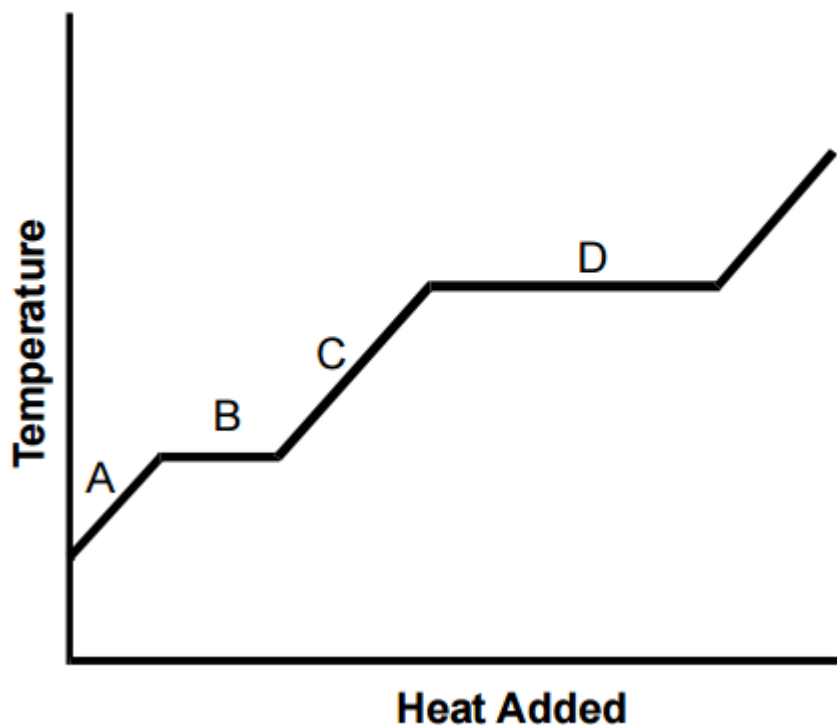
D Apply methods for measuring the physical properties of solids, liquids, and gases.

Question Source:

MTTC (Michigan) Chemistry Sample Test

Use the graph below to answer the question that follows.

Heating Curve for a Substance



The graph above is the heating curve for a substance covering its solid, liquid, and gaseous phases. Which segment of the graph gives information about this substance's molar heat of fusion?

- A. segment A
- B. segment B
- C. segment C
- D. segment D

B Apply knowledge of the kinetic molecular theory to the states of matter, phase changes, and the gas laws.

Question Source:

MTTC (Michigan) Chemistry Sample Test

According to quantum theory, an atomic orbital represents:

- A. a region of space around the nucleus where the probability of finding an electron is high.
- B. the three-dimensional path that a given electron follows around the nucleus.
- C. the particular distance from the nucleus that a given electron must maintain.
- D. a particular point around the nucleus where a given electron must be located.

A Understand quantum mechanics.

Question Source:

MTTC (Michigan) Chemistry Sample Test

A food scientist has a sample of a plant oil and wants to determine if the oil contains saturated or unsaturated fatty acids. Which of the following spectroscopic techniques would be most useful for this purpose?

- A. ultraviolet spectroscopy
- B. visible spectroscopy
- C. infrared spectroscopy
- D. mass spectroscopy

C Understand the basic principles and methods of spectroscopy.

Question Source:

MTTC (Michigan) Chemistry Sample Test

Which of the following molecules can have both *cis* and *trans* geometrical isomers?

- A. $\text{CH}_3(\text{CH}_2)_2\text{CH}_3$
- B. $\text{CH}_2\text{CHCH}_2\text{CH}_3$
- C. CH_3CCCH_3
- D. $\text{CH}_3\text{CHCHCH}_3$

D Understand the structure and nomenclature of organic compounds.

Question Source:

MTTC (Michigan) Chemistry Sample Test

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



Which of the following kinds of chemical reaction is represented by the equation above?

- A. addition
- B. condensation
- C. elimination
- D. substitution

A Understand organic reactions of major functional groups.

Question Source:

MTTC (Michigan) Integrated Science Sample Test

A student spills concentrated hydrochloric acid on his hand during a laboratory experiment. Which of the following actions is most appropriate for the teacher to take first?

- A. Flush the skin with water for 15 minutes.
- B. Send the student to the school nurse.
- C. Dry the hand with a clean cloth.
- D. Explain to the class the hazard posed by the spilled substance.

A Apply knowledge of methods and equipment used in scientific investigations.

Question Source:

MTTC (Michigan) Integrated Science Sample Test

Methane is a gas that is plentiful in nature and is the main ingredient in natural gas. It is composed of a single carbon atom attached to four hydrogen atoms by single covalent bonds. Methane is produced from the breakdown of organic matter in a variety of natural settings including swamps, soils, and sediments. Methane, in the form of natural gas, is also found in association with oil deposits where, until the 1960s, it was considered a nuisance that was disposed of as cheaply as possible so as not to hinder the pumping of oil. Methane hydrate is a crystalline compound composed of methane molecules trapped inside a cage-like lattice of water molecules. The compound is found in great quantities in ocean sediments and in the soils of permafrost regions, making it an attractive potential energy resource. At times in the geologic past, methane hydrates and the deposits that contain them have become unstable, releasing large quantities of methane into the oceans and atmosphere.

One of the reasons that methane is a relatively stable compound is that:

- A. atomic hydrogen's high electronegativity creates a strong attraction to the central carbon atom.
- B. transfer of electrons between the hydrogen and carbon atoms creates a tetrahedron.
- C. hydrogen atoms that surround the central carbon atom share electrons to form ionic bonds.
- D. shared electrons fill the valence orbitals in the hydrogen and carbon atoms.

D Understand the nature of chemical changes in matter.

Question Source:

MTTC (Michigan) Integrated Science Sample Test

Methane is a gas that is plentiful in nature and is the main ingredient in natural gas. It is composed of a single carbon atom attached to four hydrogen atoms by single covalent bonds. Methane is produced from the breakdown of organic matter in a variety of natural settings including swamps, soils, and sediments. Methane, in the form of natural gas, is also found in association with oil deposits where, until the 1960s, it was considered a nuisance that was disposed of as cheaply as possible so as not to hinder the pumping of oil. Methane hydrate is a crystalline compound composed of methane molecules trapped inside a cage-like lattice of water molecules. The compound is found in great quantities in ocean sediments and in the soils of permafrost regions, making it an attractive potential energy resource. At times in the geologic past, methane hydrates and the deposits that contain them have become unstable, releasing large quantities of methane into the oceans and atmosphere.

New technology is making the use of methane hydrate resources found in ocean sediments a possible future source of energy. A major reason for developing methane hydrates as an energy resource is that:

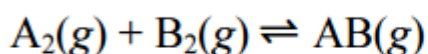
- A. the solid nature of methane hydrates allows them to be burned like coal or liquified for pipeline transport.
- B. combustion of methane from methane hydrates does not produce nitrogen and sulfur oxides.
- C. the inert nature of methane hydrates makes them less explosive than natural gas.
- D. retrieval of methane hydrates would cause less environmental damage than oil or natural gas

- B** Understand the relationship of science and technology to contemporary, historical, and societal issues.

Question Source:

MTTC (Michigan) Integrated Science Sample Test

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



Two gases are combined in a closed container and react according to the equation above. Which of the following statements defines what will occur after the reaction reaches equilibrium?

- A. The concentration of reactants will be twice the concentration of the products.
- B. The concentration of products and reactants will be equal.
- C. The concentration of products will be twice the concentration of the reactants.
- D. The concentration of the reactants and products will remain constant.

D Understand the chemical properties of matter.

Question Source:

MTTC (Michigan) Integrated Science Sample Test

Cubes of ice are placed in a beaker over a heat source. Which of the following best explains why the temperature of the ice water will remain constant at 0°C until all of the ice has melted?

- A. Melting and evaporation are occurring at the same time and there is no net gain in kinetic energy.
- B. As the ice melts, the kinetic energy gained by the molecules is used to increase the volume of the water.
- C. The energy is used to rearrange the molecules rather than increasing the molecules' kinetic energy.
- D. Kinetic energy gained by the system is used to re-form crystals on the surface of the ice cubes.

- C** Understand the physical properties of matter, the ideal gas laws, and the nature of physical changes in terms of molecular behavior.