

Question Source:

NES Chemistry Sample Test

Which of the following is best accomplished using a mass spectrometer?

- A. determining the percent abundance of an element's natural isotopes
- B. determining the triple point of an unknown substance
- C. determining the reaction rate for a chemical reaction involving a gas
- D. determining the electronegativity value of an element

Correct Response and Explanation

A. This question requires the examinee to demonstrate knowledge of the equipment used in chemistry. A mass spectrometer measures the masses and relative abundance of atomic or molecular ions in a sample. These numerical values can be used to calculate the percent abundance of an element's natural isotopes.

Question Source:

NES Chemistry Sample Test

DNA → RNA → protein

Which of the following biological processes does the pathway shown above summarize?

- A. mitosis
- B. cellular respiration
- C. meiosis
- D. gene expression

Correct Response and Explanation

D. This question requires the examinee to demonstrate knowledge of major contemporary concepts in biology. DNA is a molecule that stores genetic information in cells. The pathway shows the translation of genetic information from DNA to RNA to protein, a process that leads to the active expression of genetic information.

Question Source:

NES Chemistry Sample Test

Which of the following only occurs during a nuclear change?

- A. Valence electrons are raised to higher energy levels.
- B. Two or more types of atoms are combined.
- C. Energy is released to the surroundings.
- D. An element's atomic number is reduced.

Correct Response and Explanation

D. This question requires the examinee to demonstrate knowledge of the characteristics of radioactive materials. Chemical and physical changes do not involve changes within the nucleus of an atom and therefore would not lead to a reduction in an element's atomic number. This type of change would only result from a nuclear change.

Question Source:

NES Chemistry Sample Test

Which of the following elements is the most electronegative?

- A. hydrogen
- B. fluorine
- C. radon
- D. francium

Correct Response and Explanation

B. This question requires the examinee to demonstrate knowledge of the periodic table and its usefulness in predicting the relative reactivity of given elements. The electronegativity of elements in the periodic table tends to increase from bottom to top within a group and from left to right across a period. Of the given elements, fluorine is in the uppermost position on the right-hand side of the periodic table.

Question Source:

NES Chemistry Sample Test

A gas occupies a volume of 1.25 liters at a pressure of 825 mm Hg. What will be the final pressure of this gas if it is compressed into a volume of 725 mL at constant temperature?

- A. 479 mm Hg
- B. 748 mm Hg
- C. 1.30×10^3 mm Hg
- D. 1.42×10^3 mm Hg

Correct Response and Explanation

D. This question requires the examinee to solve a problem involving the gas laws. If the temperature and number of moles of a gas are held constant, the relationship between initial pressure and initial volume and a new pressure and a new volume is $P_1V_1 = P_2V_2$. This relationship can be used to calculate the new pressure when the initial pressure, initial volume, and new volume are known.

Question Source:

NES Chemistry Sample Test

A 4.75 g sample of solid NaOH is dissolved in 50.5 g of H₂O in a constant-pressure calorimeter having a heat capacity of 18.5 J/°C. The temperature rises from 21.1°C to 33.6°C. Assuming that the solution has a specific heat capacity of 4.184 J/g•°C and negligible heat loss from the calorimeter, how much heat is produced in the solution process?

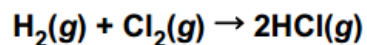
- A. 2.64 kJ
- B. 2.89 kJ
- C. 3.12 kJ
- D. 4.27 kJ

Correct Response and Explanation

C. This question requires the examinee to analyze the results of a calorimetry experiment. The total heat produced in the given solution process is equal to the heat absorbed by the solution plus the heat absorbed by the calorimeter. The heat absorbed by the solution is calculated using the equation $q = m \times s \times \Delta T$. The heat absorbed by the calorimeter is equal to $C_{\text{calorimeter}} \times \Delta T$.

Question Source:
NES Chemistry Sample Test

Bond	Bond Enthalpy (kJ/mol)
H—H	436.4
H—Cl	431.9



$$\Delta H^\circ_{\text{rxn}} = -184.6 \text{ kJ}$$

Given the information shown above, what is the best estimate of the bond enthalpy for the Cl—Cl bond?

- A. 189.1 kJ/mol
- B. 242.8 kJ/mol
- C. 256.3 kJ/mol
- D. 585.1 kJ/mol

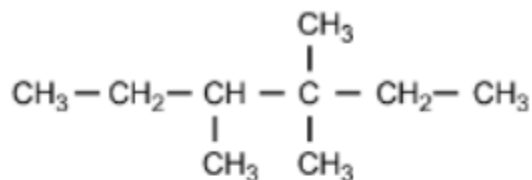
Correct Response and Explanation

B. This question requires the examinee to analyze energy changes due to the formation or breaking of chemical bonds. The enthalpy change for a chemical reaction is equal to the sum of the enthalpy changes involved in breaking existing bonds minus the sum of the enthalpy changes involved in forming new bonds. The bond enthalpy for the Cl–Cl bond can be calculated using this relationship and the given bond enthalpies for H–H and H–Cl.

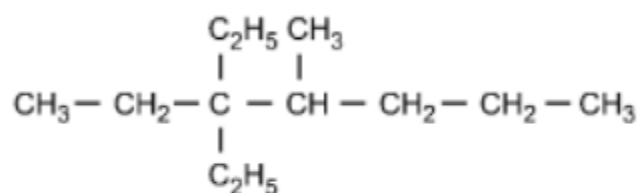
Question Source:
NES Chemistry Sample Test

Which of the following structural formulas represents 4-ethyl-3, 3-dimethylhexane?

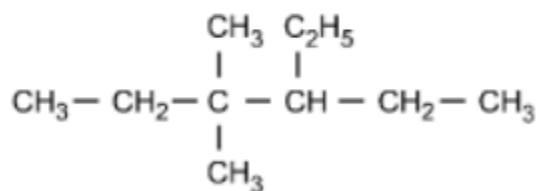
A.



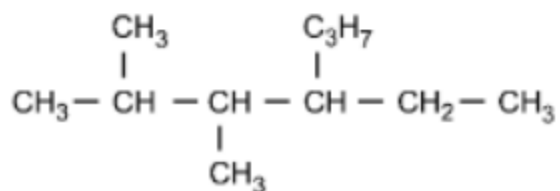
B.



C.



D.



Correct Response and Explanation

C. This question requires the examinee to apply the International Union of Pure and Applied Chemistry (IUPAC) rules of nomenclature. 4-ethyl-3, 3-dimethylhexane is an alkane consisting of six continuous carbon atoms. An ethyl group (C_2H_5) is attached to the number 4 carbon and two methyl groups (CH_3) are attached to the number 3 carbon.

Question Source:

NES Chemistry Sample Test

The high melting point of diamond is due to:

- A. strong covalent bonds between carbon atoms.
- B. an irregular, three-dimensional crystal structure.
- C. delocalized, highly mobile bonding electrons.
- D. extensive van der Waals forces between carbon atoms.

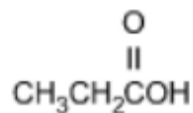
Correct Response and Explanation

A. This question requires the examinee to relate the properties of substances to their atomic bonds. Diamond is a covalent-network crystalline solid. The carbon atoms in this network are linked by covalent bonds. This strong bonding between carbon atoms is responsible for the high melting point of diamond.

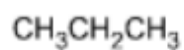
Question Source:
NES Chemistry Sample Test

Which of the following products is formed by an esterification reaction between acetic acid ($\text{CH}_3\text{CO}_2\text{H}$) and ethanol ($\text{CH}_3\text{CH}_2\text{OH}$)?

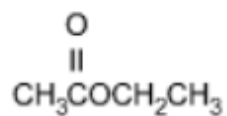
A.



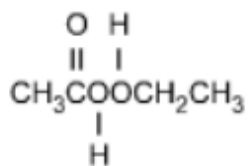
B.



C.



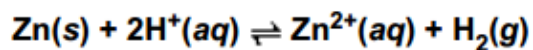
D.



Correct Response and Explanation

C. This question requires the examinee to analyze different types of chemical reactions. In the esterification reaction between acetic acid and ethanol, the OH group from acetic acid and the H attached to the O in ethanol combine to form water. The remaining portions of the acetic acid and ethanol molecules combine to form the ester, ethyl acetate.

Question Source:
NES Chemistry Sample Test



Which of the following is the equilibrium constant expression for the equation shown above?

A.

$$\frac{[\text{Zn}^{2+}] [\text{H}_2]}{[\text{Zn}] [\text{H}^+]}$$

B.

$$\frac{[\text{Zn}^{2+}] + (P_{\text{H}_2})}{[\text{Zn}] + 2[\text{H}^+]}$$

C.

$$\frac{[\text{Zn}^{2+}]}{2[\text{H}^+]}$$

D.

$$\frac{[\text{Zn}^{2+}] (P_{\text{H}_2})}{[\text{H}^+]^2}$$

Correct Response and Explanation

D. This question requires the examinee to solve problems involving equilibrium constants. When writing equilibrium constant expressions, pure solid and pure liquid compounds are omitted and the pressure of gaseous compounds can be used in place of concentration. The equilibrium constant expression for this reaction is equal to the concentration of $\text{Zn}^{2+}(aq)$ \times the pressure of $\text{H}_2(g)$ each raised to a power equal to its stoichiometric coefficient, divided by the concentration of $\text{H}^+(aq)$ raised to a power equal to its stoichiometric coefficient.

Question Source:

NES Chemistry Sample Test

Which of the following explains why nitric acid (HNO_3) is a stronger acid than nitrous acid (HNO_2)?

- A. The additional oxygen present in nitric acid increases the polarity of the O–H bond.
- B. The extent of ionization is directly related to molecular weight when comparing related compounds.
- C. The anion formed by removing H^+ from nitrous acid is more stable than the anion formed by removing H^+ from nitric acid.
- D. The O–H bond in nitrous acid is weaker than the O–H bond in nitric acid.

Correct Response and Explanation

A. This question requires the examinee to demonstrate knowledge of the relationship between molecular structure and acid strength. The strength of an acid is a function of its tendency to ionize. For oxoacids with the same central atom, acid strength increases as the oxidation number of the central atom increases because of the resulting increase in polarity of the O–H bond. The oxidation number of nitrogen in HNO_3 is +5 and in HNO_2 it is +3, thus the O–H bond in HNO_3 is more polar and ionizes more readily.

Question Source:

NES Chemistry Sample Test

Which of the following is equivalent to 1.42×10^{23} atoms?

- A. 25.0 g Br
- B. 15.0 g Cu
- C. 19.0 g Sn
- D. 23.0 g Mn

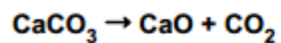
Correct Response and Explanation

B. This question requires the examinee to demonstrate knowledge of the mole concept. The number of moles of an element is equal to the product of the mass of the element \div the molar mass of the element \times Avogadro's number.

Question Source:

NES Middle Grades General Science Sample Test

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



What is the mass of calcium oxide (CaO) that is produced by heating 80.0 g of calcium carbonate (CaCO₃)?

- A. 44.8 g
- B. 47.7 g
- C. 65.9 g
- D. 70.2 g

A. This question requires the examinee to apply knowledge of chemical formulas, the mole concept, and chemical equations to solve problems. Since the reaction is already written in balanced form, one mole of CaO is produced for each mole of CaCO₃ that reacts. The molecular weight of CaCO₃ is the sum of the atomic weights of the atoms in CaCO₃. The molecular weight of CaCO₃ is $1(40 \text{ amu}) + 1(12 \text{ amu}) + 3(16 \text{ amu}) = 100 \text{ amu}$. This means that CaCO₃ has a mass of 100 g per mole. Therefore, 80.0 g of CaCO₃ represents 0.8 moles of CaCO₃ and must produce 0.8 moles of CaO. CaO has a molecular weight of $1(40 \text{ amu}) + 1(16 \text{ amu}) = 56 \text{ amu}$, and 0.8 moles of CaO has a mass of $(0.8) \times (56)$ or 44.8 g.

Question Source:

NES Middle Grades General Science Sample Test

Which of the following is predicted by the kinetic theory of matter?

- A. The electrons surrounding an atom are in constant motion.
- B. The pressure of a gas will decrease if its volume is increased.
- C. The density of a solid depends on its composition.
- D. The charge of the atomic nucleus depends on its mass.

B. This question requires the examinee to recognize historic and contemporary theories of atomic structure and the kinetic theory of matter. According to the kinetic theory of matter, pressure in a gas-filled container results from collisions between molecules of gas and the sides of the container. If the volume of a container is increased, molecules will travel greater distances before striking the walls, and the collisions will therefore occur less frequently. This will result in a reduced pressure.