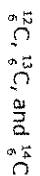


Three isotopes of carbon are indicated below:



How are these isotopes alike?

- A They have the same number of protons and the same atomic mass.
- B They have the same number of neutrons and the same atomic mass.
- C They have the same number of protons and the same atomic number.
- D They have the same number of neutrons and the same atomic number.

Which statement correctly compares an atom of boron-11 and an atom of carbon-14?

- A An atom of boron-11 has one fewer proton and two fewer neutrons than an atom of carbon-14.
- B An atom of boron-11 has one fewer neutron and two fewer protons than an atom of carbon-14.
- C An atom of boron-11 has one fewer proton and three fewer neutrons than an atom of carbon-14.
- D An atom of boron-11 has one fewer neutron and three fewer protons than an atom of carbon-14.

Which *best* represents the electron configuration for an atom of iron?

- A $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$
- B $1s^2 1p^6 2s^2 2p^6 3s^2 3p^6 4s^2$
- C $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8$
- D $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4d^6$

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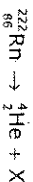
4 How many electrons are in the outermost energy level of an electrically neutral atom of aluminum?

- A 13
- B 8
- C 3
- D 2

5 Which transition occurs when light with a wavelength of 434 nm is emitted by a hydrogen atom?

- A The electron jumps from $n = 2$ to $n = 4$.
- B The electron jumps from $n = 2$ to $n = 5$.
- C The electron falls from $n = 4$ to $n = 2$.
- D The electron falls from $n = 5$ to $n = 2$.

6 The nuclear equation below represents the alpha decay of ${}^{222}_{86}\text{Rn}$:



What is the mass number of the element represented by X?

- A It is 88, because element X gains 2 protons.
- B It is 218, because element X loses 2 protons and 2 neutrons.
- C It is 220, because element X loses 2 neutrons.
- D It is 226, because element X gains 2 protons and 2 neutrons.

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What **best** compares the properties of ionic and metallic substances?

- A The bonds of metallic substances are composed of delocalized electrons, and the bonds of ionic substances are composed of transferred electrons.
- B The bonds of metallic substances are composed of isolated electrons, and the bonds of ionic substances are composed of shared electrons.
- C A metallic substance insulates heat and electricity, and solid ionic substances conduct heat and electricity.
- D A metallic substance has a low melting point, and an ionic substance has a low melting point.

8 When aluminum and sulfur react, which compound is produced?

- A Al_2S_3
- B Al_3S_2
- C AlS_2
- D AlS

9 Which combination of elements would **most likely** form an ionic compound?

- A hydrogen and oxygen
- B carbon and chlorine
- C sodium and fluorine
- D silicon and sulfur



10 Which is an accurate comparison of the bonds that can occur between carbon atoms in terms of bond length and strength?

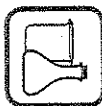
- A Double bonds are shorter than single bonds, but single bonds are stronger than triple bonds.
- B Triple bonds are shorter than double bonds, and double bonds are stronger than single bonds.
- C Double bonds are both shorter and stronger than triple bonds.
- D Triple bonds are the longest and strongest.

11 Which represents the formula for iron(III) chromate?

- A $Fe_2(CrO_4)_3$
- B $Fe_2(CrO_4)_2$
- C $Fe_3(CrO_4)_2$
- D $Fe_3(CrO_4)_3$

12 What is the IUPAC name for the chemical formula PbO_2 ?

- A lead oxide
- B lead(II) oxide
- C lead(IV) oxide
- D lead dioxide



- 13 Which is true about the melting points of ionic and molecular compounds?
- A The melting points of ionic and molecular compounds are similar.
 - B The melting points of ionic compounds are lower than the melting points of molecular compounds.
 - C The melting points of ionic and molecular compounds increase with the number of atoms present in the compound.
 - D The melting points of ionic compounds are higher than the melting points of molecular compounds.
- 14 Which pair of elements is both malleable and able to conduct heat?
- A bromine and silver
 - B iodine and neon
 - C iron and bromine
 - D silver and iron
- 15 Which group includes elements with the most similar properties?
- A N, O, and F
 - B O, S, and Se
 - C Cr, Pb, and Xe
 - D Br, Ga, and Hg
- 16 An atom of which element has the strongest attraction for electrons?
- A Ba
 - B Cs
 - C O
 - D F
- 17 What occurs when energy is removed from a liquid-vapor system in equilibrium?
- A The amount of liquid increases.
 - B The amount of vapor increases.
 - C The amounts of liquid and vapor increase equally.
 - D The amounts of liquid and vapor decrease equally.
- 18 Which **best** explains the relationship between heat energy and temperature?
- A As heat energy increases and temperature increases, freezing occurs.
 - B As heat energy decreases and temperature remains constant, condensat occurs.
 - C As heat energy decreases and temperature remains constant, evaporatic occurs.
 - D As heat energy increases and temperature decreases, melting occurs.

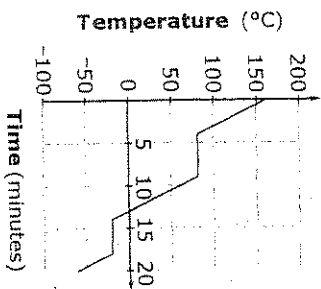


- 19 Why does it require 5,511 J of heat energy to melt 16.5 g of ice?
- A 2,260 J/g of heat energy is absorbed by the ice as it is converted from a solid to a liquid.
 - B 334 J/g of heat energy is absorbed by the ice as it is converted from a solid to a liquid.
 - C 4.18 J/g°C of heat energy is required as ice is converted from a solid to a liquid.
 - D 2.05 J/g°C of heat energy is required as ice is converted from a solid to a liquid.



- 20 The graph below shows a cooling curve for a sample of gas that is uniformly cooled from 155°C.

Cooling Curve

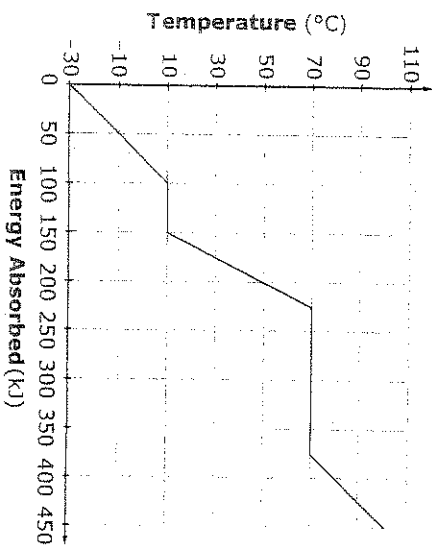


- Why does the freezing point of the substance occur at -20°C ?
- A because the latent heat energy is absorbed by the substance as it is converted from a liquid to a solid
 - B because the latent heat energy is released into the air as the substance is converted from a liquid to a solid
 - C because the average kinetic energy is increasing for the substance as it is converted from a solid to a liquid
 - D because the average kinetic energy is decreasing for the substance as it is converted from a solid to a liquid



The graph below represents a substance being heated from -30°C to 110°C .

Heating Curve



If 50 kJ of heat are removed from the substance when it is at 50°C , what will be the state and temperature of the substance?

- A gas at 70°C
- B gas at 100°C
- C liquid at 0°C
- D liquid at 10°C

How many moles of nitrogen gas are in 135 L of nitrogen gas at Standard Temperature and Pressure (STP)?

- A 4.82 moles of N_2
- B 5.53 moles of N_2
- C 6.02 moles of N_2
- D 9.64 moles of N_2

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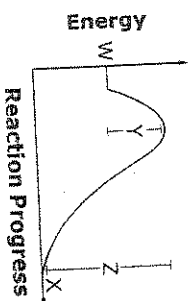
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- 23 A mixture of gases (NO_2 , CO_2 , SO_2) is collected in a bottle. The partial pressure of NO_2 is 1.25 atm, and the partial pressure of CO_2 is 2.63 atm. If the total pressure of the gases is 11.20 atm, what is the partial pressure of SO_2 ?
- A 2.89 atm
 - B 7.32 atm
 - C 9.23 atm
 - D 11.20 atm

- 24 This is a potential energy diagram.

Potential Energy Diagram



- What can be concluded from the potential energy diagram?
- A The reaction produced a covalent compound.
 - B The reaction produced an ionic compound.
 - C The reaction was exothermic.
 - D The reaction was endothermic.

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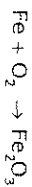
25 How does increasing temperature affect the collisions of reactant molecules in a chemical reaction?

- A The reactant molecules collide more frequently with greater energy per collision.
- B The reactant molecules collide more frequently with less energy per collision.
- C The reactant molecules collide less frequently with less energy per collision.
- D The reactant molecules collide less frequently with greater energy per collision.

Which reaction produces gas that turns lime water milky?

- A $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$
- B $2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2$
- C $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
- D $2\text{NaCl} \rightarrow 2\text{Na} + \text{Cl}_2$

The chemical equation below represents an unbalanced chemical reaction:



When the equation is balanced, what coefficient is needed for Fe_2O_3 ?

- A 1
- B 2
- C 3
- D 4



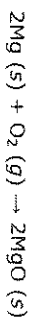
28 When AgNO_3 (aq) is mixed with NaCl (aq), which type of reaction will occur?

- A single replacement
- B synthesis
- C decomposition
- D double replacement

29 How much mass is in a 3.25-mole sample of NH_4OH ?

- A 10.8 g
- B 34.0 g
- C 35.1 g
- D 114 g

30 The equation below represents a balanced chemical reaction:



How many moles of MgO are produced when 7.2 moles of O_2 react with excess Mg ?

- A 3.6 moles
- B 14 moles
- C 22 moles
- D 29 moles



Why does the rate of a chemical reaction increase when the surface area of a reactant is increased?

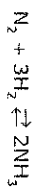
- A When the surface area increases, the reaction temperature increases.
- B When the surface area increases, the number of particle collisions increases.
- C When the surface area increases, the concentration of the substance increases.
- D When the surface area increases, the density of the substance increases.

Which *best* describes the role of enzymes in a chemical reaction?

- A They lower the activation energy in the reaction.
- B They prevent the reaction from occurring.
- C They are produced by the reaction.
- D They are consumed by the reaction.



33 The equation below represents the reaction between nitrogen gas and hydrogen gas to form ammonia. The reaction occurs within a closed container and comes to equilibrium:



What expression represents the equilibrium expression for this reaction?

- A $K_{\text{eq}} = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}$
- B $K_{\text{eq}} = \frac{[\text{N}_2][\text{H}_2]^3}{[\text{NH}_3]^2}$
- C $K_{\text{eq}} = \frac{[\text{N}_2][\text{H}_2]}{[\text{NH}_3]}$
- D $K_{\text{eq}} = \frac{[\text{N}_2]^2[\text{H}_2]^2}{[\text{NH}_3]^3}$

34 A sample of ammonia gas and hydrogen chloride gas is placed in a sealed container at 25°C and allowed to come to equilibrium according to this equation:



After equilibrium is established, the container is opened to allow the $\text{NH}_3(g)$ and $\text{HCl}(g)$ to escape. How would this affect the equilibrium?

- A The reaction would produce less $\text{NH}_3(g)$ and $\text{HCl}(g)$.
- B The reaction would shift to the right to produce more $\text{NH}_4\text{Cl}(s)$.
- C The reaction would shift to the left to produce more $\text{NH}_3(g)$ and $\text{HCl}(g)$.
- D The reaction would produce more $\text{NH}_3(g)$, $\text{HCl}(g)$, and $\text{NH}_4\text{Cl}(s)$ until the original equilibrium is reestablished.



36. Why is KOH considered to be an Arrhenius base?
- It produces OH^- ions in solution.
 - It produces H^+ ions in solution.
 - It produces H^- ions in solution.
 - It produces OH^- ions in solution.

36. The chart below shows the characteristics of several common acid-base indicators.

Characteristics of Common Acid-Base Indicators

Indicator	pH Range	Color Range
Bromocresol Green	3.8–5.4	Yellow to Blue
Congo Red	3.0–5.0	Blue to Red
Phenol Red	6.8–8.2	Yellow to Red
Indigo Carmine	11.6–13.0	Blue to Yellow

Which indicator would appear to be yellow in a solution with a hydrogen ion concentration of 1.0×10^{-7} ?

- Bromocresol Green
- Congo Red
- Phenol Red
- Indigo Carmine

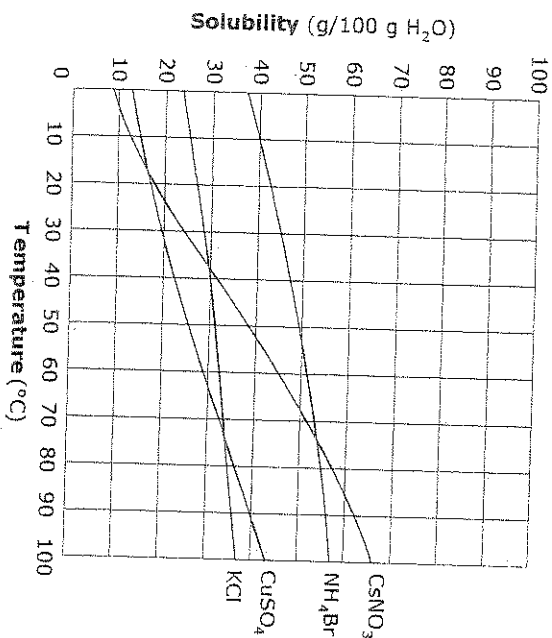
37. Which **best** describes electrolytic and nonelectrolyte solutions?

- Electrolytic solutions produce ions in solution, while nonelectrolytes do not produce ions in solution.
- Electrolytic solutions include alcohols and sugars, while nonelectrolytes include acids and bases.
- Electrolytic solutions are not able to conduct electricity, while nonelectrolytes are able to conduct electricity.
- Electrolytic solutions are composed of polar covalent substances, while nonelectrolytes are composed of ionic compounds.



38 The graph below shows the solubility of various compounds.

Solubility of Various Compounds



At what temperature will 50 g of NH₄Br produce a saturated solution when dissolved in 100 g of water?

- A 48°C
- B 54°C
- C 60°C
- D 66°C

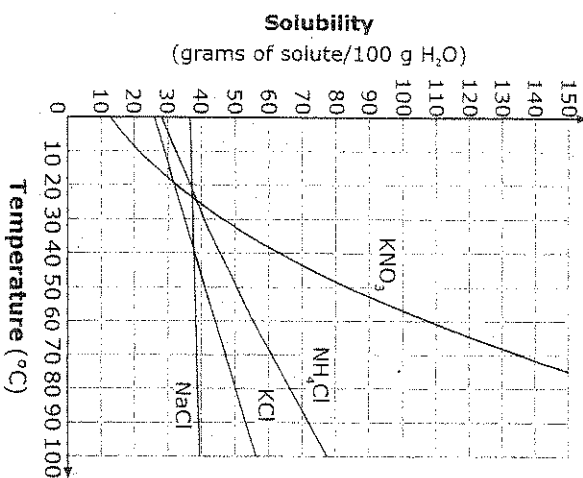
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39 The graph below shows the solubility of various compounds.

Solubility of Various Compounds



Which salt solution could contain *approximately* 50 g of solute per 100 g of H₂O at 80°C?

- A a saturated solution of KCl
- B a saturated solution of KNO₃
- C an unsaturated solution of NaCl
- D a supersaturated solution of NH₄Cl

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When salt (NaCl) is dissolving in water (H₂O), what happens to the attraction between the salt ions and the oxygen atoms of the water?

- A The chlorine ion is attracted to the partial negative charge of the oxygen atoms.
- B The chlorine ion is attracted to the partial positive charge of the oxygen atoms.
- C The sodium ion is attracted to the partial negative charge of the oxygen atoms.
- D The sodium ion is attracted to the partial positive charge of the oxygen atoms.

Finish the end of the multiple-choice portion of the test.



The questions you read next will require you to answer in writing.

1. Write your answers on separate paper.
2. Be sure to write your name on each page.

- 1 Ionization energy of an element is one of many trends found on the periodic table.
 - Describe ionization energy trends of the elements in the periodic table.
 - List the elements beryllium, boron, carbon, fluorine, nitrogen, and oxygen based on *increasing* ionization energy.
- 2 A compound with a molecular mass of 78 g/mol contains the elements carbon and hydrogen in a ratio of 1 carbon : 1 hydrogen. Answer the questions using the data provided. Show your work.
 - What is the empirical formula for this compound?
 - What is the molecular formula for this compound?
 - What is the percent composition of carbon in this compound?
- 3 Acids and bases are substances classified as electrolytes.
 - Why are acids and bases considered electrolytes?
 - Compare the electrical conductivity of strong acids and bases to the electrical conductivity of weak acids and bases.