Name: Date:
Teacher: Class/Period:

1) Anything that takes up space and has mass can be referred to as which of the following?

A. Compound

B. Matter

C. Mixture

D. Element

2) Which of the following statements does NOT accurately describe acids or bases?

A. Acids are corrosive.

B. Acids have endothermic reactions with water.

C. Bases have lower hydrogen ion (H^+) concentrations than pure water.

D. Bases turn red litmus paper blue.

3) Evaporation of water from a surface is an efficient way to cool the surface. The heat of vaporization of H_2O is 40.8 kJ/mol. If 36.0 g of H_2O evaporates from the surface, how much heat does the surface lose?

(Note: Assume all the heat comes from the surface.)

A. 20.4 kJ

B. 76.8 kJ

C. 81.5 kJ

D. 94.8 kJ

4) If a student adds 2.00 g of NaOH to 250.0 mL of pure water, which value is closest to the resulting pOH of the water?

A. 0.7

B. 3.7

C. 10.3

D. 13.3

5) Balance this oxidation-reduction reaction occurring in basic aqueous solution.

$$Bi(OH)_3 + SnO_2^{2-} \rightarrow Bi + SnO_3^{2-}$$

A. $Bi(OH)_3 + SnO_2^{2-} \rightarrow Bi + SnO_3^{2-} + 2H_2O$

B. $2Bi(OH)_3 + 3SnO_2^{2-} \rightarrow 2Bi + 3SnO_3^{2-} + 3H_2O$

C. $2Bi(OH)_3 + SnO_2^{2-} \rightarrow 2Bi + SnO_3^{2-} + 2H_2O + 2OH^-$

D. $Bi(OH)_3 + 3SnO_2^{2-} + 2OH^- \rightarrow Bi + 3SnO_3^{2-} + 4H_2O$

6) Consider this balanced oxidation-reduction reaction.

$$6Sb + 10HNO_3 \rightarrow 3Sb_2O_5 + 10NO + 5H_2O$$

Which statement correctly describes how the oxidation number of the reducing agent changes in this reaction?

A. The oxidation number of H changes from +1 to −1.

B. The oxidation number of N changes from +5 to +2.

C. The oxidation number of O changes from −2 to −1.

D. The oxidation number of Sb changes from 0 to +5.

7) The voltaic cell in a Ni-Cd battery contains half-cells with these half-reactions.

Half-reaction	Standard reduction potential ($E°$)
$Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$	−0.25 V
$Cd^{2+}(aq) + 2e^- \rightarrow Cd(s)$	−0.40 V

Use the standard reduction potentials of the half-reactions to determine the standard cell potential ($E°_{cell}$) of the voltaic cell, and determine if the overall reaction in the voltaic cell is spontaneous.

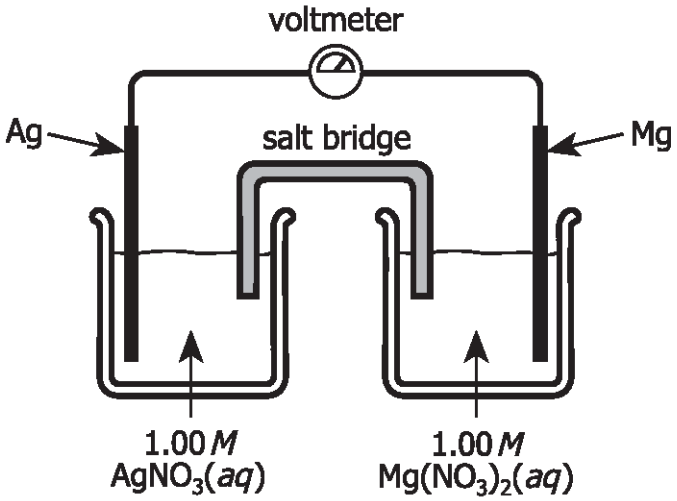
A. +0.15 V, spontaneous

B. +0.15 V, not spontaneous

C. −0.15 V, spontaneous

D. −0.15 V, not spontaneous

8) This diagram shows a voltaic cell containing silver and magnesium electrodes.



Use the standard reduction potentials ($E°$) in the table to determine the standard cell potential ($E°_{cell}$) for this voltaic cell.

Half-reaction	Standard reduction potential ($E°$)
$Ag^+(aq) + 1e^- \rightarrow Ag(s)$	+0.80 V
$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$	−2.37 V

A. −1.57 V

B. −0.77 V

C. +3.17 V

D. +3.97 V

9) In 1911, Marie Curie won the Nobel Prize in Chemistry for discovering radium (Ra) and polonium (Po). During the nuclear decay of polonium-210, alpha (α) particle emission occurs.

$$^{210}_{84}\text{Po} \rightarrow {}^{4}_{2}\text{He} + \text{\_\_\_\_}$$

What other product forms?

A. $^{214}_{86}\text{Rn}$

B. $^{206}_{82}\text{Pb}$

C. $^{208}_{84}\text{Po}$

D. $^{204}_{81}\text{Tl}$

10) Which of the following statements accurately defines the law of conservation of energy in any chemical process?

A. Energy can be created and destroyed.

B. Energy can be created but not destroyed.

C. Energy can not be created but can be destroyed.

D. Energy can not be created nor can it be destroyed.

11) This equation shows the heat of reaction (ΔH°_{rxn}) for the formation of 1 mol of water from the reaction of hydrogen and oxygen.

$$H_2(g) + \frac{1}{2}\,O_2(g) \rightarrow H_2O(l);\ \Delta H^\circ_{rxn} = -286\ \text{kJ}$$

What is the minimum amount of energy required to produce 1 mol of O_2 through the decomposition of H_2O ?

A. 572 kJ

B. 286 kJ

C. −286 kJ

D. −572 kJ

12) Which chemical reaction involves an increase in the entropy of the system?

A. $CO_2(g) \rightarrow CO_2(s)$

B. $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

C. $2NaN_3(s) \rightarrow 2Na(l) + 3N_2(g)$

D. $Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$

13) As the pH of an aqueous solution increases from 5 to 9, what happens?

A. The concentrations of H^+ and OH^- both decrease.

B. The concentrations of H^+ and OH^- both increase.

C. The concentration of H^+ decreases, and the concentration of OH^- increases.

D. The concentration of H^+ increases, and the concentration of OH^- decreases.

14) What is the balanced chemical equation for the reaction of solid aluminum hydroxide with aqueous hydrochloric acid?

A. $Al(OH)_2(s) + 2HCl(aq) \rightarrow AlCl_2(aq) + H_2O(l)$

B. $Al(OH)_2(s) + 2HCl(aq) \rightarrow AlCl_2(aq) + 2H_2O(l)$

C. $Al(OH)_3(s) + 3HCl(aq) \rightarrow AlCl_3(aq) + 3H_2O(l)$

D. $Al(OH)_3(s) + 3HCl(aq) \rightarrow AlCl_3(aq) + 4H_2O(l)$

15) At 25°C, an aqueous solution of LiOH has a molarity of 0.025 *M*. What is the pH of this solution?

A. 1.60

B. 2.40

C. 12.40

D. 13.60

16) The reducing agent in an oxidation-reduction reaction contains the species that is:

A. reduced, because that results in the reduction of another species in the reaction.

B. reduced, because that results in the oxidation of another species in the reaction.

C. oxidized, because that results in the reduction of another species in the reaction.

D. oxidized, because that results in the oxidation of another species in the reaction.

17) A redox reaction occurs when aqueous solutions of iodine (I_2) and hypochlorite ion (OCl^-) are mixed. This unbalanced chemical equation shows the species involved in the reaction.

$$I_2 + OCl^- \rightarrow Cl^- + IO_3^-$$

Balance this redox reaction occurring in acidic aqueous solution.

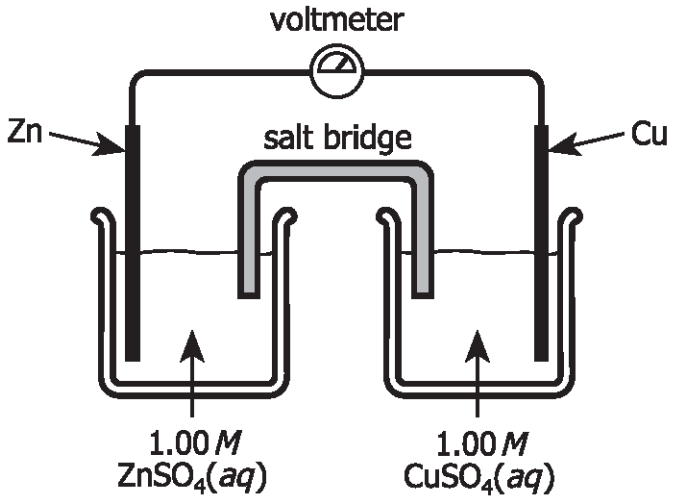
A. $I_2 + 6OCl^- \rightarrow 6Cl^- + 2IO_3^-$

B. $I_2 + OCl^- + 2H_2O \rightarrow Cl^- + IO_3^- + 4H^+$

C. $I_2 + OCl^- + 5H_2O \rightarrow Cl^- + 2IO_3^- + 10H^+$

D. $I_2 + 5OCl^- + H_2O \rightarrow 5Cl^- + 2IO_3^- + 2H^+$

18) This diagram shows a voltaic cell. One half-cell contains a zinc electrode in 1.00 *M* aqueous $ZnSO_4$. The other half-cell contains a copper electrode in 1.00 *M* aqueous $CuSO_4$.



During normal operation, this voltaic cell produces a voltage of +1.10 V. If a chemist removes the salt bridge, what voltage will the cell produce?

A. −1.10 V

B. 0.00 V

C. +0.55 V

D. +1.10 V

19) When the nuclei of some isotopes are bombarded with neutrons, some of the nuclei split into 2 lighter fragments. What is the name of this process?

A. Fission

B. Fusion

C. Mutation

D. Neutron decay

20) What type of radiation resulting from nuclear decay reactions has the greatest energy and the greatest penetrating ability?

A. Alpha particles

B. Beta particles

C. Gamma rays

D. X-rays

21) For a research project, Ruth studies the nuclear decay of silicon-31 and identifies phosphorus-31 as 1 of the products. What is the other product?

$$^{31}_{14}\text{Si} \rightarrow {}^{31}_{15}\text{P} + \text{\_\_\_\_}$$

A. Proton

B. Gamma ray

C. Beta particle

D. Alpha particle

22) A student needs 250.0 mL of aqueous 2.50 *M* hydrochloric acid for an experiment. The student has 150.0 mL of 6.00 *M* HCl(*aq*). Which procedure can the student use to prepare the required solution?

A. Adding 3.600 mL of 6.00 *M* HCl(*aq*) to approximately 225 mL of water and diluting to 250.0 mL with water

B. Adding 16.67 mL of 6.00 *M* HCl(*aq*) to approximately 200 mL of water and diluting to 250.0 mL with water

C. Adding 62.50 mL of 6.00 *M* HCl(*aq*) to approximately 175 mL of water and diluting to 250.0 mL with water

D. Adding 104.2 mL of 6.00 *M* HCl(*aq*) to approximately 125 mL of water and diluting to 250.0 mL with water

23) Phosgene ($COCl_2$) decomposes to produce carbon monoxide (CO) and chlorine (Cl_2) in this equilibrium reaction.

$$COCl_2(g) \rightleftharpoons CO(g) + Cl_2(g)$$

A chemist performs this reaction in a 2 L container and obtains a 7.0% yield of Cl_2. How can the chemist improve the percent yield of Cl_2 in this equilibrium reaction?

A. By reducing the volume of the container

B. By increasing the volume of the container

C. By using a smaller amount of $COCl_2$

D. By adding CO

24) What is the equilibrium constant expression for this chemical equilibrium?

$$4NH_3(g) + 3O_2(g) \rightleftharpoons 6H_2O(g) + 2N_2(g)$$

A. $K_{eq} = \dfrac{[H_2O] + [N_2]}{[NH_3] + [O_2]}$

B. $K_{eq} = \dfrac{[H_2O] - [N_2]}{[NH_3] - [O_2]}$

C. $K_{eq} = \dfrac{[H_2O]^6 \times [N_2]^2}{[NH_3]^4 \times [O_2]^3}$

D. $K_{eq} = \dfrac{6[H_2O]^6 \times 2[N_2]^2}{4[NH_3]^4 \times 3[O_2]^3}$

25) Two students conducted an experiment to determine how temperature affects the solubility of Compound M in H_2O. For each trial, they added Compound M to 10.0 mL of H_2O until it no longer dissolved in the H_2O. The students recorded their results in this table.

Trial	H_2O Temperature (°C)	Mass of Compound M that dissolved (g)
1	25.0	1.75
2	30.0	2.10
3	35.0	2.25
4	40.0	2.37

Identify the dependent variable(s) in this experiment.

A. Temperature of H_2O used only

B. Mass of Compound M that dissolved only

C. Temperature of H_2O used and volume of H_2O used only

D. Mass of Compound M that dissolved and volume of H_2O used only

26) Peroxidase is an enzyme that breaks down peroxides.

Dr. Cortez performs an experiment to determine how pH affects the ability of peroxidase to break down peroxides. She performs the experiment at 37°C and records her results in this table. Dr. Cortez defines peroxidase activity as a measure of its ability to break down peroxides.

pH	Peroxidase activity
2	none
4	low
6	medium
7	high

At 37°C, Dr. Cortez adjusts the pH of a sample solution from 5.0 to 7.0. What effect, if any, would this pH change have on the ability of peroxidase to break down peroxides?

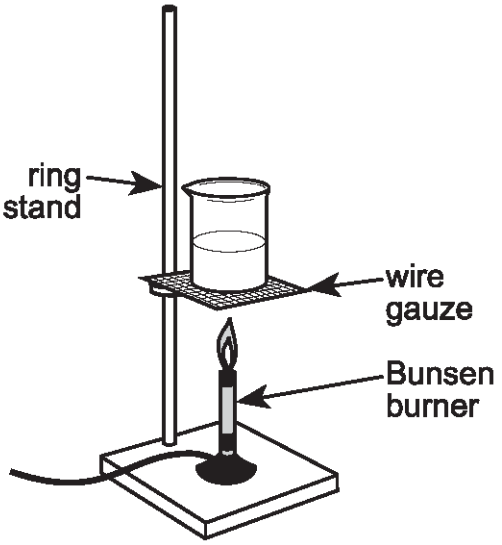
A. It would stop the rate of breakdown.

B. It would decrease the rate of breakdown.

C. It would increase the rate of breakdown.

D. It would have no effect on the rate of breakdown.

27) A chemistry student heats a beaker of water using a Bunsen burner, as shown in this diagram.



Why does the student most likely use the wire gauze?

A. To absorb all of the heat from the beaker

B. To transport the hot beaker after heating

C. To provide a stable stage for heating the beaker

D. To protect the Bunsen burner if the beaker breaks

28) The field of nanotechnology investigates the uses of carbon compounds in products such as microchips and superconductors. Which is NOT a necessary criterion for nanotechnology research to meet for the research to be considered scientific?

A. Reporting all results

B. Altering experimental results to confirm hypotheses

C. Submitting results to peer-reviewed journals that are open to critique

D. Modifying hypotheses as new information and techniques become available

29) Which of the following statements is an example of a scientific law?

A. The atomic mass of tin is 118.7 amu.

B. The specific heat capacity of iron is 0.46 J/g·°C.

C. The density of liquid water is greater than the density of ice at room temperature.

D. The kelvin temperature of a gas is directly proportional to the volume of the gas.

30) Which property of a solid aluminum cube is different on Earth than it is on the Moon?

A. Weight

B. Volume

C. Mass

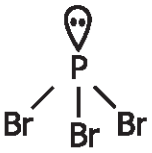
D. Density

31) White phosphorus (P_4) reacts with bromine (Br_2) to produce phosphorus tribromide (PBr_3).

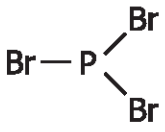
$$P_4(s) + 6Br_2(l) \rightarrow 4PBr_3(l)$$

Use the valence-shell electron-pair repulsion (VSEPR) theory to determine the molecular geometry of PBr_3.

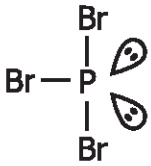
A. Trigonal pyramidal



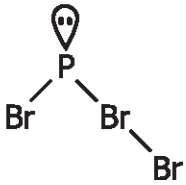
B. Trigonal planar



C. T-shaped

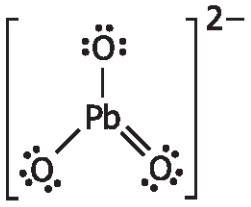


D. Bent

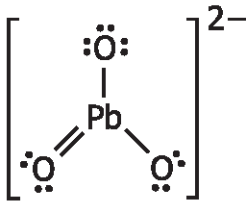


32) In chemistry class, Jeremy learns that the plumbate ion (PbO_3^{2-}) has 3 resonance structures that obey the octet rule. Which of the following structures is 1 of the resonance structures of PbO_3^{2-} ?

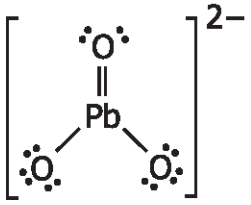
A.



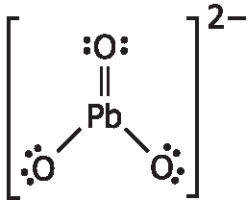
C.



B.



D.



33) Which molecule has a dipole moment of zero?

A. SO_2

B. NH_3

C. $CHCl_3$

D. CCl_4

34) What is the electron configuration of the chromium ion in CrO_3 ?

A. [Ar]

B. [Ar] $3d^3$

C. [Ar] $4s^2\ 3d^1$

D. [Ar] $4s^2\ 3d^4$

35) Dr. Li, a visiting chemistry professor from a local university, performed a demonstration in the high school chemistry lab. Behind a protective shield in the fume hood, she carefully added a small piece of Na to a beaker of water, and a very exothermic reaction occurred. Which property of Na would best explain this result?

A. Low density

B. Large atomic radius

C. Low first ionization energy

D. High electronegativity

36) Which statement describes a property of all of the Group 4A (14) elements?

A. They are metals.

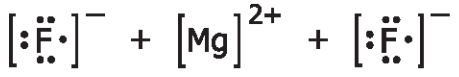
B. They are nonmetals.

C. They form anions with a 2– charge.

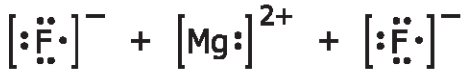
D. They have 2 valence electrons in *p* orbitals.

37) Which set of Lewis dot structures accurately represents the ions bound in MgF_2 ?

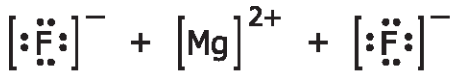
A.



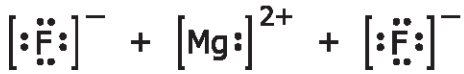
B.



C.



D.



38) The sulfide ion (S^{2-}) has an ionic radius of 184 pm (1 pm = 10^{-12} m). Use the periodic table to determine the most likely ionic radii for the oxide ion (O^{2-}) and the selenide ion (Se^{2-}).

A. O^{2-} = 140 pm and Se^{2-} = 198 pm

B. O^{2-} = 198 pm and Se^{2-} = 140 pm

C. O^{2-} = 198 pm and Se^{2-} = 226 pm

D. O^{2-} = 226 pm and Se^{2-} = 198 pm

39) In a famous experiment, scientists bombarded a very thin gold (Au) foil with positively charged alpha particles. They found that most of the alpha particles passed right through the Au foil. However, a few of the alpha particles were deflected or bounced back toward the source. How did these scientists explain their results?

A. Negative charges are spread throughout the atom.

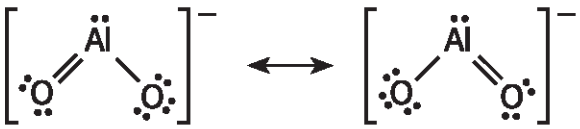
B. Negative charges are located in the tiny nucleus of the atom.

C. Positive charges are spread throughout the atom.

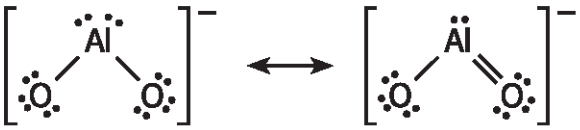
D. Positive charges are located in the tiny nucleus of the atom.

40) In geology class, Lauren learns that the mineral chrysoberyl is an aluminate (AlO_2^-) of beryllium (Be). Using her chemistry knowledge, she decides to draw the Lewis dot structure(s) of AlO_2^-, and she finds that there are several resonance structures of AlO_2^-. Which of the following shows 2 resonance structures of AlO_2^- ?

A.



B.



C.

D.

41) Oxygen and sulfur are in the same group in the periodic table. However, H_2S has a boiling point of −60.7°C, and H_2O has a boiling point of 100.0°C. Which statement best explains this difference in boiling points?

A. H_2O has a larger molar mass.

B. H_2O has stronger intermolecular hydrogen bonds.

C. H_2S has a larger heat of vaporization.

D. H_2S has stronger intermolecular van der Waals forces.

42) Which of the following statements accurately compares the properties of ionic and covalent compounds? In general, ionic compounds:

A. are less soluble in H_2O than covalent compounds.

B. have lower melting points than covalent compounds.

C. are not solids at room temperature, while covalent compounds are usually solids at room temperature.

D. conduct electricity when they are molten, while covalent compounds usually do not conduct electricity when they are molten.

43) In sodium hypochlorite (NaClO), chlorine has an oxidation number of +1. What is the electron configuration of Cl^+ ?

A. [Ne] $3s^2\ 3p^3$

B. [Ne] $3s^2\ 3p^4$

C. [Ne] $3s^2\ 3p^5$

D. [Ne] $3s^2\ 3p^6$

44) At 22°C, the air pressure in a car tire is 1,293 torr. Convert this pressure to atm.

A. 12.76 atm

B. 5.262 atm

C. 1.701 atm

D. 1.293 atm

45) At high temperatures, chlorine reacts with fluorine to produce chlorine trifluoride.

$$Cl_2(g) + 3F_2(g) \rightarrow 2ClF_3(g)$$

A chemist carries out the reaction of 0.250 mol of F_2 with excess Cl_2. At 250.0°C and 1.00 atm, what is the maximum volume of ClF_3, that the reaction can produce?

A. 3.42 L

B. 3.73 L

C. 7.16 L

D. 10.7 L

46) Which statement correctly describes 1 mole of I_2 ?

A. Its mass is 126.9 g.

B. Its mass is 380.7 g.

C. It contains 6.02×10^{23} atoms.

D. It contains 6.02×10^{23} molecules.

47) At 25°C, germanium(II) chloride rapidly reacts with chlorine to produce germanium(IV) chloride.

$$GeCl_2 + Cl_2 \rightarrow GeCl_4$$

Which statement correctly describes this reaction?

A. The sum of the masses of $GeCl_2$ and Cl_2 consumed equals the mass of $GeCl_4$ produced.

B. The sum of the masses of Cl_2 and $GeCl_4$ consumed equals the mass of $GeCl_2$ produced.

C. The mass of $GeCl_2$ consumed is greater than the mass of $GeCl_4$ produced.

D. The mass of Cl_2 consumed is greater than the mass of $GeCl_4$ produced.

48) At high temperatures, nitrogen reacts with magnesium to produce magnesium nitride.

$$N_2(g) + 3Mg(s) \rightarrow Mg_3N_2(s)$$

Which statement accurately describes the information represented by this balanced chemical equation?

A. 1 atom of N_2 reacts with 3 atoms of Mg to produce 1 atom of Mg_3N_2.

B. 1 formula unit of N_2 reacts with 3 formula units of Mg to produce 1 formula unit of Mg_3N_2.

C. 1 mole of N_2 reacts with 3 moles of Mg to produce 1 mole of Mg_3N_2.

D. 1 molecule of N_2 reacts with 3 atoms of Mg to produce 1 molecule of Mg_3N_2.

49) In the chemistry laboratory, a student adds aqueous ammonium chloride to aqueous silver acetate to produce aqueous ammonium acetate and solid silver chloride. What is the net ionic equation for this reaction?

A. $Cl^-(aq) + Ag^+(aq) \rightarrow AgCl(s)$

B. $NH_4^+(aq) + C_2H_3O_2^-(aq) \rightarrow NH_4C_2H_3O_2(aq)$

C. $NH_4Cl(aq) + AgC_2H_3O_2(aq) \rightarrow NH_4C_2H_3O_2(aq) + AgCl(s)$

D. $NH_4^+(aq) + Cl^-(aq) + Ag^+(aq) + C_2H_3O_2^-(aq) \rightarrow NH_4^+(aq) + C_2H_3O_2^-(aq) + AgCl(s)$

50) Chemists add ammonium lauryl sulfate, $CH_3(CH_2)_{11}SO_4NH_4$, to shampoo to reduce the surface tension of water. How many hydrogen atoms are in 1 molecule of ammonium lauryl sulfate?

A. 9

B. 20

C. 25

D. 29

51) What is the chemical formula of calcium cyanide?

A. $CaCN$

B. $CaCN_2$

C. $Ca(CN)_2$

D. $Ca(CN)_3$

52) A sample of a compound containing only nickel and oxygen has a mass of 24.6 g. Analysis of the sample shows that 10.4 g is Ni and the remaining 14.2 g is O. What is the percent by mass of Ni in this sample?

A. 26.8%

B. 42.3%

C. 57.7%

D. 73.2%

53) What is the molar mass of $Al(NO_3)_3$?

A. 88.99 g/mol

B. 151.00 g/mol

C. 165.01 g/mol

D. 213.01 g/mol

54) When aqueous ammonium carbonate is mixed with aqueous calcium nitrate, solid calcium carbonate and aqueous ammonium nitrate are produced. What is the balanced chemical equation for this reaction?

A. $NH_4CO_3(aq) + Ca(NO_3)_2(aq) \rightarrow CaCO_3(s) + 2NH_4NO_3(aq)$

B. $NH_4CO_3(aq) + Ca_2NO_3(aq) \rightarrow Ca_2CO_3(s) + (NH_4)_2NO_3(aq)$

C. $(NH_4)_2CO_3(aq) + Ca_2NO_3(aq) \rightarrow Ca_2CO_3(s) + (NH_4)_2NO_3(aq)$

D. $(NH_4)_2CO_3(aq) + Ca(NO_3)_2(aq) \rightarrow CaCO_3(s) + 2NH_4NO_3(aq)$

55) In chemistry lab, Justin adds an aqueous solution of $Ba(OH)_2$ to an aqueous solution of K_2SO_4. Use the solubility data in the table to predict the products and determine the balanced chemical equation for this reaction.

Solubility of Ionic Compounds in H_2O		
	Hydroxide	Sulfate
Ba^{2+}	soluble	insoluble
K^+	soluble	soluble

A. $Ba(OH)_2(aq) + K_2SO_4(aq) \rightarrow 2KOH(aq) + BaSO_4(s)$

B. $Ba(OH)_2(aq) + K_2SO_4(aq) \rightarrow 2KOH(s) + BaSO_4(aq)$

C. $2Ba(OH)_2(aq) + K_2SO_4(aq) \rightarrow 2K(OH)_2(aq) + Ba_2SO_4(s)$

D. $2Ba(OH)_2(aq) + K_2SO_4(aq) \rightarrow 2K(OH)_2(s) + Ba_2SO_4(aq)$

56) An atom of which element has this ground-state electron configuration?

$$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$$

A. N

B. O

C. P

D. S

57) In Mg_3N_2, nitrogen has a charge of 3–. What is the electron configuration of the N^{3-} ion?

A. [He] $2s^1$

B. [He] $2s^2$

C. [He] $2s^2\ 2p^3$

D. [He] $2s^2\ 2p^6$

58) How many electrons does a calcium atom lose when it forms a stable compound with elemental bromine?

A. 0

B. 1

C. 2

D. 4

59) A bond between 2 atoms having identical electronegativities is best classified as which of the following?

A. Covalent bond

B. Hydrogen bond

C. Ionic bond

D. Polar bond

60) Hydrogen bonding does NOT explain which of the following properties of H_2O ?

A. The pH of pure H_2O is 7.

B. H_2O has a high surface tension.

C. Solid H_2O is less dense than liquid H_2O.

D. H_2O has a relatively high boiling point.

61) What type of solid is CsBr ?

A. Ionic

B. Metallic

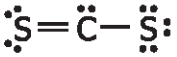
C. Molecular

D. Network

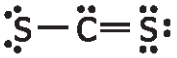
62) For a homework assignment, a student is asked to draw the Lewis structure of CS_2. Which of the following structures should the student draw?

A.

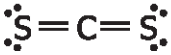
B.



C.

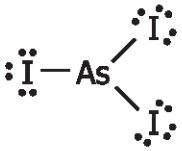


D.

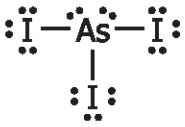


63) What is the Lewis structure of AsI_3 ?

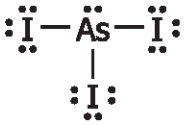
A.



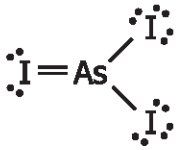
C.



B.



D.



64) Use the valence-shell electron-pair repulsion (VSEPR) theory to determine the molecular geometry of SCl_2.

A. Trigonal planar

B. Tetrahedral

C. Linear

D. Bent

65) Use the valence-shell electron-pair repulsion (VSEPR) theory to determine the geometry of the NO_3^- ion.

A. T-shaped

B. Trigonal planar

C. Trigonal pyramidal

D. Trigonal bipyramidal

66) A student dissolves 2.00 g of sodium hydroxide in enough distilled water to make 250.0 mL of solution. What is the concentration of the resulting solution?

A. $2.00 \times 10^{-4}\ M$

B. $8.00 \times 10^{-3}\ M$

C. $0.200\ M$

D. $8.00\ M$

67) Luis prepares a carbonated beverage using carbon dioxide gas, solid sucrose ($C_{12}H_{22}O_{11}$), and liquid H_2O. Identify only the solute(s).

A. CO_2 only

B. H_2O only

C. CO_2 and $C_{12}H_{22}O_{11}$ only

D. $C_{12}H_{22}O_{11}$ and H_2O only

68) A pharmacist prepared a liquid medication and gave instructions to shake the medication well before using. How is the medicine most likely formulated?

A. As a suspension with particles that settled to the bottom of the container

B. As a solution with particles that settled to the bottom of the container

C. As a colloid with particles that remain unevenly distributed throughout the container

D. As a homogeneous mixture with particles that remain unevenly distributed throughout the container

69) Which of the following substances is a solution?

A. Graphite

B. Brass

C. Silicon dioxide

D. Molten gold

70) While a total of 2.0 L of iced tea was prepared, 150 g of sucrose ($C_{12}H_{22}O_{11}$) was added. What is the concentration of the $C_{12}H_{22}O_{11}$ in the iced tea?

A. 0.11 *M*

B. 0.22 *M*

C. 0.44 *M*

D. 0.88 *M*

71) A biochemistry student prepares a saline solution containing the same concentration of NaCl as that of normal human blood. The student adds 2.25 g of NaCl to 250.0 g of sterile water. What is the percent by mass of NaCl in the saline solution?

A. 0.884%

B. 0.892%

C. 0.900%

D. 0.908%

72) A scientist adds 1.0 g of a solid to 1 L of water. The solid does not dissolve, and the mixture is cloudy. Can this mixture be classified as a solution?

A. Yes, because the solid is the solute and water is the solvent.

B. Yes, because the solid is distributed uniformly throughout the water.

C. No, because the solid does not settle to the bottom of the mixture.

D. No, because the solid does not dissolve in the solvent.

73) Adriana prepares barium carbonate ($BaCO_3$) through the reaction of barium nitrate ($Ba(NO_3)_2$) with sodium carbonate (Na_2CO_3).

$$Ba(NO_3)_2(aq) + Na_2CO_3(aq) \rightarrow BaCO_3(s) + 2NaNO_3(aq)$$

If she combines 15 mL of aqueous 0.10 *M* $Ba(NO_3)_2$ and excess Na_2CO_3, what is the maximum mass of $BaCO_3$ that can be produced?

A. 0.0015 g

B. 0.30 g

C. 1.5 g

D. 3.0 g

74) Samantha suspects that the tap water in the lab contains high levels of Cl^-. Use the data in the table to determine which procedure she should use to test for Cl^- in the water.

Solubility of Ionic Compounds in H_2O				
	Al^{3+}	K^+	Pb^{2+}	Zn^{2+}
Cl^-	soluble	soluble	insoluble	soluble
NO_3^-	soluble	soluble	soluble	soluble
SO_4^{2-}	soluble	soluble	insoluble	soluble

A. Adding $Al_2(SO_4)_3(aq)$ to produce solid $AlCl_3$

B. Adding $K_2SO_4(aq)$ to produce solid KCl

C. Adding $Pb(NO_3)_2(aq)$ to produce solid $PbCl_2$

D. Adding $Zn(NO_3)_2(aq)$ to produce solid $ZnCl_2$

75) Brian investigated the solubility rate of sugar in coffee and recorded his procedure in this table.

Solubility of Sugar in Coffee		
Experiment	Form of sugar	Temperature (°C)
1	cube	95
2	cube	50
3	granulated	95
4	granulated	50

For each experiment, he used 4.0 g of sugar, 250.0 mL of coffee, and an equal amount of stirring. The sugar most likely dissolved fastest in:

A. Experiment 1.

B. Experiment 2.

C. Experiment 3.

D. Experiment 4.

76) Max must prepare an aqueous solution of $MgCl_2$ with a molality of 0.250. What mass of $MgCl_2$ must he add to 1.40 kg of H_2O ?

A. 5.60 g

B. 17.0 g

C. 23.8 g

D. 33.3 g

77) A student observes the combustion of propane (C_3H_8). Because of the heat and light it generates, the student concludes that the reaction has NO activation energy. Is the student's conclusion correct, and why?

A. Yes; because the propane is flammable, there is no activation energy.

B. Yes; because the reaction generates heat, there is no activation energy.

C. No; because the reaction requires an ignition source, it does have an activation energy.

D. No; because the reaction generates light, it does have an activation energy.

78) Chemists generate hydrogen gas using this exothermic reaction.

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

Assuming that the reaction is at equilibrium, which of the following changes will increase the amount of H_2 ?

A. Removing CO_2 from the reaction

B. Removing CO from the reaction

C. Increasing the temperature

D. Adding a catalyst

79) At 25°C, the solubility product constant (K_{sp}) for MgF_2 is 3.70×10^{-8}. During chemistry class, Chenise prepares a saturated aqueous solution of MgF_2 at 25°C. What is the concentration of F^- in the saturated solution?

A. 1.36×10^{-4} *M*

B. 2.10×10^{-3} *M*

C. 3.33×10^{-3} *M*

D. 4.20×10^{-3} *M*

80) The label on a bottle of water indicates the bottle contains 455 mL of water. How many liters of water are in the bottle?

A. 0.455 L

B. 4.55 L

C. 45,500 L

D. 455,000 L

81) The mass of a dry, empty beaker is 81.05 g. Richard places a wet solid in this beaker. Next, he places the beaker containing the wet solid in an oven at 100°C for 24 hours to dry the solid. He allows the beaker to cool for 1 hour, and then he determines that the mass of the beaker and the dried solid is 87.35 g. Using the correct number of significant figures, calculate the mass of the dried solid.

A. 6.3 g

B. 6.30 g

C. 6.300 g

D. 6.3000 g

82) The speed of light in a vacuum is 299,800,000 m/sec. Which of the following is the best expression of this number in scientific notation?

A. 2.998×10^{8} m/sec

B. 2.998×10^{5} m/sec

C. 2.998×10^{-5} m/sec

D. 2.998×10^{-8} m/sec

83) Which of the following statements are characteristics of a scientific theory?

I. It is supported by experimental evidence.
II. It allows scientists to make valid predictions.
III. It is still subject to new experimental data and could be modified.

A. I and II only

B. I and III only

C. II and III only

D. I, II, and III

84) A chemist creates a new element and reports the discovery. In order to confirm this discovery, what should another group of scientists do?

A. Review the discoverer's notes and try to repeat the experiment

B. Interview the discoverer and view the new element

C. Discuss the discoverer's previous work

D. Tour the discoverer's laboratory

85) What is the percent by mass of chlorine in $BaCl_2 \cdot 2H_2O$?

A. 14.5%

B. 17.0%

C. 29.0%

D. 34.1%

86) In a closed container at STP, hydrogen reacts with iodine to produce hydrogen iodide, as shown in this chemical equilibrium.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

This equilibrium reaction is endothermic. According to Le Châtelier's principle, which of these changes to reaction conditions would increase the production of HI at equilibrium?

A. Adding $HI(g)$ to the reaction

B. Removing $I_2(g)$ from the reaction

C. Decreasing the pressure

D. Increasing the temperature

87) At 25°C, the solubility product constant (K_{sp}) for CaF_2 is 3.90×10^{-11}. What is the concentration of Ca^{2+} in a saturated solution of CaF_2 at 25°C ?

A. $3.39 \times 10^{-4}\ M$

B. $2.14 \times 10^{-4}\ M$

C. $6.25 \times 10^{-6}\ M$

D. $4.42 \times 10^{-6}\ M$

88) During chemistry lab, James studied the equilibrium reaction between Compound D and Compound X in water.

$$2D(aq) + 3X(aq) \rightleftharpoons D_2X_3(aq)$$

He studied the reaction at 4 different temperatures, and he measured the concentration of each chemical species at equilibrium. James recorded his results in this table.

Temperature (°C)	D (*M*)	X (*M*)	D_2X_3 (*M*)
25	0.350	0.400	0.250
35	0.280	0.310	0.340
45	0.220	0.270	0.360
55	0.210	0.280	0.360

Use the data in the table to determine the temperature of the reaction with the largest equilibrium constant.

A. 25°C

B. 35°C

C. 45°C

D. 55°C

89) At 25°C, a chemistry student prepared a saturated aqueous solution of AgBr. The concentration of Br^- in the solution was 7.07×10^{-7} *M*. Calculate the solubility product constant (K_{sp}) for AgBr at 25°C.

A. 5.00×10^{-13}

B. 2.00×10^{-12}

C. 3.54×10^{-7}

D. 1.41×10^{-6}

90) Phosphorus pentachloride reacts with water to produce phosphoric acid and hydrochloric acid.

$$PCl_5(s) + 4H_2O(l) \rightarrow H_3PO_4(aq) + 5HCl(aq)$$

Which of the following statements correctly relates the rate of disappearance of a reactant to the rate of appearance of a product in this reaction?

A. H_2O disappears at a faster rate than HCl appears.

B. H_2O disappears at a slower rate than H_3PO_4 appears.

C. PCl_5 disappears at a faster rate than H_3PO_4 appears.

D. PCl_5 disappears at a slower rate than HCl appears.

91) Experimental evidence suggests that the reaction between hydrogen and bromine occurs in 3 steps.

Step 1: $Br_2 \rightarrow 2Br$

Step 2: $Br + H_2 \rightarrow HBr + H$

Step 3: $H + Br \rightarrow HBr$

What is the term used to describe the sequence of steps in this chemical reaction?

A. Reaction catalysis

B. Reaction mechanism

C. Equation analysis

D. Equation dynamics

92) Which of the following is a term used to describe the arrangement of atoms that exists at the peak of the activation energy barrier for a chemical reaction?

A. Activated complex

B. Activated intermediate

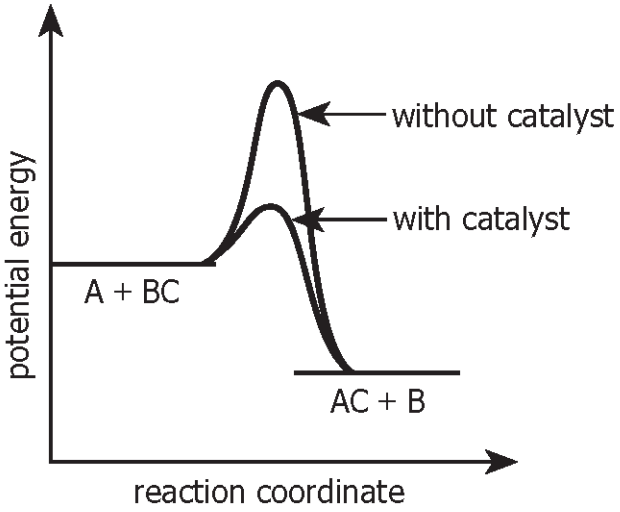
C. Discrete complex

D. Discrete intermediate

93) In chemistry lab, 2 students studied this reaction.

$$A + BC \rightarrow AC + B$$

They carried out the reaction with a catalyst and again without a catalyst. Then, they displayed their results in this diagram.



Which statement correctly describes their results?

A. Adding a catalyst decreased the activation energy of the reaction.

B. Adding a catalyst increased the activation energy of the reaction.

C. Adding a catalyst decreased the potential energy of the products.

D. Adding a catalyst increased the potential energy of the products.

94) Which of the following statements correctly describes one role of a catalyst in a chemical reaction?

A. It is consumed during the reaction.

B. It increases the rate of the reaction.

C. It changes the product of the reaction.

D. It decreases the equilibrium constant for the reaction.

95) Which of the following compounds is capable of forming hydrogen bonds?

A. BH_3

B. CH_4

C. HBr

D. HF

96) What type of solid is a diamond?

A. Ionic

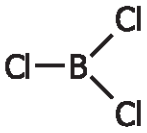
B. Metallic

C. Covalent molecular

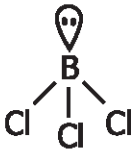
D. Covalent network

97) Use the valence-shell electron-pair repulsion (VSEPR) theory to predict the geometry of boron trichloride (BCl_3).

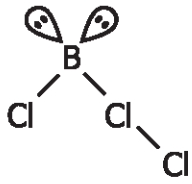
A. Trigonal planar



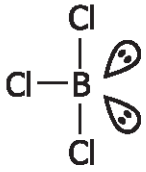
B. Trigonal pyramidal



C. Bent



D. T-shaped



98) A chemist dissolves KCl in water at constant temperature until no more KCl dissolves. How would the chemist most accurately classify this solution?

A. Dilute

B. Saturated

C. Unsaturated

D. Supersaturated

99) A technician dissolves 20.0 g of $MgBr_2$ in 100.0 g of H_2O. What is the percent by mass of $MgBr_2$ in the solution?

A. 10.9%

B. 13.0%

C. 16.7%

D. 20.0%

100) Under which of the following conditions will oxygen gas most likely have the greatest solubility in water?

A. 15°C and 0.5 atm

B. 15°C and 2.0 atm

C. 75°C and 0.5 atm

D. 75°C and 2.0 atm

101) The boiling point of chlorine is −34.6°C. This corresponds to what Kelvin temperature?

A. 307.6 K

B. 238.4 K

C. −238.4 K

D. −307.6 K

102) A chemistry student is given a beaker containing a mixture of solid $CuSO_4$ and sand. The student adds water to the beaker, a blue $CuSO_4$ solution forms, and the sand settles to the bottom of the beaker. What technique would best separate the blue $CuSO_4$ solution from the sand?

A. Chromatography

B. Distillation

C. Evaporation

D. Filtration

103) What scientist proposed that it is impossible to know both the location and the velocity of an electron in an atom at the same time?

A. Maria Goeppert-Mayer

B. Werner Heisenberg

C. H. Friedrich Hund

D. Wolfgang Pauli

104) Methane reacts with chlorine to produce carbon tetrachloride and hydrogen chloride.

$$CH_4(g) + 4Cl_2(g) \rightarrow CCl_4(l) + 4HCl(g)$$

A student carries out the reaction of 5.00 g of CH_4 with 82.5 g of Cl_2. What is the maximum mass of CCl_4 that the reaction can produce?

A. 17.5 g

B. 44.7 g

C. 47.9 g

D. 87.5 g

105) Consider this reaction:

$$6PbO(s) + O_2(g) \rightarrow 2Pb_3O_4(s)$$

Montel combined 15.3 g of PbO with excess O_2, and he obtained a 72.0% yield of Pb_3O_4. What mass of Pb_3O_4 did the reaction produce?

A. 33.8 g

B. 21.3 g

C. 11.3 g

D. 3.67 g

106) When Alex distills Liquid X, he obtains 3 different pure liquids with boiling points of 150°C, 250°C, and 350°C. How should Alex classify Liquid X ?

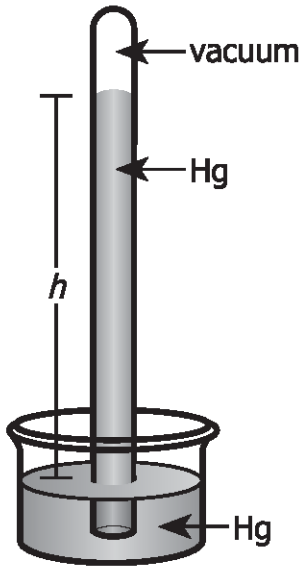
A. Element

B. Compound

C. Mixture

D. Molecule

107) This diagram shows a closed-end mercury barometer.



At an atmospheric pressure of 1.30 atm, what would be the height (*h*), in millimeters, of the Hg in the barometer?

A. 132 mm Hg

B. 585 mm Hg

C. 760 mm Hg

D. 988 mm Hg

108) A chemist compresses a 1.5 L sample of carbon dioxide gas at 1.2 atm to a final volume of 0.75 L at a constant temperature. What is the final pressure of the gas?

A. 0.60 atm

B. 0.94 atm

C. 1.7 atm

D. 2.4 atm

109) Real gases best imitate the behavior of ideal gases under which of the following conditions?

A. 100 K and 1 atm

B. 100 K and 300 atm

C. 1,000 K and 1 atm

D. 1,000 K and 300 atm

110) A chemist purchases a 43.7 L cylinder of CH_4 gas. At 295 K, the pressure inside the cylinder is 1.88 atm. What mass of CH_4 is in the cylinder?

A. 3.39 g

B. 12.2 g

C. 23.2 g

D. 54.4 g

111) At 83.7 kPa and 35.0°C, what is the density of PH_3 gas?

A. 0.528 g/L

B. 1.11 g/L

C. 1.52 g/L

D. 2.39 g/L

112) Sodium bicarbonate reacts with nitric acid to produce water, sodium nitrate, and carbon dioxide.

$$NaHCO_3(s) + HNO_3(aq) \rightarrow H_2O(l) + NaNO_3(aq) + CO_2(g)$$

Paul carefully adds 7.50 g of $NaHCO_3$ to an excess of HNO_3. The reaction produces 3.25 g of CO_2. What is the percent yield of CO_2 in this reaction?

A. 82.7%

B. 76.5%

C. 56.7%

D. 43.3%

113) A scientist measures the density of iridium (Ir) metal as 21.52 g/cm^3. The actual density of Ir metal is 22.65 g/cm^3. What is the percent error in the scientist's measurement?

A. 0.04989%

B. 0.05251%

C. 4.989%

D. 5.251%

114) Fluorine gas reacts with aqueous iron(II) iodide to produce aqueous iron(II) fluoride and iodine liquid. What is the balanced chemical equation for this reaction?

A. $F_2(g) + FeI_2(aq) \rightarrow FeF_2(aq) + I_2(l)$

B. $F_2(g) + 2Fe_2I(aq) \rightarrow 2Fe_2F(aq) + I_2(l)$

C. $2F(g) + FeI_2(aq) \rightarrow FeF_2(aq) + 2I(l)$

D. $F(g) + Fe_2I(aq) \rightarrow Fe_2F(aq) + I(l)$

115) A certain chemical reaction has 2 steps.

Step 1: $NH_3 + C_2H_4O_2 \rightarrow NH_4C_2H_3O_2$

Step 2: $NH_4C_2H_3O_2 \rightarrow C_2H_5NO + H_2O$

Classify the chemical reactions in Step 1 and Step 2, respectively.

A. Synthesis and decomposition

B. Synthesis and single replacement

C. Decomposition and single replacement

D. Double replacement and single replacement

116) At room temperature, sodium reacts with sulfur hexafluoride to produce sodium sulfide and sodium fluoride.

$$8Na(s) + SF_6(g) \rightarrow Na_2S(s) + 6NaF(s)$$

Which statement correctly describes the information provided by this balanced chemical equation?

A. The products have a larger mass than the reactants.

B. The products have a smaller mass than the reactants.

C. The number of moles of products is larger than the number of moles of reactants.

D. The number of moles of products is smaller than the number of moles of reactants.

117) At 1.0 atm, Terell heats a sample of solid caffeine. At 178°C, the solid converts directly into a gas. What is the name of this phase change?

A. Sublimation

B. Evaporation

C. Crystallization

D. Condensation

118) Which phase changes are all exothermic processes?

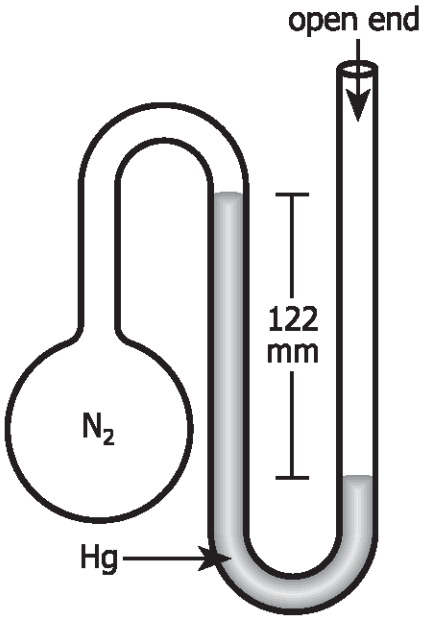
A. Condensation, deposition, and freezing

B. Condensation, melting, and vaporization

C. Deposition, freezing, and sublimation

D. Melting, sublimation, and vaporization

119) A vessel connected to an open-end mercury manometer contains N_2 gas. The atmospheric pressure is 0.993 atm. The height difference of the Hg between the 2 arms of the manometer is 122 mm.



What is the pressure of the N_2 gas?

A. 122 mm Hg

B. 633 mm Hg

C. 755 mm Hg

D. 877 mm Hg

120) At 1.00 atm, a sealed weather balloon contains 20.0 L of He gas at 25.0°C. Assume that no He escapes and the pressure is constant. What is the volume of He in the weather balloon at 35.0°C ?

A. 40.0 L

B. 28.0 L

C. 20.7 L

D. 14.3 L

121) At 1,254 m above sea level, the city of Helena, Montana, has an average atmospheric pressure of 0.859 atm. A chemistry student in Helena finds that distilled water boils at 95.9°C. Compared to the boiling point of water at sea level, the boiling point of water at high elevations:

A. increases due to lower atmospheric pressure.

B. increases due to higher atmospheric pressure.

C. decreases due to lower atmospheric pressure.

D. decreases due to higher atmospheric pressure.

122) For a chemistry homework assignment, Beth must consider the effusion rates of CH_4 gas and NF_3 gas at 25°C. Effusion occurs as gas particles escape from a container through a small hole. Which of the following statements best compares the effusion rates of CH_4 and NF_3 at 25°C ?

A. CH_4 effuses approximately 2 times faster than NF_3.

B. CH_4 effuses approximately 4 times faster than NF_3.

C. NF_3 effuses approximately 2 times faster than CH_4.

D. NF_3 effuses approximately 4 times faster than CH_4.

123) At 15°C, 0.252 mol of Ar gas occupies 174 mL. The pressure of the Ar gas is:

A. 1.78 atm.

B. 2.92 atm.

C. 12.6 atm.

D. 34.2 atm.

124) The boiling point of Liquid X is 56.3°C. Sylvia heats 2.28 g of Liquid X until it completely vaporizes. She collects all the gas in a 750.0 mL vessel. The pressure of the gas is 1.41 atm at 56.3°C. The molar mass of Liquid X is:

A. 9.97 g/mol.

B. 22.3 g/mol.

C. 58.3 g/mol.

D. 121 g/mol.

125) Which of the following statements correctly describes the melting of a crystalline solid?

A. The particles in the solid lose enough energy to overcome the interactions preventing them from approaching one another.

B. The particles in the solid lose enough energy to overcome the interactions holding them in an organized pattern.

C. The particles in the solid gain enough energy to overcome the interactions preventing them from approaching one another.

D. The particles in the solid gain enough energy to overcome the interactions holding them in an organized pattern.

126) At constant temperature, Kelly increases the volume of a fixed amount of a gas. Which of the following statements explains how increasing the volume affects the pressure of the gas?

A. The pressure decreases because there are fewer collisions between gas molecules and the container walls.

B. The pressure decreases because there are more collisions between gas molecules and the container walls.

C. The pressure increases because there are fewer collisions between gas molecules and the container walls.

D. The pressure increases because there are more collisions between gas molecules and the container walls.

127) As the wavelength of a light wave increases, how are the energy and the frequency affected?

A. The energy increases and the frequency increases.

B. The energy increases and the frequency decreases.

C. The energy decreases and the frequency decreases.

D. The energy decreases and the frequency increases.

128) Which of the following statements is an accurate description of Period 3 in the periodic table? Period 3 contains several different elements with:

A. the same number of protons.

B. the same number of valence electrons.

C. outermost protons in the same principal energy level.

D. outermost electrons in the same principal energy level.

129) The boiling point of pure liquid ethanol is 78.5°C. Which of the following statements correctly describes liquid ethanol while it is boiling?

A. Its molecules donate enough kinetic energy that they can escape the liquid.

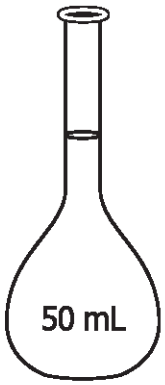
B. Its molecules acquire enough kinetic energy that they can escape the liquid.

C. Its vapor pressure is lower than atmospheric pressure.

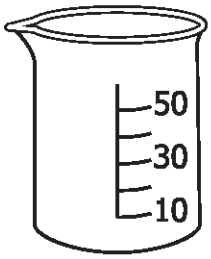
D. Its vapor pressure is higher than atmospheric pressure.

130) Which of the following devices should a student use to measure 50 mL of water most accurately?

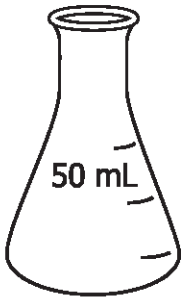
A.



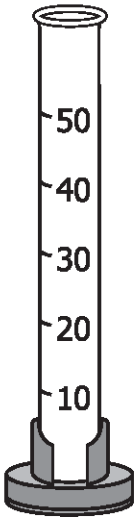
B.



C.



D.



131) What is the volume of a sample of glycerol with a density of 1.20 g/mL and a mass of 43.7 g ?

A. 36.4 mL

B. 42.5 mL

C. 44.9 mL

D. 52.4 mL

132) Which of the following statements is always correct for a compound?

A. It has a constant composition.

B. It contains only 1 element.

C. It is soluble in water.

D. It decomposes by physical means.

133) Deuterium (^2H) is an isotope of hydrogen. A scientist finds that both of these reactions occur.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

$$^2H_2(g) + Cl_2(g) \rightarrow 2\,^2HCl(g)$$

Which statement best explains the scientist's findings?

A. Isotopes have different chemical properties.

B. Isotopes have similar chemical properties.

C. Isotopes have different physical properties.

D. Isotopes have similar physical properties.

134) Which of the following representations is a structural formula?

A. O

B. HO

C. H_2O_2

D. H−O−O−H

135) What is the correct chemical formula for iron(III) sulfide?

A. Fe_2S_3

B. Fe_3S_2

C. $Fe_2(SO_4)_3$

D. $Fe_3(SO_4)_2$

136) Using a Bunsen burner, Melina heats a 12.50 g sample of a hydrate of iridium(III) bromide in a large crucible to drive off all the associated water. After removing all the water, the mass of the anhydrous salt was 10.72 g. What is the empirical formula of the hydrate?

A. $IrBr_3 \cdot 2H_2O$

B. $IrBr_3 \cdot 3H_2O$

C. $IrBr_3 \cdot 4H_2O$

D. $IrBr_3 \cdot 5H_2O$

137) When a chemist places K metal into H_2O, H_2 gas is released and a solution of KOH forms. What is the balanced chemical equation for this reaction, including the appropriate symbols of state for each species?

A. $2K(s) + 2H_2O(l) \rightarrow H_2(g) + 2KOH(aq)$

B. $2K(s) + 2H_2O(aq) \rightarrow H_2(g) + 2KOH(s)$

C. $K(s) + H_2O(l) \rightarrow H_2(g) + KOH(aq)$

D. $K(s) + H_2O(aq) \rightarrow H_2(g) + KOH(s)$

138) Jovan placed 10 mL of aqueous $Al_2(SO_4)_3$ into 2 separate test tubes. Then, he added a 2 g sample of Mg metal into one test tube and a 2 g sample of Cu metal into the other test tube. A reaction occurs in only 1 tube. Use this table to determine which balanced chemical reaction occurs.

Activity Series of Metals

Lithium	Li
Potassium	K
Calcium	Ca
Sodium	Na
Magnesium	Mg
Aluminum	Al
Zinc	Zn
Iron	Fe
Lead	Pb
Copper	Cu
Silver	Ag

decreasing activity ↓

A. $3Mg(s) + Al_2(SO_4)_3(aq) \rightarrow 3MgSO_4(aq) + 2Al(s)$

B. $3Mg(s) + Al_2(SO_4)_3(aq) \rightarrow 3MgO(s) + Al_2S_3(aq) + 3O_3(g)$

C. $3Cu(s) + Al_2(SO_4)_3(aq) \rightarrow 3CuSO_4(aq) + 2Al(s)$

D. $3Cu(s) + Al_2(SO_4)_3(aq) \rightarrow 3CuO(s) + Al_2S_3(aq) + 3O_3(g)$

139) Calcium carbonate reacts with hydrochloric acid to produce calcium chloride, carbon dioxide, and water.

$$CaCO_3(s) + 2HCl(aq) \rightarrow$$
$$CaCl_2(aq) + CO_2(g) + H_2O(l)$$

A chemistry student adds 21.54 g of $CaCO_3$ to an excess of HCl. Assuming the reaction goes to completion, what mass of CO_2 does the reaction produce?

A. 3.877 g

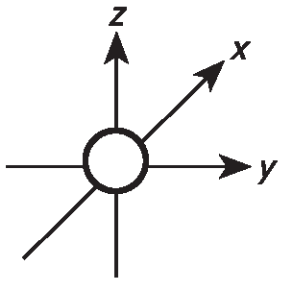
B. 9.471 g

C. 23.88 g

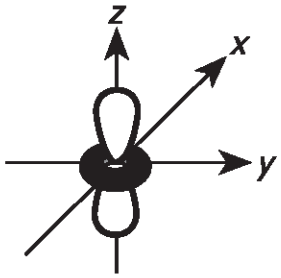
D. 48.99 g

140) These representations show 4 different types of atomic orbitals. Which type of atomic orbital contains the outermost electron in a neon atom?

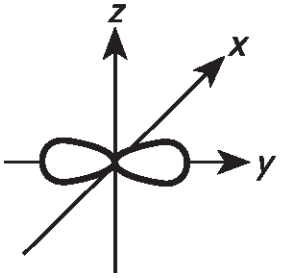
A.



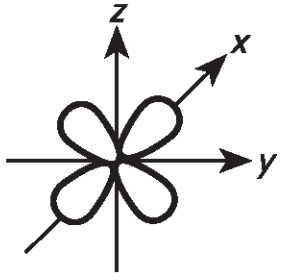
C.



B.



D.



141) What is the ground-state electron configuration of an atom of As?

A. [Ar] $4s^2\ 3d^{10}\ 4p^3$

B. [Ar] $4s^2\ 3d^{10}\ 4p^4$

C. [Ar] $4s^2\ 4d^{10}\ 4p^3$

D. [Ar] $4s^2\ 4d^{10}\ 4p^4$

142) How many protons and how many neutrons are in the nucleus of a $^{60}_{27}Co$ atom?

A. 27 protons and 33 neutrons

B. 27 protons and 60 neutrons

C. 33 protons and 27 neutrons

D. 33 protons and 60 neutrons

143) Element Q has 3 isotopes with the relative abundances shown in this table.

Isotope	Atomic mass (amu)	Relative abundance (%)
1	53.00	40.00
2	56.60	35.00
3	58.90	25.00

What is the weighted average atomic mass of Element Q ?

A. 55.74 amu

B. 55.97 amu

C. 56.17 amu

D. 56.62 amu

144) Which set of elements has the same number of valence electrons as Ge ?

A. Al, Sb, Po

B. As, Br, Ga

C. C, Pb, Si

D. In, O, P

145) For his term paper, Juan plans to write about the unique features of bonding in carbon compounds. Which of the following statements should Juan include in his paper to accurately describe the bonding in carbon compounds?

A. Carbon forms covalent bonds with sodium atoms.

B. Carbon forms ionic bonds with hydrogen atoms.

C. Carbon forms single and double covalent bonds with oxygen atoms.

D. Carbon forms single, double, and triple ionic bonds with other carbon atoms.

146) At 1 atm, carbon disulfide (CS_2) has a boiling point of 46°C, and methanol (CH_3OH) has a boiling point of 65°C. At 46°C, which of the following statements accurately compares the vapor pressure and intermolecular forces of CS_2 and CH_3OH ?

A. CS_2 has a higher vapor pressure and stronger intermolecular forces.

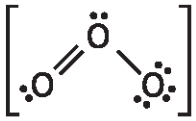
B. CS_2 has a higher vapor pressure and weaker intermolecular forces.

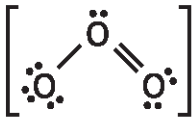
C. CH_3OH has a higher vapor pressure and stronger intermolecular forces.

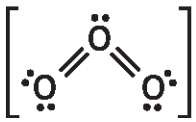
D. CH_3OH has a higher vapor pressure and weaker intermolecular forces.

147) Chemists represent the Lewis structure of O_3 using 2 resonance forms that obey the octet rule. Which of the following structures is 1 of the resonance structures of O_3 ?

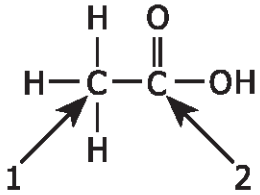
A. 

B. 

C. 

D. 

148) Acetic acid ($C_2H_4O_2$) has 2 carbon (C) atoms, 1 and 2.



Which statement accurately describes the orbital hybridizations and the geometries of Atom 1 and Atom 2 ?

A. Atom 1 has sp^3 hybridization and tetrahedral geometry, and Atom 2 has sp^2 hybridization and trigonal planar geometry.

B. Atom 1 has sp^3 hybridization and trigonal planar geometry, and Atom 2 has sp^2 hybridization and tetrahedral geometry.

C. Atom 1 has sp^2 hybridization and tetrahedral geometry, and Atom 2 has sp^3 hybridization and trigonal planar geometry.

D. Atom 1 has sp^2 hybridization and trigonal planar geometry, and Atom 2 has sp^3 hybridization and tetrahedral geometry.

149) Ethylene has the chemical structure $H_2C=CH_2$. Which of the following statements does NOT describe the bonding between the 2 carbon atoms in ethylene?

A. A sigma (σ) bond occupies the region between the 2 C atoms.

B. A pi (π) bond occupies the regions above and below the 2 C atoms.

C. An sp^2-hybridized orbital from 1 C atom overlaps with an sp^2-hybridized orbital from the other C atom to form a sigma (σ) bond.

D. An *sp*-hybridized orbital from 1 C atom overlaps with an *sp*-hybridized orbital from the other C atom to form a pi (π) bond.

150) Which of the following compounds is the most polar?

A. H_2O

B. CO_2

C. CH_4

D. $SiCl_4$

151) At room temperature, a student adds 125 g of solid glucose to a beaker containing 100 mL of water. He stirs the resulting mixture until no more glucose dissolves, but some solid glucose remains in the water. Next, he heats the mixture until all the solid glucose dissolves. Then he removes the solution of glucose from the heat and slowly cools it to room temperature. No precipitate forms during the cooling process. He adds a small amount of solid glucose to the cooled solution, resulting in the formation of a precipitate. What is the best characterization of the cooled solution of glucose immediately prior to the addition of a small amount of solid glucose?

A. Dilute

B. Saturated

C. Supersaturated

D. Unsaturated

152) What is the orbital diagram for the outermost electrons in a ground-state Mn^{2+} ion?

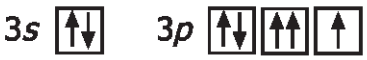
A.

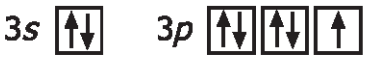

B.

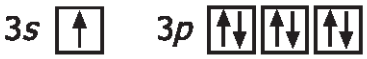

C.

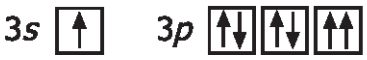

D.


153) What is the orbital diagram for the outermost electrons in a ground-state chlorine atom?

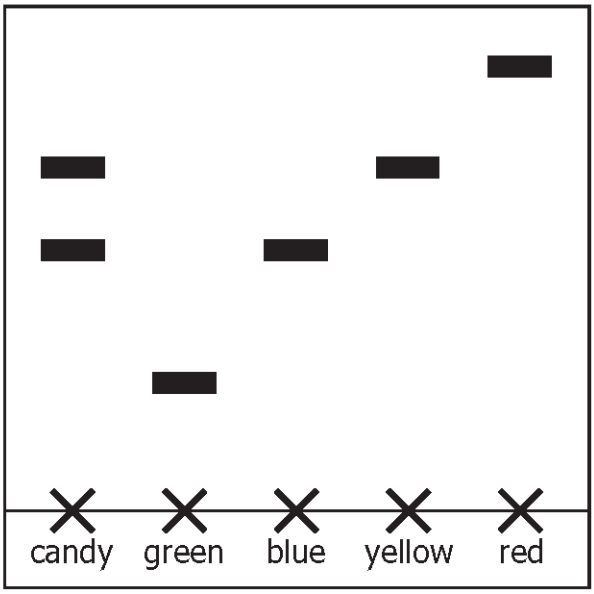
A.


B.


C.


D.


154) A student performs a chromatography experiment to identify the dye(s) present in a sample of candy. The student compares the results of this sample to the results obtained for pure samples of green, blue, yellow, and red dyes in this chromatogram.



Based on the chromatogram, which statement best describes the dye content of the candy sample?

A. It contains only blue dye.

B. It contains only green dye.

C. It contains only blue and yellow dyes.

D. It contains only green and yellow dyes.

155) A chemistry student has 4 empty cubes. Two of the cubes have 1 cm sides and masses of 0.5 g. The other two cubes have 2 cm sides and masses of 1.0 g. The student adds 1 or more balls to each cube, as shown in this table.

Cube	Side length (cm)	Mass of empty cube (g)	Number of balls added
A	1	0.5	1
B	1	0.5	2
C	2	1.0	8
D	2	1.0	11

The mass of each ball is 1.0 g. After the addition of the ball(s), which cube has the greatest density?

A. Cube A

B. Cube B

C. Cube C

D. Cube D

156) This table shows the percent composition data for an unknown organic compound.

Element	% Composition
C	70.54
H	10.66
O	18.80

What is the empirical formula of this compound?

A. C_5H_9O

B. $C_6H_{11}O$

C. $C_7H_{10}O_2$

D. $C_8H_8O_2$

157) At very high temperatures, aluminum metal reacts with chromium(III) oxide to produce aluminum oxide and chromium metal. What is the balanced chemical equation for this reaction?

A. $2Al(s) + CrO_3(s) \rightarrow Al_2O_3(s) + Cr(l)$

B. $2Al(s) + Cr_2O_3(s) \rightarrow Al_2O_3(s) + 2Cr(l)$

C. $3Al(s) + Cr_3O_2(s) \rightarrow Al_3O_2(s) + 3Cr(l)$

D. $6Al(s) + Cr_3O_4(s) \rightarrow 2Al_3O_2(s) + 3Cr(l)$

158) During chemistry class, Lisa pours 200 mL of an aqueous solution of $Zn(NO_3)_2$ into a beaker. Then, she adds 5.0 g each of Cu, Al, Fe, and Ag into the beaker. A reaction occurs, and a precipitate forms. Use this table to determine the products of the reaction that occurs.

Activity Series of Metals

decreasing activity ↓	Lithium	Li
	Potassium	K
	Calcium	Ca
	Sodium	Na
	Magnesium	Mg
	Aluminum	Al
	Zinc	Zn
	Iron	Fe
	Lead	Pb
	Copper	Cu
	Silver	Ag

A. $Zn(s)$ and $Cu(NO_3)_2(aq)$

B. $Zn(s)$ and $Al(NO_3)_3(aq)$

C. $Zn(s)$ and $Fe(NO_3)_2(aq)$

D. $Zn(s)$ and $AgNO_3(aq)$

159) Oxygen gas reacts with aqueous hydrazine to produce aqueous hydrogen peroxide and nitrogen gas.

$$2O_2(g) + N_2H_4(aq) \rightarrow 2H_2O_2(aq) + N_2(g)$$

When 18.5 g of O_2 reacts completely with excess N_2H_4, the reaction produces what mass of N_2 ?

A. 3.46 g

B. 8.10 g

C. 9.25 g

D. 16.2 g

160) Under anhydrous conditions, sodium peroxide reacts with carbon dioxide to produce sodium carbonate and oxygen.

$$2Na_2O_2 + 2CO_2 \rightarrow 2Na_2CO_3 + O_2$$

What is the minimum mass of CO_2 required to produce 26.7 g of O_2 ?

A. 73.4 g

B. 36.7 g

C. 18.4 g

D. 9.71 g

161) In the chemistry lab, Juanita adds solid potassium chlorate ($KClO_3$) and a small amount of a catalyst to a flame-dried test tube. Using a Bunsen burner, she carefully heats the test tube until the solid melts. Then, she continues heating the liquid until a solid forms in the test tube and a gas is given off. Which balanced chemical equation contains the correct products for this reaction?

A. $KClO_3(s) \rightarrow KClO(s) + O_2(g)$

B. $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

C. $2KClO_3(s) \rightarrow 2KClO_2(s) + O_2(g)$

D. $2KClO_3(s) \rightarrow 2K(s) + Cl_2(g) + 3O_2(g)$

162) Calcium chloride reacts with sodium phosphate to produce calcium phosphate and sodium chloride.

$$3CaCl_2(aq) + 2Na_3PO_4(aq) \rightarrow Ca_3(PO_4)_2(s) + 6NaCl(aq)$$

When a chemist adds 200.0 mL of 0.150 *M* $CaCl_2(aq)$ to 115.0 mL of 0.250 *M* $Na_3PO_4(aq)$, what is the maximum number of moles of $Ca_3(PO_4)_2$ that the reaction can produce?

A. 0.0100 mol

B. 0.0144 mol

C. 0.0288 mol

D. 0.0300 mol

163) A chemistry student adds 0.50 mol of CH_3OH and 1.0 mol of C_3H_7OH to 2.0 mol of H_2O in a beaker. What is the mole fraction of H_2O in the resulting mixture?

A. 0.57

B. 0.29

C. 0.14

D. 0.11

164) Dr. Estevez developed Molecule X as a new biodegradable treatment for ice on roads. Molecule X is very soluble in water, and it does not corrode automobiles. Molecule X is nonvolatile, and it is a nonelectrolyte. When Dr. Estevez dissolves 4.25 mol of Molecule X in 3.00 kg of H_2O, what is the freezing point of the resulting solution?

A. −1.31°C

B. −2.33°C

C. −2.64°C

D. −7.92°C

165) In chemistry class, a student studies this reaction.

$$A(g) + B(g) \rightarrow C(g)$$

The student performs the reaction 3 times in a sealed 2.5 L vessel at 25°C. The student uses different amounts of Reactants A and B in each reaction. The student measures the rate of each reaction and records the results in this table.

Reaction	A (mol)	B (mol)	Rate of reaction (*M*/sec)
1	0.018	0.018	0.026
2	0.025	0.025	0.038
3	0.032	0.032	0.052

According to the kinetic molecular theory, which of the following statements provides the best explanation for the data in the table?

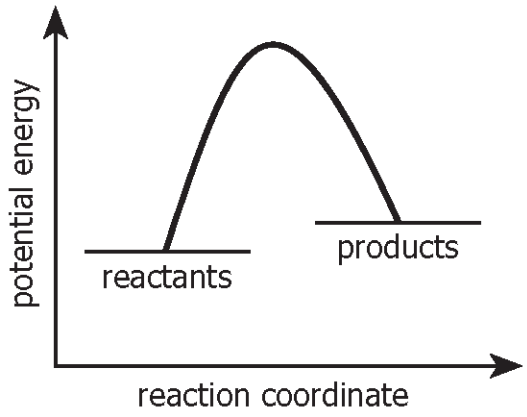
A. The reaction rate decreases at higher concentrations of reactants because fewer collisions per second occur between the reactants.

B. The reaction rate decreases at lower concentrations of reactants because more collisions per second occur between the reactants.

C. The reaction rate increases at higher concentrations of reactants because more collisions per second occur between the reactants.

D. The reaction rate increases at lower concentrations of reactants because fewer collisions per second occur between the reactants.

166) This diagram shows the progress of a chemical reaction from reactants to products.



Which statement most accurately describes this chemical reaction?

A. The reaction has an enthalpy change that is endothermic.

B. The reaction has a 2-step mechanism with a stable intermediate.

C. The products have a lower potential energy than the reactants.

D. The activated complex of the reaction has a lower potential energy than the products.

167) Nitrogen dioxide is a dark brown gas. In a closed system, NO_2 establishes an equilibrium with dinitrogen tetroxide, a colorless gas.

$$N_2O_4(g) + \text{heat} \rightleftharpoons 2NO_2(g)$$

A scientist places a sealed tube of $NO_2(g)$ in a hot water bath for 15 minutes. Then, the scientist moves the sealed tube of $NO_2(g)$ to an ice water bath. How do the contents of the tube change after being placed in the ice water bath?

A. The color intensity of the contents of the tube decreases.

B. The mass of the contents of the tube decreases.

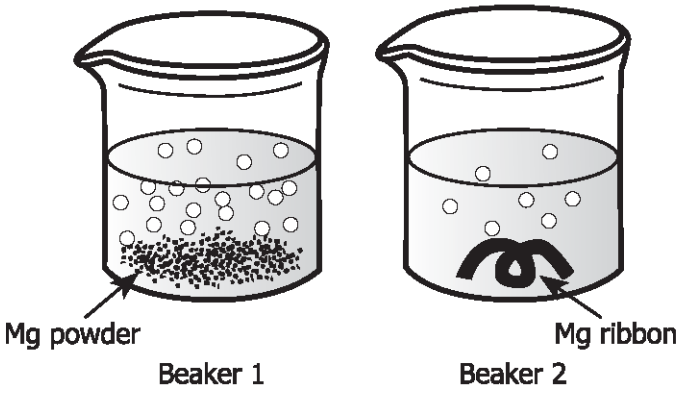
C. The number of molecules of gas in the tube increases.

D. The volume of the contents of the tube increases.

168) Magnesium reacts with hydrochloric acid to produce hydrogen and magnesium chloride.

$$Mg(s) + 2HCl(aq) \rightarrow H_2(g) + MgCl_2(aq)$$

Megan adds equal masses of Mg powder to Beaker 1 and Mg ribbon to Beaker 2. She then adds 100.0 mL of 3.0 *M* HCl(*aq*) to each beaker. Both beakers are at the same temperature and pressure. Bubbles form more rapidly in Beaker 1 than in Beaker 2.



Which of the following statements accurately compares Beaker 1 and Beaker 2 ?

A. The concentration of HCl is greater in Beaker 1.

B. The density of the reaction mixture is lower in Beaker 2.

C. The number of moles of reactants is lower in Beaker 2.

D. The rate of the disappearance of Mg is greater in Beaker 1.

169) A reaction occurs between 2 gases in a sealed vessel. The rate of the reaction increases as the temperature of the system increases. According to the collision theory of chemical kinetics, which of the following statements best explains this rate increase?

A. The concentration of the catalyst increases.

B. The kinetic energy of the reactants increases.

C. The activation energy for the reaction decreases.

D. The frequency of collisions between reactant molecules decreases.

170) Which of the following statements describes a characteristic of all exothermic reactions?

A. The initial mass of the reactants is less than the final mass of the products.

B. The enthalpy of the reactants is greater than the enthalpy of the products.

C. The reaction absorbs energy from its surroundings.

D. The volume of the reactants increases as the reaction proceeds.

171) Ammonia reacts with hydrochloric acid to produce ammonium ions and chloride ions, as shown in this equilibrium.

$$NH_3(aq) + HCl(aq) \rightleftharpoons NH_4^+(aq) + Cl^-(aq)$$

Which of the following is the role of NH_3 in this equilibrium?

A. Arrhenius acid

B. Arrhenius base

C. Brønsted–Lowry acid

D. Brønsted–Lowry base

172) According to the definition of the ion-product constant for water (K_w) in homogenous systems at 25°C, which of the following statements describing the relationship between the hydrogen ion and the hydroxide ion is always correct?

A. The concentration of H^+ equals the concentration of OH^-.

B. The sum of the concentrations of H^+ and OH^- equals 14.

C. Whenever the concentration of H^+ decreases, the concentration of OH^- decreases.

D. Whenever the concentration of H^+ increases, the concentration of OH^- decreases.

173) Chemists use sulfuric acid to neutralize potassium hydroxide. What is the balanced chemical equation for this reaction?

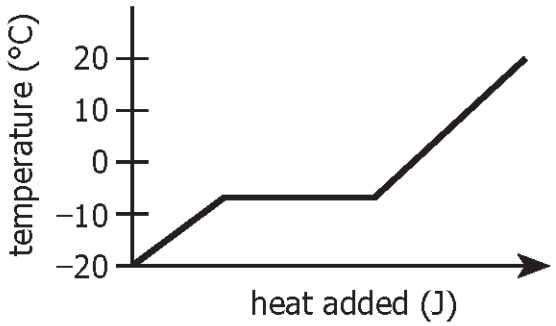
A. $2KOH(aq) + H_2SO_4(aq) \rightarrow K_2O(aq) + SO_3(g) + 2H_2O(l)$

B. $2KOH(aq) + H_2SO_4(aq) \rightarrow K_2S(aq) + 2O_2(g) + 2H_2O(l)$

C. $2KOH(aq) + H_2SO_4(aq) \rightarrow 2K(s) + 2H_2O(l) + SO_4(g)$

D. $2KOH(aq) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$

174) During chemistry lab, Chen obtains a sample of solid Br_2 at $-20°C$. He heats the Br_2 until it reaches $20°C$, and he plots his results in this graph.



Which statement accurately describes Chen's results?

A. The temperature increases after the Br_2 sample evaporates.

B. The temperature remains constant after the Br_2 sample evaporates.

C. The temperature increases as the Br_2 sample melts.

D. The temperature remains constant as the Br_2 sample melts.

175) A 10.0 g sample of Au at 55.0°C gives off 45.0 J of heat to its surroundings. The specific heat capacity (C) of Au is 0.129 J/g·°C. What is the final temperature of the Au sample?

A. 58.1°C

B. 34.9°C

C. 20.1°C

D. 15.8°C

176) Hydrazine (N_2H_4) reacts with hydrogen peroxide to produce nitrogen and water.

$$N_2H_4(l) + 2H_2O_2(l) \rightarrow N_2(g) + 4H_2O(l)$$

The standard enthalpy of reaction (ΔH°_{rxn}) for this reaction is −818.23 kJ. Use ΔH°_{rxn} and the data in this table to calculate ΔH°_f for $N_2H_4(l)$.

Substance	ΔH°_f (kJ/mol)
$N_2H_4(l)$	?
$H_2O_2(l)$	−187.80
$N_2(g)$	0
$H_2O(l)$	−285.80

A. −1,291.83 kJ/mol

B. −344.63 kJ/mol

C. 50.63 kJ/mol

D. 700.57 kJ/mol

177) Which of the following compounds is amphoteric when dissolved in water?

A. $NaHCO_3$

B. NaOH

C. H_3PO_4

D. NH_3

178) Nitric acid reacts with the fluoride ion to produce hydrofluoric acid and the nitrate ion, as shown in this chemical equilibrium.

$$HNO_3(aq) + F^-(aq) \rightleftharpoons HF(aq) + NO_3^-(aq)$$

Which statement accurately describes 1 of the conjugate acid-base pairs in this equilibrium?

A. F^- is the conjugate acid of HF.

B. F^- is the conjugate acid of HNO_3.

C. NO_3^- is the conjugate base of HF.

D. NO_3^- is the conjugate base of HNO_3.

179) A student measured the pH of some common household substances and recorded the results in this table.

Substance	pH
Lemon juice	2.3
Tomato juice	4.2
Black coffee	5.0
Milk of magnesia	10.5

Which substance has a H^+ concentration greater than 1.0×10^{-4} *M*?

A. Lemon juice

B. Tomato juice

C. Black coffee

D. Milk of magnesia

180) Ingrid uses the acid-base indicator bromothymol blue in a titration of approximately 0.1 *M* KOH with 0.05 *M* HCl. Bromothymol blue is yellow in acidic solutions and blue in basic solutions. What colors does Ingrid observe, and when?

A. Blue at the start of the titration, green at the equivalence point, and yellow after adding excess HCl

B. Blue at the start of the titration, yellow at the equivalence point, and green after adding excess HCl

C. Yellow at the start of the titration, green at the equivalence point, and blue after adding excess HCl

D. Yellow at the start of the titration, blue at the equivalence point, and green after adding excess HCl

181) Carbonic acid (H_2CO_3) has an acid dissociation constant (K_a) of 4.4×10^{-7} for its first ionizable hydrogen, and nitrous acid (HNO_2) has a K_a value of 7.2×10^{-4}. Which statement accurately compares the 2 acids?

A. H_2CO_3 is a stronger acid than HNO_2 because H_2CO_3 has a larger K_a value.

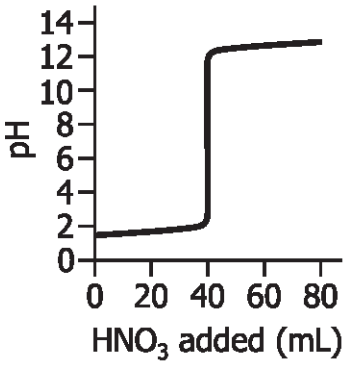
B. H_2CO_3 is a stronger acid than HNO_2 because H_2CO_3 has a smaller K_a value.

C. H_2CO_3 is a weaker acid than HNO_2 because H_2CO_3 has a larger K_a value.

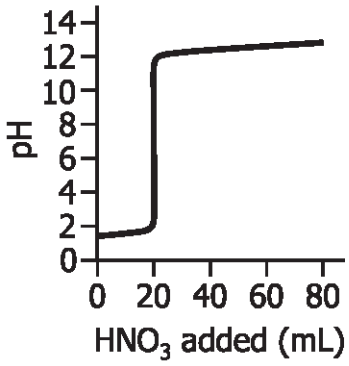
D. H_2CO_3 is a weaker acid than HNO_2 because H_2CO_3 has a smaller K_a value.

182) Jason must determine the concentration of sodium hydroxide in an aqueous solution. He knows that the concentration is approximately 0.2 *M* NaOH. Which titration curve would most likely result from titrating 20.0 mL of the NaOH solution with aqueous 0.100 *M* HNO_3 ?

A.



C.



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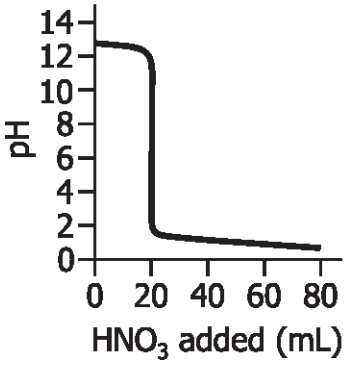
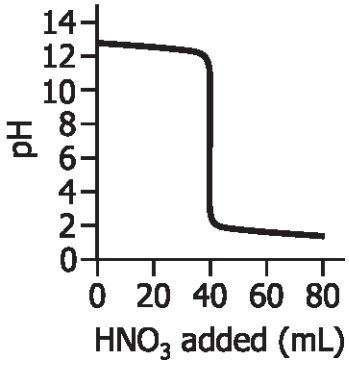


D.



183) A scientist must carry out a reaction in water. This reaction is very sensitive to small changes in pH. What can she add to the water to prevent pH changes during the reaction?

A. Acid only

B. Base only

C. Buffer only

D. Indicator only

184) A student pours some oil, a mixture of compounds composed only of carbon and hydrogen atoms, into a bottle containing H_2O. Is the oil miscible with the H_2O ?

A. No; the oil contains polar compounds and H_2O is a nonpolar compound.

B. No; the oil contains nonpolar compounds and H_2O is a polar compound.

C. Yes; the oil contains polar compounds and H_2O is a polar compound.

D. Yes; the oil contains nonpolar compounds and H_2O is a nonpolar compound.

185) A student is given separate samples of $SrSO_4$, LiCl, Hg_2Cl_2, and $CaCO_3$.

Solubility of Ionic Compounds in H_2O	
Anion	Solubility of compounds
Cl^-	soluble except for Ag^+, Hg_2^{2+}, and Pb^{2+} compounds
CO_3^{2-}	insoluble except for Group 1A and NH_4^+ compounds
SO_4^{2-}	soluble except for Pb^{2+}, Ag^+, Hg_2^{2+}, Ba^{2+}, Sr^{2+}, and Ca^{2+} compounds

Use the data in this table to determine which of the following compounds is most soluble in water.

A. $SrSO_4$

B. LiCl

C. Hg_2Cl_2

D. $CaCO_3$

186) How does adding a solute to water affect the freezing point, boiling point, and vapor pressure of the solution?

A. They all increase.

B. They all decrease.

C. Freezing point decreases, and boiling point and vapor pressure increase.

D. Boiling point increases, and freezing point and vapor pressure decrease.

187) According to the collision theory of reactions, which statement does NOT accurately describe gas particles in a reaction at constant volume?

A. When the particles move faster, more collisions occur per second.

B. When the number of particles increases, more collisions occur per second.

C. The particles need a minimum activation energy in order to react.

D. Each collision between particles produces products regardless of the available kinetic energy.

188) Which of the following conditions always exists in a chemical reaction at equilibrium?

A. The concentrations of the reactants and the products change.

B. The concentrations of the reactants and the products are the same.

C. The rates of the forward and the reverse reactions are the same.

D. The rates of the forward and the reverse reactions are different.

189) In a sealed 4.50 L vessel at a constant temperature, sulfur dioxide reacts with oxygen to produce sulfur trioxide.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

At equilibrium, there are 1.50 mol of SO_2, 0.750 mol of O_2, and 2.25 mol of SO_3. What is the concentration equilibrium constant (K_{eq}) for this reaction?

A. 27.0

B. 13.5

C. 4.50

D. 3.00

190) A saturated aqueous solution of $PbCl_2$ has a concentration of 1.59×10^{-2} *M* at 25°C. What is the solubility product constant (K_{sp}) of $PbCl_2$ at 25°C ?

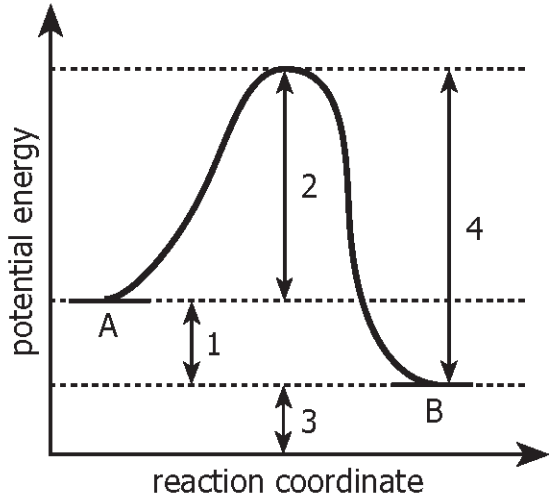
A. 5.06×10^{-4}

B. 1.61×10^{-5}

C. 8.04×10^{-6}

D. 4.02×10^{-6}

191) This diagram shows the conversion of Reactant A to Product B.



Which number in the diagram has the correct description?

A. 1 = Potential energy of Reactant A

B. 2 = Activation energy

C. 3 = Enthalpy of reaction

D. 4 = Potential energy of Product B

192) When heated, calcium carbonate decomposes to form calcium oxide and carbon dioxide.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

Use the data in this table to calculate the standard enthalpy of reaction (ΔH°_{rxn}) for the decomposition of $CaCO_3$.

Standard Enthalpies of Formation	
Substance	ΔH°_f (kJ/mol)
$CaCO_3(s)$	−1,207.0
$CaO(s)$	−635.1
$CO_2(g)$	−393.5

A. 1,448.6 kJ

B. 178.4 kJ

C. −965.4 kJ

D. −2,235.6 kJ

193) Butane (C_4H_{10}) reacts with oxygen to produce carbon dioxide and water.

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$$

Use the data in this table to calculate the standard enthalpy of reaction (ΔH°_{rxn}) for the complete combustion of C_4H_{10}.

Standard Enthalpies of Formation	
Substance	ΔH°_f (kJ/mol)
$C_4H_{10}(g)$	−125.7
$O_2(g)$	0
$CO_2(g)$	−393.5
$H_2O(l)$	−285.8

A. −5,754.6 kJ

B. −2,877.3 kJ

C. −805.0 kJ

D. −553.6 kJ

194) Which of the following statements best describes a role of H_2O when HCl dissolves in H_2O ? When HCl dissolves in H_2O, the H_2O:

A. accepts a hydrogen ion (H^+) from HCl.

B. donates a hydrogen ion (H^+) to HCl.

C. accepts a hydroxide ion (OH^-) from HCl.

D. donates a hydroxide ion (OH^-) to HCl.

195) Which of the following statements always accurately describes acids and bases?

A. Strong acids and strong bases are weak electrolytes.

B. Strong acids and strong bases partially ionize in water.

C. Weak acids and weak bases are strong electrolytes.

D. Weak acids and weak bases partially ionize in water.

196) Quinn must determine the concentration of HCl in an unknown aqueous solution. He decides to titrate 35.0 mL of the unknown HCl solution with 1.038 *M* aqueous NaOH. The equivalence point is reached when Quinn adds 45.5 mL of 1.038 *M* NaOH solution. What is the concentration of HCl in the unknown solution?

A. 1.35 *M*

B. 1.12 *M*

C. 0.958 *M*

D. 0.798 *M*

197) At 25°C, the solubility product constant (K_{sp}) for CuCl in water is 1.2×10^{-6}. What is the concentration of Cu^{+} in a saturated aqueous solution of CuCl at 25°C ?

A. 6.0×10^{-7} *M*

B. 2.4×10^{-6} *M*

C. 7.7×10^{-4} *M*

D. 1.1×10^{-3} *M*

198) At STP, a chemist burns 3.50 L of pentane (C_5H_{12}) in excess oxygen gas.

$$C_5H_{12}(l) + 8O_2(g) \rightarrow 5CO_2(g) + 6H_2O(l)$$

What is the maximum volume of CO_2 that the reaction can produce?

A. 17.5 L

B. 8.50 L

C. 5.60 L

D. 0.700 L

199) What is the wavelength of light with a frequency of 5.80×10^{14} Hz ?

A. 3.85×10^{-19} m

B. 5.17×10^{-7} m

C. 1.93×10^{6} m

D. 1.74×10^{23} m

200) What is the shape of the atomic orbital occupied by the outermost electron in a ground-state Cs atom?

A. Cylinder

B. Dumbbell

C. Oval

D. Sphere

201) Of As, Ge, Fe, and Se, a ground-state atom of which element contains the greatest number of unpaired electrons?

A. As

B. Ge

C. Fe

D. Se

202) How did Henry G. J. Moseley change the periodic table created by Dmitri Mendeleev?

A. He added all of the period 6 elements.

B. He added a new column for the Group 1A metals.

C. He ordered the elements using their atomic numbers.

D. He ordered the elements in blocks of metals and nonmetals.

203) Which of the following elements is a metal in period 5 of the periodic table?

A. Sr

B. I

C. Ca

D. As

204) Which of the following lists contains elements arranged in order of increasing electronegativity?

A. Be, B, C, F

B. Br, Se, Ga, K

C. N, P, As, Sb

D. O, Ge, In, Hg

205) Which of the following sets contains only physical properties?

A. Color, taste, ability to rust

B. Boiling point, volume, viscosity

C. Density, flammability, freezing point

D. Melting point, odor, reactivity to light

206) Anne completely fills the fuel tank of her car with a mixture of gasoline and ethanol (C_2H_5OH). When filled, the fuel tank contains 4,482 g of C_2H_5OH. How many moles of C_2H_5OH are in the fuel tank?

A. 77.17 mol

B. 97.29 mol

C. 131.6 mol

D. 149.1 mol

207) A chemist purchases a small gas cylinder containing 150.0 g of phosphorus trifluoride (PF_3) gas. How many molecules of PF_3 are in the gas cylinder?

A. 3.531×10^{23} molecules

B. 1.026×10^{24} molecules

C. 3.734×10^{25} molecules

D. 1.433×10^{26} molecules

208) At high temperatures, solid SnO_2 reacts with solid C to produce molten Sn and CO gas. What is the correct balanced chemical equation for this reaction, including the appropriate symbols of state for each substance?

A. $SnO_2(l) + C(s) \rightarrow Sn(s) + CO(g)$

B. $SnO_2(s) + C(s) \rightarrow Sn(l) + CO(g)$

C. $SnO_2(l) + 2C(s) \rightarrow Sn(s) + 2CO(g)$

D. $SnO_2(s) + 2C(s) \rightarrow Sn(l) + 2CO(g)$

209) Which of the following balanced chemical equations is best classified as a single replacement reaction?

A. $2K(s) + Br_2(l) \rightarrow 2KBr(s)$

B. $2HgO(s) \rightarrow 2Hg(l) + O_2(g)$

C. $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

D. $NaCl(aq) + AgNO_3(aq) \rightarrow NaNO_3(aq) + AgCl(s)$

210) Which balanced chemical equation contains the correct product(s) for the reaction of solid Rb with Cl_2 gas?

A. $Rb(s) + Cl_2(g) \rightarrow RbCl_2(s)$

B. $Rb(s) + Cl_2(g) \rightarrow RbCl(s) + Cl(g)$

C. $2Rb(s) + Cl_2(g) \rightarrow 2RbCl(s)$

D. $2Rb(s) + 3Cl_2(g) \rightarrow 2RbCl_2(s) + 2Cl(g)$

211) What is the correct balanced chemical equation for the complete combustion of octane (C_8H_{18}) ?

A. $C_8H_{18}(l) + 4O_2(g) \rightarrow 8CO(g) + 9H_2(g)$

B. $C_8H_{18}(l) + 8O_2(g) \rightarrow 8CO_2(g) + 9H_2(g)$

C. $2C_8H_{18}(l) + 17O_2(g) \rightarrow 16CO(g) + 18H_2O(l)$

D. $2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(l)$

212) Use the data in this table to determine which of the following reactions produces a precipitate.

Key
S = soluble
I = insoluble

Solubilities of Ionic Compounds in H_2O at 25°C					
	Br^-	Cl^-	NO_3^-	OH^-	SO_4^{2-}
Cu^{2+}	S	S	S	I	S
K^+	S	S	S	S	S
Li^+	S	S	S	S	S
Mg^{2+}	S	S	S	I	S
Na^+	S	S	S	S	S

A. $CuSO_4 + MgBr_2 \rightarrow CuBr_2 + MgSO_4$

B. $CuSO_4 + 2KNO_3 \rightarrow Cu(NO_3)_2 + K_2SO_4$

C. $CuSO_4 + 2LiCl \rightarrow CuCl_2 + Li_2SO_4$

D. $CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$

213) In water, ammonia reacts with nitric acid to produce ammonium nitrate.

$$NH_3(aq) + HNO_3(aq) \rightarrow NH_4NO_3(aq)$$

Dana carefully adds 0.550 mol of NH_3 to an excess of HNO_3. What is the maximum mass of NH_4NO_3 that the reaction can produce?

A. 44.0 g

B. 53.4 g

C. 115 g

D. 146 g

214) Boron trioxide, B_2O_3, reacts with water to produce boric acid, $B(OH)_3$.

$$B_2O_3(s) + 3H_2O(l) \rightarrow 2B(OH)_3(s)$$

Ricardo adds 27.2 g of B_2O_3 to an excess of H_2O, and the reaction goes to completion. What mass of $B(OH)_3$ does the reaction produce?

A. 12.1 g

B. 24.2 g

C. 48.3 g

D. 61.2 g

215) At 900°C, beryllium reacts with nitrogen to produce beryllium nitride.

$$3Be(s) + N_2(g) \rightarrow Be_3N_2(s)$$

Dr. Jia combines 55.90 g of Be with 23.75 g of N_2. What is the maximum mass of Be_3N_2 that the reaction can produce?

A. 32.15 g

B. 46.67 g

C. 79.65 g

D. 113.8 g

216) At high temperatures, tantalum(V) oxide (Ta_2O_5) reacts with carbon to produce tantalum and carbon dioxide.

$$2Ta_2O_5(s) + 5C(s) \rightarrow 4Ta(s) + 5CO_2(g)$$

Greg adds 2.34 g of Ta_2O_5 to an excess of C in a crucible. Using a Bunsen burner, he heats the mixture until CO_2 is no longer released and isolates 1.75 g of Ta. What is the percent yield of Ta for this reaction?

A. 37.4%

B. 54.7%

C. 74.8%

D. 91.3%

217) A student measures the mass of a nickel on an analytical balance and records a result of 4.947 g in her laboratory notebook. The United States Mint has a specification of 5.000 g for the mass of a nickel. Assuming the United States Mint's specification is the actual mass of a nickel, what is the percent error associated with the student's measurement?

A. 1.071%

B. 1.060%

C. 0.01071%

D. 0.01060%

218) Aqueous barium sulfide reacts with aqueous zinc bromide to produce aqueous barium bromide and solid zinc sulfide.

$$BaS(aq) + ZnBr_2(aq) \rightarrow BaBr_2(aq) + ZnS(s)$$

What are the spectator ions in this reaction?

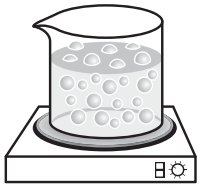
A. Ba^{2+} and Zn^{2+}

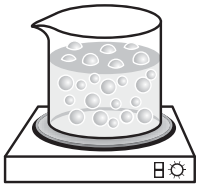
B. Ba^{2+} and Br^{-}

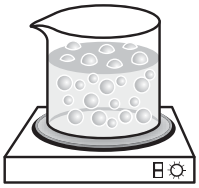
C. S^{2-} and Zn^{2+}

D. S^{2-} and Br^{-}

As part of a demonstration, the teacher uses a hot plate to heat three liquids in beakers to boiling. Liquid A is water, Liquid B is ethanol, and Liquid C is an aqueous copper(II) sulfate solution. The students observe the boiling liquids and note that, in each beaker, bubbles form on the bottom and side surfaces of the beaker and then rise to the liquid's surface.


Liquid A


Liquid B


Liquid C

219) What do the bubbles forming in Liquid A during boiling contain?

A. Air

B. Heat

C. Hydrogen gas and oxygen gas

D. Water vapor

220) What do the bubbles forming in Liquid B during boiling contain?

A. Air

B. Ethanol vapor

C. Hydrogen gas and oxygen gas

D. Water vapor

221) What do the bubbles forming in Liquid C during boiling contain?

A. Air

B. Copper(II) sulfate vapor

C. Hydrogen gas and oxygen gas

D. Water vapor

222) Which of the following is NOT a recommended laboratory safety rule?

A. Use a dustpan and brush to clean up broken glassware.

B. Remove dangling jewelry and wear closed-toed shoes in the laboratory.

C. Report injuries, even minor ones, to the teacher immediately.

D. Add water to acid when diluting strong acids.

223) The length of the double bond between the oxygen atoms in a molecule of oxygen is 0.000000000121 m. Express this measurement in correct scientific notation.

A. 1.21×10^{-9} m

B. 1.21×10^{-10} m

C. 1.21×10^{9} m

D. 1.21×10^{10} m

224) What is the chemical symbol for the element iron?

A. F

B. Fe

C. I

D. Ir

225) Which chemical name and symbol are NOT correctly matched?

A. Copper, Cu

B. Potassium, K

C. Silver, Au

D. Sodium, Na

226) In 2003, the U.S. Department of Commerce, Census Bureau, published the percentage of students in grades 1–12 who used the Internet. The following data were collected.

Percentage of Students in Grades 1–12 Who Use the Internet

Location of Internet use	All grades	Grades 1–5	Grades 6–8	Grades 9–12
At school	49.0	33.4	54.9	63.0
At home	49.3	33.6	54.4	64.1
At public library	10.9	5.7	13.1	15.3

Which of the following types of graphs should students use to display this data in one graph?

A. Bar graph

B. Line graph

C. Histogram

D. Pie graph

227) The U.S. Geological Survey (USGS) conducts water usage surveys every 5 years. For 2005, the estimated population and total water withdrawals per day for each state was determined. A water withdrawal refers to water removed from the ground or diverted from a surface-water source for use (as defined by the USGS).

Estimated Total Water Withdrawals by State for 2005

State	Population (in thousands)	Total withdrawals (in million gallons per day)
California	36,100	45,700
Florida	17,900	18,300
New Mexico	1,930	3,330
Oregon	3,640	7,220

Which of the states listed in the data table used the most water per person per day?

A. California

B. Florida

C. New Mexico

D. Oregon

228) A student measures the side of a solid aluminum cube, as shown.

How many significant figures should the student use to report the measurement?

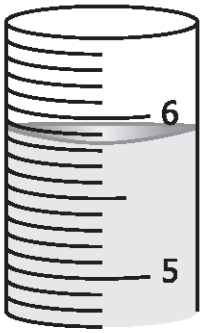
A. 1; 1 cm

B. 2; 1.0 cm

C. 3; 1.00 cm

D. 4; 1.000 cm

229) Report the measurement shown in the figure with the correct number of significant figures.



A. 6 mL

B. 5.8 mL

C. 5.84 mL

D. 5.840 mL

230) In which set of measurements are all 3 values reported with the same number of significant figures?

A. 89 m, 7.2 m, 0.060 m

B. 11 m, 25.0 m, 8.03 m

C. 38 m, 171 m, 0.525 m

D. 62 m, 49.0 m, 5.000 m

231) An irregular solid with a mass of 6.253 g is placed in a graduated cylinder containing 6.01 mL of water. The volume in the graduated cylinder increases to 8.31 mL. Using the correct number of significant figures, what is the density of the irregular solid?

A. 2.719 g/mL

B. 2.72 g/mL

C. 2.7 g/mL

D. 3 g/mL

232) Sodium stearate, a surfactant, is a common ingredient in soaps. Surfactants reduce the surface tension of water, allowing for easy removal of dirt from a surface such as human skin or clothing. The chemical formula for sodium stearate is $CH_3(CH_2)_{16}COONa$. How many carbon atoms are in 1 formula unit of sodium stearate?

A. 3

B. 18

C. 20

D. 36

233) To keep her strawberry plants healthy, a local gardener uses aluminum sulfate, $Al_2(SO_4)_3$, to decrease the pH of the soil. How many oxygen atoms are in 1 formula unit of aluminum sulfate?

A. 12

B. 7

C. 4

D. 3

234) Ground magnesium silicate, $Mg_3Si_4O_{10}(OH)_2$, is commonly referred to as talcum powder. How many oxygen atoms are in 1 formula unit of magnesium silicate?

A. 2

B. 3

C. 11

D. 12

235) This table shows the percent composition data for aspartame, an artificial sweetener used in many diet soft drinks.

Element	% Composition
C	57.133
H	6.165
N	9.521
O	27.181

What is the empirical formula of aspartame?

A. $C_5H_6NO_2$

B. $C_7H_9NO_3$

C. $C_9HN_2O_4$

D. $C_{14}H_{18}N_2O_5$

236) This table shows the mass composition of a sample of ethyl acetate, a solvent used in some fingernail polish removers.

Element	**Mass Composition (g)**
C	6.16
H	1.03
O	4.11

If the molar mass of ethyl acetate is 88.10 g/mol, what is the molecular formula for ethyl acetate?

A. C_2H_4O

B. $C_3H_4O_3$

C. $C_4H_8O_2$

D. C_6HO_4

237) Lucas adds 10 g of table salt and 20 g of sand to 50 g of distilled water. The mixture is then stirred for 1 hour. Which of the following sequences of separation techniques will allow Lucas to separate the mixture back into these 3 distinct components?

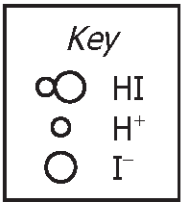
A. Filtration then evaporation

B. Evaporation then filtration

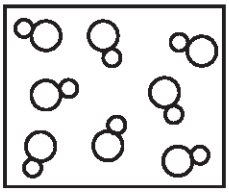
C. Centrifugation then decantation

D. Decantation then centrifugation

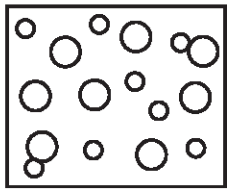
238) Hydroiodic acid, HI, is a strong acid. Which of the following diagrams best represents the degree of dissociation of HI in water? (Note: Individual H_2O molecules have been omitted from the diagram)



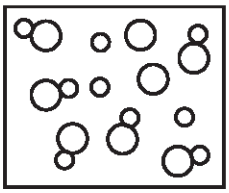
A.



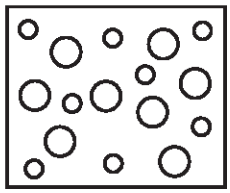
C.



B.



D.



239) Which of the following acids is a strong acid?

A. HBr

B. HCN

C. H_2O

D. H_2S

240) Which of the following bases is a weak base?

A. LiOH

B. KOH

C. NH_4OH

D. $Ca(OH)_2$

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QualityCore® Reference Sheet
Chemistry

Atomic Structure

$E = h\nu$

$c = \lambda\nu$

E = energy
h = Planck's constant = 6.63×10^{-34} J•s
ν = frequency
c = speed of light = 3.0×10^{8} m/s
λ = wavelength
N_A = Avogadro's number = 6.02×10^{23} mol^{-1}

Gases

$d = \frac{m}{V}$

$T(\text{K}) = °\text{C} + 273$

$P_{total} = P_A + P_B + P_C + \ldots$

$PV = nRT$

$n = \frac{m}{\text{M}}$

$d = \frac{P\text{M}}{RT}$

$P_1V_1 = P_2V_2$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

d = density (solids, liquids, and gases)
m = mass
V = volume
T = temperature
P = pressure
n = number of moles
R = gas constant = 0.0821 L•atm/mol•K
M = molar mass
STP = 1.00 atm and 0.00°C
1 atm = 760 mm Hg = 760 torr = 101.3 kPa
1 mol of ideal gas = 22.4 L at STP

Percent Yield and Percent Error

$$\% \text{ Yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

$$\% \text{ Error} = \frac{|\text{accepted value} - \text{experimental value}|}{\text{accepted value}} \times 100$$

continued

Liquids and Solutions

$$\text{Percent (mass/mass)} = \frac{\text{mass of solute (g)}}{\text{mass of solution (g)}} \times 100$$

$$M = \frac{\text{moles of solute}}{\text{L of solution}}$$

$$m = \frac{\text{moles of solute}}{\text{kg of solvent}}$$

$$X_A = \frac{\text{moles}_A}{\text{moles}_{total}}$$

$$M_1V_1 = M_2V_2$$

$$\Delta T_f = K_f \times m$$

$$\Delta T_b = K_b \times m$$

M = molarity
m = molality
X_A = mole fraction of component A
V = volume
ΔT = temperature change
K_f = molal freezing point depression constant
K_f (H_2O) = 1.86°C/m
K_b = molal boiling point elevation constant
K_b (H_2O) = 0.512°C/m

Calorimetry and Thermodynamics

$$q = mC\Delta T$$

$$\Delta H^\circ_{rxn} = \Delta H^\circ_f(\text{products}) - \Delta H^\circ_f(\text{reactants})$$

$$\Delta S^\circ_{rxn} = S^\circ(\text{products}) - S^\circ(\text{reactants})$$

q = heat
m = mass
C = specific heat capacity
C (H_2O) = 4.184 J/g•°C
ΔT = temperature change
ΔH° = standard enthalpy change
ΔS° = standard entropy change

Acids, Bases, and Equilibrium

$$\text{pH} = -\log [H^+]$$

$$\text{pOH} = -\log [OH^-]$$

$$\text{pH} + \text{pOH} = 14$$

$$K_w = [H^+][OH^-]$$

$$K_{eq} = \frac{[C]^c[D]^d}{[A]^a[B]^b} \text{ where } a\,A + b\,B \rightleftharpoons c\,C + d\,D$$

$$K_{sp} = [A^+]^a[B^-]^b \text{ where } A_aB_b(s) \rightleftharpoons a\,A^+(aq) + b\,B^-(aq)$$

$[H^+]$ = H^+ molarity
$[OH^-]$ = OH^- molarity
K_w = ion-product constant for water
$K_w = 1.0 \times 10^{-14}$ at 25°C
K_{eq} = equilibrium constant
K_{sp} = solubility product constant

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Periodic Table of the Elements

1 **H** 1.008																	2 **He** 4.003
3 **Li** 6.941	4 **Be** 9.012											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.88	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.38	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57 **La*** 138.9	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.9	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** 226.0	89 **Ac†** (227)	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (264)	108 **Hs** (265)	109 **Mt** (268)	110 **Ds** (281)								

*	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
†	90 **Th** 232.0	91 **Pa** (231)	92 **U** 238.0	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)

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* 0 1 9 2 4 9 0 8 0 * Rev 1

Answer Key

1) B
2) B
3) C
4) A
5) B
6) D
7) A
8) C
9) B
10) D
11) A
12) C
13) C
14) C
15) C
16) C
17) D
18) B
19) A
20) C
21) C
22) D
23) B
24) C
25) B
26) C
27) C
28) B
29) D
30) A
31) A
32) B
33) D
34) A
35) C
36) D
37) C

38) A
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40) C
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42) D
43) B
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74) C

75) C
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112) A
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116) D
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120) C
121) C
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123) D
124) C
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126) A
127) C
128) D
129) B
130) A
131) A
132) A
133) B
134) D
135) A
136) C
137) A
138) A
139) B
140) B
141) A
142) A
143) A
144) C
145) C
146) B
147) C
148) A

149) D
150) A
151) C
152) D
153) B
154) C
155) B
156) A
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158) B
159) B
160) A
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162) A
163) A
164) C
165) C
166) A
167) A
168) D
169) B
170) B
171) D
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186) D
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188) C
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195) D
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197) D
198) A
199) B
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201) C
202) C
203) A
204) A
205) B
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207) B
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214) C
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218) B
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220) B
221) D
222) D

223) B
224) B
225) C
226) C
227) D
228) C
229) C
230) A
231) B
232) B
233) A
234) D
235) D
236) C
237) A
238) D
239) A
240) C