Chemistry Practice Exam

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. Which of the following statements is ***true*** regarding Lewis diagrams?
a. They do not contain the symbol, only the number of protons.
b. The number of electrons in Lewis diagrams are the same for elements in the same column in the periodic table.
c. Lewis diagrams are useful for transition metals.
d. Lewis diagrams are only used to show chemical reactions.
e. All of the above are true.

____ 2. Which of the following has one lone pair of electrons?
a. nitrogen c. fluorine e. chlorine
b. oxygen d. carbon

New Element Data:

Protons:	undetermined	Ionization energy:	low
Neutrons:	27	Reactivity in water:	low
Electrons:	undetermined	Conductivity:	high

____ 3. Based on the data provided above, which is likely the identity of the element?
a. scandium d. cobalt
b. vanadium e. an element not listed
c. manganese

____ 4. Which is ***true*** regarding diatomic chlorine?
a. has six lone pairs of electrons d. has a total mass of 19 u
b. has a double bond e. All of the above are true.
c. has one atom

____ 5. Using electronegativity, determine which of the following bonds is the most polar.
a. C–O b. C–N c. C–C d. C–H e. C–Cl

____ 6. Determine the approximate electronegativity difference and identity (polar, non-polar) of the bond between carbon and fluorine.
a. 0.0 non-polar c. 1.0 polar e. 1.5 non-polar
b. 0.5 ionic d. 1.5 polar

____ 7. A multivalent metal is involved in a synthesis reaction. Describe the behaviour of the metal in the reaction.
a. The metal can take on any of its valences.
b. The metal will take on its lowest valence.
c. The metal will take on its highest valence.
d. The metal will take on the average of the valences.
e. The metal will take on a weighted average of the valences.

____ 8. A chemical reaction can be classified as more than one type of reaction. This statement is
a. always true d. true only when water is a product
b. never true e. true only when oxygen is a reactant
c. sometimes true

____ 9. What are the possible products of an incomplete combustion reaction?

a. solid carbon
b. carbon dioxide gas
c. water vapour
d. carbon monoxide gas
e. all of the above

____ 10. Which halogen(s) can be displaced by iodine?
a. fluorine
b. chlorine
c. bromine
d. all halogens
e. None of the halogens can be displaced by iodine.

____ 11. Which metal(s) can displace potassium?
a. lead
b. copper
c. platinum
d. iron
e. none of the above

____ 12. If it is known that aluminum can displace zinc from zinc nitrate, then which of the following is ***true*** about the displacement of aluminum from aluminum nitrate by zinc?
a. The reaction will only occur in an acidic solution.
b. The reaction will occur only in a basic solution.
c. The reaction will occur only in warm water.
d. The reaction will always occur.
e. The reaction will not occur.

____ 13. Which of the following is a representation of the Avogadro constant?
a. 1 mol of particles
b. 6.02×10^{23} particles
c. a gross of particles
d. a ream of particles
e. Two of the above are correct.

____ 14. Which of the following is the equivalent of 0.25 mol?
a. 1.505×10^{23} molecules
b. 18 g of water
c. 9 g of water
d. 58.44 g of sodium chloride
e. Two of the above are the equivalent of 0.25 mol.

____ 15. Which of the following best describes the meaning of *molar mass*?
a. the mass of one mole of electrons
b. the mass of one mole of water
c. the mass of one mole of a substance
d. the volume that a mole of a given mass occupies
e. the mass of one of your back teeth

____ 16. Which of the following has the largest atomic molar mass?
a. copper
b. lead
c. gold
d. mercury
e. They all have the same atomic molar mass.

____ 17. Which of the following is an example of an empirical formula?
a. CH_2Cl
b. $C_2H_4Cl_2$
c. $C_3H_6Cl_3$
d. $C_4H_8Cl_4$
e. $C_5H_{10}Cl_5$

____ 18. Why is it important for industries to carefully control reactants that are in excess during the chemical processes used in their industry?
a. Excess chemicals can be released into the environment causing environmental damage.

b. Excess chemicals that are released into the environment and not used waste money.
c. Excess chemicals must be free of impurities to be effective in the chemical reactions.
d. Two of the above statements are valid.
e. All three of the above statements are valid.

____ 19. Which of the following phrases best describes the term *homogeneous*?
a. uniform composition throughout
b. mixed, but can be separated
c. not a uniform composition throughout
d. mixed, but will separate over time
e. two liquids that are mixed together

____ 20. What term is associated with the part of a solution that is present in the smallest amount?
a. ionic compound
b. covalent compound
c. solute
d. solvent
e. soluble

____ 21. Which of the following forces have an effect on the solubility of a solid in a liquid?
a. attraction of solute particles to each other
b. attraction of solute particles to solvent particles
c. attraction of solvent particles to each other
d. Two of the above have an effect.
e. All of (a), (b), and (c) have an effect.

____ 22. Which of the following is a description for the term *hydration*?
a. the process by which water molecules surround molecules of a solvent
b. the process by which water molecules surround ions of a solute
c. the process of adding water to a solution
d. Two of the above are descriptions for the term.
e. All of (a), (b), and (c) are descriptions for the term.

____ 23. Which of the following tests can be used to distinguish between an ionic solution and most molecular solutions?
a. pH measurement
b. solubility test
c. conductivity test
d. test for saturation
e. test for supersaturation

____ 24. Which of the following statements describes the term *concentration*?
a. the quantity of solute per unit quantity of solution
b. the ratio of the quantity of solute to the quantity of solvent
c. a ratio of the mass of solute to the temperature of the solvent
d. Two of the above describe the term *concentration.*
e. All three describe the term *concentration.*

____ 25. Which of the following ions would be harmful to human health if found to be in a drinking water supply?
a. calcium ions
b. sulfate ions
c. iron(II) ions
d. iron(III) ions
e. arsenic ions

____ 26. What is the concentration of 35.00 mL of a lithium hydroxide solution if it is neutralized in a titration by 24.15 mL of 0.1500 mol/L hydrochloric acid?
a. 0.05175 mol/L
b. 0.2070 mol/L
c. 0.1035 mol/L
d. 0.2174 mol/L
e. There is not enough information given to find the concentration.

____ 27. A sample of an ideal gas has its volume doubled while its temperature remains constant. If the original pressure was 100 kPa, what is the new pressure?
a. 10 kPa
c. 100 kPa
e. 100 kPa

b. 50 kPa d. 200 kPa

____ 28. Which of the following changes would increase the pressure of a gas in a sealed container?

I. adding more moles of gas to the container

II. The container size is decreased.

III. The temperature is increased.

IV. The external pressure is decreased.

a. I only c. I, II, and III e. II, III, and IV
b. I and II d. II and IV

____ 29. A pressure of 2.00 atm is the same as a pressure of
a. 101 kPa c. 760 kPa e. 29.4 kPa
b. 202 kPa d. 1520 kPa

____ 30. Under what conditions will neon deviate from the ideal gas?
a. high temperature and high pressure
b. high temperature and low pressure
c. low temperature and high pressure
d. low temperature and low pressure
e. at moderate temperature and pressure

____ 31. Which of the following gas laws states, "equal volumes of gases at the same temperature and pressure contain the same number of molecules"?
a. ideal gas law d. law of combining volumes
b. combined gas law e. Avogadro's law
c. Dalton's law of partial pressures

____ 32. At moderate to high pressures, the measured pressure exerted by CO_2 gas is less than that predicted by the ideal gas equation. This is mainly because
a. such high pressures cannot be accurately measured
b. CO_2 will condense to a liquid at 200 atm pressure
c. gas phase collisions prevent CO_2 molecules from colliding with the walls of the container
d. of attractive intermolecular forces between CO_2 molecules
e. the volume occupied by the CO_2 molecules themselves becomes significant

____ 33. Use the combined gas law. The pressure of a gas is decreased from 400 kPa to 200 kPa and the temperature is raised from 200 K to 300 K. The volume of the gas will
a. decrease by half d. increase by three times
b. remain the same e. increase by four times
c. increase by two times

____ 34. Which of the following statements corresponds to Avogadro's law?
a. The sum of the volume of gaseous reactants equals the sum of the volume of gaseous products.
b. The product of pressure and volume is directly related to the amount of a gas at constant temperature.
c. Volume is directly related to the amount of a gas at constant temperature and pressure.
d. Pressure is directly related to the amount of a gas at constant volume and temperature.
e. Temperature is directly related to the amount of a gas at constant volume and temperature.

____ 35. When collecting a gas over water using a graduated cylinder, which of the following is ***false***?
a. Gas displaces the water in the graduated cylinder.
b. Gas rises to the top of the graduated cylinder because it is less dense than water.
c. Gaseous water vapour must be accounted for using Dalton's law of partial pressures.
d. The collection of trapped air must be avoided.

e. The solubility of the gas in water has no effect on the volume of gas collected.

____ 36. What was John Dalton's major contribution to the atomic model?
a. All atoms are identical.
b. Atoms are indivisible.
c. Atoms of each element are identical.
d. Atoms are all unique.
e. Atoms possess electrons.

____ 37. How is the work of Bohr and Schrödinger mutually corroborative?
a. They both demonstrate the same electron distance from the atom.
b. The both provide rings for electron location.
c. The mathematical calculations are identical.
d. The average electron distance from the nucleus is the same using two different mathematical methods.
e. The average electron distance from the nucleus is the same using two different models of the atom.

____ 38. What is the maximum number of electrons in the second shell?
a. 2 electrons
b. 8 electrons
c. 9 electrons
d. 18 electrons
e. none of the above

____ 39. What is the Lewis diagram for oxygen?

a. 
b. 
c. 
d. 
e. 

____ 40. Which atoms naturally occur in diatomic form?

I. carbon
II. nitrogen and chlorine
III. lithium and magnesium
IV. argon and neon
V. oxygen and fluorine

a. I, II, and V
b. IV and V
c. I, II, and IV
d. II and V
e. IV only

____ 41. Which best describes a molecular compound?
a. A substance composed of non-metals.
b. A chemical compound stabilized by covalent bonds.
c. A connection between atoms resulting in the sharing of electrons.
d. A chemical compound held together through electrostatic forces.
e. All of the above are molecular compounds.

____ 42. Determine the number of bonding pairs in a water molecule.
a. 1 b. 2 c. 3 d. 4 e. 5

____ 43. Electronegativity is used to
a. determine if a bond is ionic
b. determine if a bond is covalent
c. determine the extent of electron sharing in a bond
d. determine polarity of a bond
e. all of the above

____ 44. Which compound(s) in the following chemical reaction is (are) in solution?

$$HClO(aq) + HCl(aq) \rightarrow Cl_2(aq) + H_2O(l)$$

a. $H_2O(l)$ only
d. all reactants

b. $HCl(aq)$ and $H_2O(l)$
c. all reactants and products
e. all products

____ 45. Write the skeleton equation for the reaction in which solid aluminum reacts with chloride gas to form solid aluminum chloride.

a. $AlCl_3(s) \rightarrow Al(s) + Cl_2(g)$
b. $AlCl_2(s) \rightarrow Al(s) + Cl_2(g)$
c. $Al(s) + Cl_2(g) \rightarrow AlCl(s)$
d. $Al(s) + Cl_2(g) \rightarrow AlCl_2(s)$
e. $Al(s) + Cl_2(g) \rightarrow AlCl_3(s)$

____ 46. Find the balanced coefficients of the following chemical reaction:

$$Al(s) + Cl_2(g) \rightarrow AlCl_3(s)$$

a. 1, 2, 3 b. 1, 3, 2 c. 2, 2, 3 d. 2, 3, 2 e. 2, 4, 3

____ 47. Identify the type of chemical reaction given here:

$$2KClO_3 \rightarrow 2KCl + 3O_2$$

a. synthesis
b. decomposition
c. addition
d. combination
e. oxidation

____ 48. What is the balanced chemical equation for the single displacement reaction of solid magnesium in an aqueous solution of hydrochloric acid?

a. $Mg_{(s)} + 2HClO_{3(aq)} \longrightarrow Mg(ClO_3)_{2(aq)} + H_{2(g)}$
b. $Mg_{(s)} + 2HClO_{2(aq)} \longrightarrow Mg(ClO_3)_{2(aq)} + H_{2(g)}$
c. $Mg_{(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2(aq)} + H_{2(g)}$
d. $Mg_{(s)} + HCl_{(aq)} \longrightarrow MgCl_{(aq)} + H_{(g)}$
e. The reaction does not occur.

____ 49. Why has the Avogadro constant changed over time?

a. Scientists could not agree on how many particles should be in one mole.
b. A mole is larger today than it was in the past.
c. The constant changed when the Metric System was introduced.
d. The value is an experimentally determined value.
e. Avogadro measured the mole incorrectly.

____ 50. Which in the following list does the Avogadro constant allow you to convert between?

a. mass and the number of particles
b. amount (in moles) and number of particles
c. number of particles and amount (in moles)
d. Two of the above are correct.
e. All three of the above are correct.

____ 51. What is the amount in moles of 158.62 g of helium?

a. 158.62 mol
b. 39.66 mol
c. 79.31 mol
d. 19.83 mol
e. 9.91 mol

____ 52. Which of the following statements best describes the study called *stoichiometry*?

a. the study of the qualitative relationships between amounts of reactants used and products formed during a chemical reaction
b. the study of the quantitative relationships between amounts of reactants used and products formed during a chemical reaction
c. the study of the quantitative relationships between the amounts of reactants required to get

a reaction to occur

d. the study of balancing chemical equations using small whole number coefficients
e. the study of the writing and balancing of chemical equations using small whole number coefficients

____ 53. What are the numbers in front of reactants and products in a chemical equation called?

a. variables
b. multipliers
c. molar ratios
d. constants
e. coefficients

____ 54. What is the net ionic equation for the reaction of lead(II) nitrate with lithium chloride?

a. $Pb^{+2}(aq) + Cl^{-}(aq) \rightarrow PbCl_2(s)$

b. $Pb^{+2}(aq) + 2Cl^{-}(aq) \rightarrow PbCl_2(s)$

c. $Pb^{+2}(aq) + 2NO_3^{-}(aq) + 2Li^{+}(aq) + 2Cl^{-}(aq) \rightarrow 2Li^{+}(aq) + 2NO_3^{-}(aq) + PbCl_2(s)$

d. $Pb^{+2}(aq) + NO_3^{-}(aq) + Li^{+}(aq) + Cl^{-}(aq) \rightarrow Li^{+}(aq) + NO_3^{-}(aq) + PbCl_2(s)$

e. $Pb(NO_3)_2 + 2LiCl \rightarrow 2LiNO_3 + PbCl_2$

____ 55. Decreasing the temperature of an ideal gas at constant mass will cause which of the following to decrease

I. molar mass

II. the volume of the gas

III. the density of the gas

IV. the average kinetic energy of the gas

V. the pressure of the gas

a. II, III, and IV
b. III, IV, and V
c. I, II, and III
d. II, IV, and V
e. II, III, IV, and V

____ 56. According to the Gay-Lussac's law, which of the following will occur if the temperature on a gas is increased?

a. The volume of the gas will increase.
b. The volume of the gas will decrease.
c. The amount (in moles) of the gas will increase.
d. The pressure of the gas will increase.
e. The pressure of the gas will decrease.

Short Answer

57. What is the significance of uranium in terms of its size?

58. Write and balance the possible reaction(s) that can occur when solid lead reacts with chlorine gas.

59. List the different types of single displacement reactions.

60. Amy states that there is no such thing as a fraction of a mole, as the mole is the base unit for chemistry. Julio disagrees with her, but he is not sure why he disagrees. Who is correct? If Amy is correct, support her position with more detail, and if Julio is correct, help him support his position.

61. Create a graphic organizer to illustrate how to convert from the number of formula units of a compound to the amount (in moles) of the compound.

62. Describe the steps you would take to determine the number of atoms of a compound, if you were given the mass of the compound.

63. The salt used to melt snow on a walkway outside a house is calcium chloride and is sold in 20 kg bags. How many molecules of calcium chloride would be contained in five bags of the salt?

64. Determine the mass percent of oxygen in two copper sulfates that exist.

65. Briefly explain why the temperature of a chemical reaction can affect the percentage yield.

66. Industry uses the reaction of solid carbon with iron(III) oxide to extract solid iron from the oxide. In the process, carbon dioxide is also formed. The reaction that describes this process is

    $3C_{(s)} + 2Fe_2O_{3(s)} \longrightarrow 4Fe_{(s)} + 3CO_{2(g)}$.

    a. Determine the mass of iron that will form if 295.84 g of iron(III) oxide reacts with an excess of solid carbon..

    b. If 200.05 g of iron actually form, what is the percentage yield?

67. Distinguish between the terms *soluble* and *saturated.* Give an example of each to support your explanation.

68. Explain how water from the water cycle on Earth can pick up dissolved ions in solution.

69. Acids ionize in water while bases dissociate in water. Explain the difference between these two processes.

70. Why must an indicator change colour for you to be able to classify the solution as an acid or a base? Include an example to help explain your answer.

71. What volume of 1.15 mol/L magnesium hydroxide is needed to neutralize 66.65 mL of 0.731 mol/L sulfuric acid?

72. Describe how Robert Boyle investigated the relationship between the volume and pressure of a gas.

73. Draw both the Lewis diagram and the structural diagram for ethanol, C_2H_3OH.

74. Illustrate the polar interaction between water and ammonia.

75. Stefanie states that one mole of hydrogen gas is the approximate equivalent of one gram of hydrogen, since the atomic molar mass of hydrogen is 1.01 g/mol. Do you agree or disagree with her statement? Explain.

76. A sample of potassium sulfate has been found to contain 0.15 mol of the molecules. Determine the number of each type of atom this contains.

77. In using $c_1V_1 = c_2V_2$ to find a concentration of a diluted solution, Rachel uses the given volumes in millilitres, instead of converting them to litres. Will Rachel be able to correctly find the concentration of the dilute solution? Explain why or why not.

78. Each of the following observations relates to the properties of gases. Name the property observed and explain the observation. Use diagrams as necessary.

    a. When entering a burning building, emergency personnel wear an assisted-breathing apparatus containing an air tank. This tank can supply air for 20 min or more.

    b. Water is pumped into a pressure tank containing air. The air is reduced in volume in the container.

    c. Oxygen gas generated during an investigation is collected in a round-bottom flask, followed by an Erlenmeyer flask, and, lastly, a large-sized test tube.

    d. A soccer ball can be easily inflated by using a hand pump and attaching it to a valve on the ball.

Problem

79. Write the balanced chemical equation for each skeleton equation.

    a. $AsCl_3 + H_2S \longrightarrow As_2S_3 + HCl$

    b. $NH_4NO_3 \longrightarrow N_2O + H_2O_{(l)}$

    c. $Bi_2O_3 + H_{2(g)} \longrightarrow Bi_{(s)} + H_2O_{(l)}$

    d. $FeCl_3 + (NH_4)_2S \longrightarrow Fe_2S_3 + NH_4Cl$

80. Kombe writes the following chemical equation:

    $NaCl + LiBr \longrightarrow LiCl + NaBr$

    He terms the reaction a double displacement reaction, as the cations have exchanged positions. Do you agree or disagree with his conclusion, based on the solubility table?

81. A sample of a compound is found to have a mass of 47.53 g. The sample is made up of 41.15 g of carbon, with the remaining mass identified as hydrogen.

    a. What is the percentage composition of the compound?

    b. Could this compound be propane, C_3H_8? Explain.

82. 1, 4 butandiol is an organic alcohol that is made up of 53.3% carbon, 11.2% hydrogen, and 35.5% oxygen. It has a molar mass of 90.14 g/mol. What is the molecular formula for 1, 4 butandiol?

83. When 0.045 mol of phosphoric acid react with 0.054 mol of barium hydroxide, water and insoluble barium phosphate form.

    a. Write and balance the chemical equation.

    b. Which is the limiting reactant and which is the reactant in excess?

    c. What mass of barium phosphate will form?

84. Find the mass of solid copper(I) chloride that will form when 17.2 mL of 5.15 mol/L copper(I) nitrate is mixed with 21.5 mL of 4.81 mol/L lithium chloride.

85. Explain the difference between the terms *concentrated* and *dilute* as they relate to acids and bases. Discuss how these terms differs from the terms *weak* and *strong*.

86. In an attempt to determine the molar mass of air, the mass of an empty 60 mL syringe was measured. The plunger was then pulled to the 60.0 mL mark and the mass of the syringe was measured again. The data are presented below.

Item Measured	**Measurement**
Mass empty syringe (g)	45.780
Mass syringe with air (g)	45.850
Air temperature (°C)	22.3
Air pressure (kPa)	100.4

a. Based on the data above, determine the molar mass of air.

b. Would the molar mass of air vary with the temperature? Explain.

c. If the air were humid, would this affect the molar mass? Explain..

Chemistry Practice Exam

Answer Section

MULTIPLE CHOICE

1.	ANS: B	PTS: 1	STA: B2.4	TOP: 1.1	MSC: K/U		
2.	ANS: A	PTS: 1	STA: B3.1	TOP: 1.1	MSC: C		
3.	ANS: B	PTS: 1	STA: B3.3	TOP: 1.3	MSC: A		
4.	ANS: A	PTS: 1	STA: B3.3	TOP: 1.3	MSC: C		
5.	ANS: A	PTS: 1	STA: B3.4	TOP: 2.1	MSC: T/I		
6.	ANS: D	PTS: 1	STA: B2.5	TOP: 2.1	MSC: K/U		
7.	ANS: A	PTS: 1	STA: C3.1 | C2.4	TOP: 3.2	MSC: T/I		
8.	ANS: C	PTS: 1	STA: C3.2 | C2.4	TOP: 3.2	MSC: T/I		
9.	ANS: E	PTS: 1	STA: C3.2	TOP: 3.3	MSC: K/U		
10.	ANS: C	PTS: 1	STA: C2.5	TOP: 4.1	MSC: K/U		
11.	ANS: E	PTS: 1	STA: C2.5	TOP: 4.1	MSC: K/U		
12.	ANS: E	PTS: 1	STA: C2.5	TOP: 4.1	MSC: K/U		
13.	ANS: E	PTS: 1	STA: D3.2	TOP: 5.1	MSC: K/U		
14.	ANS: A	PTS: 1	STA: D2.3	TOP: 5.1	MSC: K/U		
15.	ANS: C	PTS: 1	STA: D2.1	TOP: 5.2	MSC: C		
16.	ANS: B	PTS: 1	STA: D2.3	TOP: 5.2	MSC: K/U		
17.	ANS: A	PTS: 1	STA: D3.3	TOP: 6.2	MSC: T/I		
18.	ANS: D	PTS: 1	STA: D1.1	TOP: 7.2	MSC: K/U		
19.	ANS: A	PTS: 1	STA: E2.1	TOP: 8.1	MSC: K/U		
20.	ANS: C	PTS: 1	STA: E2.1	TOP: 8.1	MSC: K/U		
21.	ANS: E	PTS: 1	STA: E3.2	TOP: 8.2			

MSC: K/U

22. ANS: D PTS: 1 STA: E3.2 TOP: 8.2
MSC: K/U

23. ANS: C PTS: 1 STA: E3.2 TOP: 8.2
MSC: K/U

24. ANS: D PTS: 1 STA: E2.1 TOP: 8.3
MSC: K/U

25. ANS: E PTS: 1 STA: E1.1 TOP: 9.3
MSC: K/U

26. ANS: C PTS: 1 STA: E2.7 TOP: 10.2
MSC: A

27. ANS: B PTS: 1 STA: F2.3 | F2.1 TOP: 11.2
MSC: T/I

28. ANS: C PTS: 1 STA: F3.2 | F3.3 TOP: 11.1 | 11.2
MSC: T/I

29. ANS: B PTS: 1 STA: F2.1 TOP: 11.2
MSC: K/U

30. ANS: C PTS: 1 STA: F3.4 | F2.1 TOP: 12.2
MSC: K/U

31. ANS: E PTS: 1 STA: F3.6 TOP: 12.1
MSC: K/U

32. ANS: D PTS: 1 STA: F3.4 TOP: 12.2
MSC: K/U

33. ANS: D PTS: 1 STA: F3.6 TOP: 12.1
MSC: K/U

34. ANS: C PTS: 1 STA: F3.6 TOP: 12.1
MSC: K/U

35. ANS: E PTS: 1 STA: F3.5 TOP: 12.2
MSC: K/U

36. ANS: C PTS: 1 STA: B3.1 TOP: 1.1
MSC: K/U

37. ANS: D PTS: 1 STA: B3.1 TOP: 1.1
MSC: A

38. ANS: B PTS: 1 STA: B3.1 TOP: 1.1
MSC: T/I

39. ANS: C PTS: 1 STA: B2.4 TOP: 1.1
MSC: C

40. ANS: D PTS: 1 STA: B2.6 TOP: 2.1
MSC: K/U

41. ANS: B PTS: 1 STA: B3.5 TOP: 2.1
MSC: K/U

42. ANS: B PTS: 1 STA: B2.4 TOP: 2.1
MSC: C

43. ANS: E PTS: 1 STA: B3.4 TOP: 2.1
MSC: K/U

44. ANS: D PTS: 1 STA: C2.1 TOP: 3.1
MSC: K/U

45. ANS: E PTS: 1 STA: C2.1 | C2.2 TOP: 3.1
MSC: K/U

46. ANS: D PTS: 1 STA: C2.2 TOP: 3.1
MSC: K/U
47. ANS: B PTS: 1 STA: C3.1 TOP: 3.2
MSC: K/U
48. ANS: C PTS: 1 STA: C2.2 | C2.5 TOP: 4.1
MSC: K/U
49. ANS: D PTS: 1 STA: D3.2 TOP: 5.1
MSC: K/U
50. ANS: D PTS: 1 STA: D3.2 TOP: 5.1
MSC: K/U
51. ANS: B PTS: 1 STA: D2.3 TOP: 5.2
MSC: K/U
52. ANS: B PTS: 1 STA: D2.1 TOP: 7.1
MSC: K/U
53. ANS: E PTS: 1 STA: D2.1 TOP: 7.1
MSC: K/U
54. ANS: B PTS: 1 STA: E2.5 TOP: 9.1
MSC: K/U
55. ANS: D PTS: 1 STA: F3.4 TOP: 11.1 | 11.3
MSC: T/I
56. ANS: D PTS: 1 STA: F3.4 | F3.5 TOP: 11.3
MSC: K/U

SHORT ANSWER

57. ANS:
Uranium is the largest naturally occurring element on the periodic table. Every element that is larger does not occur naturally and can only be produced artificially. All of these elements are so large that they are radioactive.

PTS: 2 STA: B3.3 TOP: 1.2 MSC: K/U

58. ANS:
$Pb(s) + Cl_2(g) \rightarrow PbCl_2(s)$ and/or $Pb(s) + 2Cl_2(g) \rightarrow PbCl_4(s)$

PTS: 2 STA: C2.2 | C2.4 TOP: 3.2 MSC: K/U

59. ANS:
The different types of single displacement reaction are

- a metal displacing another metal
- a metal displacing hydrogen from an acid or water
- a halogen displacing another halogen

PTS: 2 STA: C3.1 TOP: 4.1 MSC: K/U

60. ANS:
Julio is correct, as a mole is 6.02×10^{23} particles, and any amount of a substance that has less than this number of particles will be a fraction of a mole. It is the same as saying half of a dozen (or 6), which is the same as saying 0.5 dozen, which is a number that exists. Therefore, 3.01×10^{23} would represent half of a mole (or 0.5 mol).

PTS: 2 STA: D2.1 TOP: 5.1 MSC: C

61. ANS:

$$\textit{number of formula units of a compound} \xrightarrow{\div N_A} \textit{amount (in moles) of the compound}$$

PTS: 2 STA: D2.1 TOP: 5.1 MSC: C

62. ANS:
You would start by determining the molar mass of the molecule. Then you would divide the mass of the compound by the molar mass of the molecule. This will determine the amount (in moles) of the compound. You would then multiply this value by the Avogadro constant to determine the number of molecules of the compound in the given mass.

PTS: 2 STA: D2.3 TOP: 5.2 MSC: C

63. ANS:
Molar mass of $CaCl_2$: $40.08 + 2 \times 35.45 = 110.98$ g/mol

5 bags at 20 kg each is a total of 100 kg, or 100 000 g.

$$100000\,g \times \frac{1\ mol}{110.98\ g} = 901.06\ mol$$

$$901.06\,mol \times \frac{6.02 \times 10^{23}\ molecules}{1\ mol} = 5.42 \times 10^{26}\ molecules$$

PTS: 2 STA: D2.3 TOP: 5.2 MSC: A

64. ANS:
$CuSO_4$: molar mass $63.55 + 32.06 + 4 \times 16.00 = 159.61$ g/mol

For oxygen: $\frac{4 \times 16.00}{159.61} \times 100\% = 40.1\%$

Cu_2SO_4: molar mass $2 \times 63.55 + 32.06 + 4 \times 16.00 = 223.16$ g/mol

For oxygen: $\frac{4 \times 16.00}{223.16} \times 100\% = 28.7\%$

PTS: 2 STA: D2.2 TOP: 6.1 MSC: K/U

65. ANS:

- If the temperature of a reaction is too low, reactant molecules will collide but may not have enough energy in their collision to have a chemical reaction occur.
- The collisions will be less frequent at lower temperatures, so more time will be required for the reaction to go to completion.

PTS: 2 STA: D2.6 TOP: 7.3 MSC: C

66. ANS:

a. $295.84\ \text{g} \times \frac{1\ \text{mol}}{159.70\ \text{g}} = 1.85\ \text{mol}\ Fe_2O_{3(s)}$

$$1.85 \text{ mol } Fe_2O_{3(s)} \times \frac{4 \text{ mol Fe}}{2 \text{ mol } Fe_2O_{3(s)}} = 3.70 \text{ mol } Fe_{(s)}$$

$$3.70 \text{ mol Fe} \times \frac{55.85 \text{ g}}{1 \text{ mol}} = 206.65 \text{ g } Fe_{(s)}$$

b. Percentage yield: $\frac{200.05 \text{ g}}{206.65 \text{ g}} \times 100\% = 96.8\%$

PTS: 2 STA: D2.6 TOP: 7.3 MSC: A

67. ANS:

Soluble simply means that the substance was able to dissolve in solution. The relative solubility of the solid is not reflected in this term. Salt is said to be soluble in water.

Saturated means that the soluble solid has reached a point in the solution that no more of the material will dissolve. Thus, the soluble solid is said to have reached its saturation point in the solution. When enough table salt is dissolved in solution that any more salt place in the solution will simply sink to the bottom of the solution and remain undissolved, the solution is said to be saturated. For table salt in water, this point is reached once approximately 36 g of the solid is dissolved in 100 mL of water.

PTS: 2 STA: E2.1 TOP: 8.1 MSC: K/U

68. ANS:

- As water moves through the water cycle, carbon dioxide dissolves into the water.
- The dissolved carbon dioxide reacts with water to form a dilute carbonic acid solution.
- As this slightly acidic water filters through the rock and sediment in the ground, some ions are dissolved from rock and mineral deposits.
- This causes the water to pick up ions in solution.

PTS: 2 STA: E1.1 TOP: 9.3 MSC: C

69. ANS:

- The process of ionization involves a molecular substance forming ions in solution, while the process of dissociation involves an ionic substance breaking apart into its ions in solution.
- Both result in ions in solution, the difference is simply what type of bonds exist and are being broken in the solid prior to the ions entering the solution.

PTS: 2 STA: E1.1 TOP: 10.1 MSC: C

70. ANS:

- Without a change in colour, the solution can either be an acid (if the colour of the indicator is indicative of an acid) or it could be neutral.
- A neutral solution will not cause a change in the colour of an indicator.
- For example, a piece of blue litmus paper will remain blue in a neutral solution or in a base.
- Therefore, if a piece of blue litmus paper is used, and there is not a colour change to red (the colour of litmus in an acid), you cannot conclude that the solution must be a base, as it could also be neutral.

PTS: 2 STA: E3.5 TOP: 10.1 MSC: K/U

71. ANS:

For the acid:

$$0.06665\ \text{L} \times \frac{0.731\ \text{mol}}{1\ \text{L}} = 0.04872115\ \text{mol}$$

$$H_2SO_{4(aq)} + Mg(OH)_{2(aq)} \longrightarrow MgSO_{4(aq)} + 2H_2O_{(l)}$$

The ratio of acid to base in this situation is 1:1, therefore, the same amount of base is needed to neutralize the acid. This means that 0.04872115 mol of magnesium hydroxide are needed.

For the base:

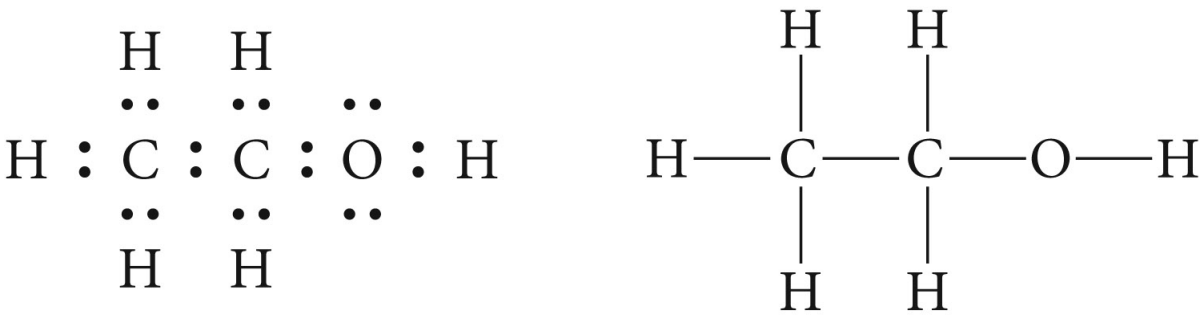
$$0.04872115\ \text{mol} \times \frac{1\ \text{L}}{1.15\ \text{mol}} = 0.0423662174\ \text{L or } 42.37\ \text{mL}$$

PTS: 2 STA: E2.2 TOP: 10.2 MSC: T/I

72. ANS:
Boyle used a J tube. Using liquid mercury, he trapped a small amount of gas in the J tube. As the height of mercury was increased in the J tube, the volume changed and could be measured.

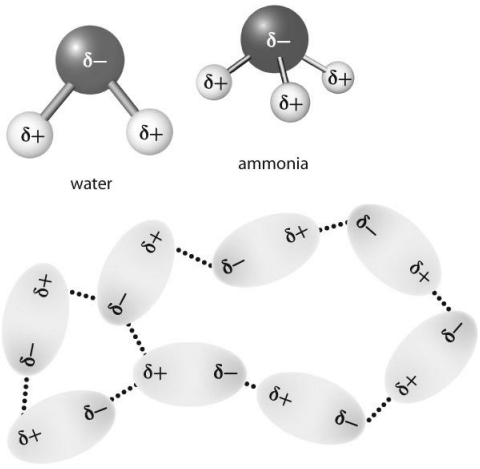
PTS: 2 STA: F3.4 TOP: 11.2 MSC: K | C

73. ANS:



PTS: 2 STA: B2.4 TOP: 2.2 MSC: C

74. ANS:



PTS: 3 STA: B2.4 TOP: 2.3 MSC: C

75. ANS:

Stefanie is incorrect, as she did not take into account that hydrogen gas is a diatomic molecule; therefore, one mole would be equal to 2.02 grams.

PTS: 2 STA: D2.1 TOP: 5.1 MSC: C

76. ANS:

Potassium sulfate has the formula K_2SO_4, which means that each molecule contains 2 atoms of potassium, 1 atom of sulfur, and 4 atoms of oxygen.

0.15 mol of molecules: $0.15\,mol \times \frac{6.02 \times 10^{23}\ molecules}{1\ mol} = 9.03 \times 10^{22}$ molecules.

To determine the number of each type of atom, take the number of molecules and multiply by the number of that atom in the molecule:

Potassium:

$$9.03 \times 10^{22}\ molecules \times \frac{2\ atoms\ of\ K}{1\ molecule} = 1.81 \times 10^{23}\ atoms\ of\ K$$

Sulfur:

$$9.03 \times 10^{22}\ molecules \times \frac{1\ atom\ of\ S}{1\ molecule} = 9.03 \times 10^{22}\ atoms\ of\ S$$

Oxygen:

$$9.03 \times 10^{22}\ molecules \times \frac{4\ atoms\ of\ O}{1\ molecule} = 3.61 \times 10^{23}\ atoms\ of\ O$$

PTS: 2 STA: D2.3 TOP: 5.1 MSC: A

77. ANS:

Rearranging the formula for the second concentration: $c_2 = \frac{c_1 V_1}{V_2}$. With this in mind, as long as the two units for volume are in the same metric unit of measure, their units would divide out of the expression, leaving units of concentration that would be used for c_1. Therefore, Rachel's method will give her the same correct answer using millilitres for volume as it would if she were to convert volumes to litres.

PTS: 2 STA: E2.3 TOP: 8.4 MSC: C

78. ANS:

a. Gases are compressible. Large amounts can be placed under pressure and compressed. Large amounts of oxygen can be stored in a tank in this manner, providing sufficient oxygen to last many minutes.

b. Gases are compressible. As water is pushed into the tank, the molecules of gas are pushed closer together.

c. The particles of a gas exhibit independent motion. As the particles move independently in a container, they will cause the gas to occupy the shape of the container, regardless of its dimensions.

d. Several properties are involved, gases are compressible, gases occupy the shape of the container.

PTS: 4 STA: F3.2 TOP: 11.1 MSC: T/I | C

PROBLEM

79. ANS:

a. $2AsCl_3 + 3H_2S \longrightarrow As_2S_3 + 6HCl$

b. $NH_4NO_3 \longrightarrow N_2O + 2H_2O_{(l)}$

c. $Bi_2O_3 + 3H_{2(g)} \longrightarrow 2Bi_{(s)} + 3H_2O_{(l)}$

d. $2FeCl_3 + 3(NH_4)_2S \longrightarrow Fe_2S_3 + 6NH_4Cl$

PTS: 5 STA: C2.2 TOP: 3.1 MSC: T

80. ANS:
All compounds given in this reaction as reactants and products are soluble in water, meaning that they all will form ions in an aqueous solution. As a result, there really is no chemical reaction that occurs, as the ions are free to move about the solution without ever joining together to form compounds. Therefore, while on paper the reaction looks to be a double displacement reaction, due to the fact that nothing happens in the process, there is no chemical reaction that occurs.

PTS: 5 STA: C2.6 TOP: 4.2 MSC: T/I

81. ANS:

a. For carbon: $\frac{41.15}{47.53} \times 100\% = 86.6\%$

For hydrogen: $\frac{47.53 - 41.15}{47.53} \times 100\% = 13.4\%$

b. For propane: molar mass $3 \times 12.01 + 8 \times 1.01 = 44.11$

For carbon: $\frac{3 \times 12.01}{44.11} \times 100\% = 81.7\%$

Since the sample is 86.6% carbon, the sample cannot be propane.

PTS: 5 STA: D2.2 TOP: 6.1 MSC: T/I

82. ANS:
In 100 g of the compound, there would be 53.3 g of carbon, 11.2 g of hydrogen, and 35.5 g of oxygen.

For carbon: $53.3\ g \times \frac{1\ mol}{12.01\ g} = 4.44\ mol$

For hydrogen: $11.2\ g \times \frac{1\ mol}{1.01\ g} = 11.09\ mol$

For oxygen: $35.5\ g \times \frac{1\ mol}{16.00\ g} = 2.22\ mol$

So, $C:H:O = 4.44:11.09:2.22$

In lowest terms: $\frac{4.44}{2.22} : \frac{11.09}{2.22} : \frac{2.22}{2.22} = 2:5:1$

This gives an empirical formula of C_2H_5O, with a molar mass of 45.07 g/mol.

To find the whole number multiple of the empirical formula in the molecule:

$$\frac{90.14\ g/mol}{45.07\ g/mol} = 2$$

Therefore, the molecular formula is $C_4H_{10}O_2$.

PTS: 5 STA: D2.4 TOP: 6.2 MSC: A

83. ANS:

a. $2H_3PO_{4(aq)} + 3Ba(OH)_{2(aq)} \longrightarrow Ba_3(PO_4)_2 + 6H_2O_{(l)}$

b. If all 0.045 mol of phosphoric acid were to be used up:

$0.045\ \text{mol}\ H_3PO_{4(aq)} \times \frac{3\ \text{mol}\ Ba(OH)_{2(aq)}}{2\ \text{mol}\ H_3PO_{4(aq)}} = 0.0675\ \text{mol}\ Ba(OH)_{2(aq)}$ would be needed. Since only 0.054 mol are available, the barium hydroxide is the limiting reactant. This means that the phosphoric acid is the reactant in excess.

c. $0.054\ \text{mol}\ Ba(OH)_{2(aq)} \times \frac{1\ \text{mol}\ Ba_3PO_{4(aq)}}{3\ \text{mol}\ Ba(OH)_{2(aq)}} = 0.018\ \text{mol}\ Ba_3PO_{4(aq)}$

Molar mass = $3 \times 137.3 + 2 \times 30.97 + 8 \times 16.00 = 601.84\ g/mol$

$0.018\ \text{mol}\ Ba_3PO_{4(aq)} \times \frac{601.84\ g}{1\ \text{mol}} = 10.83\ g\ Ba_3PO_{4(aq)}$

PTS: 2 STA: D2.6 TOP: 7.2 MSC: T/I

84. ANS:

$CuNO_3 \longrightarrow Cu^+_{(aq)} + NO^-_{3(aq)}$

$0.0172\ L \times \frac{5.15\ \text{mol}}{1\ L} = 0.0886\ \text{mol}\ CuNO_3$

Due to the 1:1 ratio between the copper(I) nitrate and the copper ions, there are also 0.0886 mol of copper ions in solution.

$LiCl \longrightarrow Li^+_{(aq)} + Cl^-_{(aq)}$

$0.0215\ L \times \frac{4.81\ \text{mol}}{1\ L} = 0.103\ \text{mol}\ LiCl$

Due to the 1:1 ratio between the lithium chloride and the chloride ions, there are also 0.103 mol of chloride ions in solution.

$Cu^+_{(aq)} + Cl^-_{(aq)} \longrightarrow CuCl_{(s)}$

Due to the 1:1 ratio between the copper ions and the chloride ions, the limiting reactant will be the copper ions (0.0886 is smaller than 0.103).

This means that 0.0886 mol of copper(I) chloride will form.

Molar mass: $63.55 + 35.45 = 99.00\ g/mol$

$$0.0886 \text{ mol} \times \frac{99.00 \text{ g}}{1 \text{ mol}} = 8.77 \text{ g } CuCl_{(s)}$$

PTS: 5 STA: E2.6 TOP: 9.2 MSC: T/I

85. ANS:

- Concentrated solutions have a large quantity of the material making up the solution present.
- Dilute solutions have a small quantity of the material making up the solution present.
- These differ from weak and strong in that concentrated and weak deal with how much of a material is present, not what form it takes when it is in solution.
- For example a concentrated solution can be either strong or weak depending on whether there are many of the molecules in the solution still moving around as molecules or if most of the molecules are now ions in solution.
- The same is true of a dilute solution.
- There is such a solution as a dilute solution of a strong acid.

PTS: 5 STA: E3.5 TOP: 10.1 MSC: T/I

86. ANS:

a. mass of air = 45.850 g – 45.780 g = 0.07 g

P = 100.4 kPa

T = 22.3C + 273.2 = 295.5 K

$$n = \frac{PV}{RT} = \frac{(100.4 \text{ kPa})(0.060 \text{ L})}{\left(8.314 \frac{\text{kPa} + \text{L}}{\text{mol} + \text{K}}\right)(295.5 \text{ K})} = 2.45¥10^{-3} \text{ mol}$$

$$\text{Molar mass} = 0.07 \text{ g} + 0.00245 \text{ mol} = 28.6 \text{ g/mol}$$

b. As the temperature is raised, air particles move faster and farther apart, so the density would be expected to decrease. If the temperature is lowered, gas molecules come closer together, so it would be expected that the density would increase.

c. If the air was humid, more water molecules would be in the air. This would have the effect of making air "heavy," so it would increase the molar mass of the air.

PTS: 5 STA: F2.5 TOP: 12.2 MSC: A | T/I