155/155

Name: ___SAMPLE EXAM - ANSWERS

BLUEVALE COLLEGIATE INSTITUTE
COURSE: SCH 3UI
TEACHERS: Mr. Arthur
DATE: June, DD, YYYY
TIME: 2 HOURS
NOTE: *Calculators are permitted but are not to be shared during the exam.
**The standard periodic table may be used.
*** Use of cell phones and or MP3 players is prohibited.

The following exam contains **10 pages**, **50 multiple choice** questions, **20 Quicks** and **15 short answer** questions. **Total Marks: 150.** Remember to read ALL questions carefully, answer all parts, **show equations** and **include units.** Failure to do so will result in loss of marks. **Good Luck!**

Part A MULTIPLE CHOICE (50 Marks)
Answer the following questions on the SCANTRON card provided. Remember to write your name and to use pencil on the SCANTRON.

1. Barium has a higher first ionization energy than strontium, based on their positions in the periodic table.
   A) true
   B) false

   B

2. Element 120 will be an alkaline earth metal.
   A) true
   B) false

   A

3. How many electrons, protons, and neutrons are in $[^{120}_{50}Sn]^{4+}$?
   A) 54 electrons, 50 protons, and 70 neutrons
   B) 50 electrons, 54 protons, and 70 neutrons
   C) 46 electrons, 50 protons, and 70 neutrons
   D) 50 electrons, 50 protons, and 120 neutrons

   C

4. In which pair of elements is the element with the smaller radius listed first?
   A) potassium, calcium
   B) oxygen, sulfur
   C) aluminum, silicon
   D) iodine, bromine

   B

5. Which molecule is not linear?
   A) H-C≡C-H
   B) SO_2
   C) H_2S — bent
   D) CO_2

   C

6. Which ion has the correct name and formula?
   A) nitrite, NO_3
   B) phosphite, PO_3^{3-}
   C) hydrogen carbonate, HCO_3^-
   D) chlorite, ClO_2^{2-}

   B

7. What is the valence of iron in the compound FeN?
   A) -3
   B) +1
   C) +3
   D) +2

   C

8. Which bond is most polar?
   A) H-O $3.44 - 2.20 = 1.24$
   B) I-Br $2.96 - 2.66 = 0.30$
   C) F-Cl $3.98 - 3.16 = 0.82$
   D) O-S $3.44 - 2.58 = 0.86$

   A

1

9. Which element will form a covalent bond with nitrogen?
   A) Be
   B) Li
   C) K
   (D) O

(handwritten: D)

10. A metal reacts with an ionic compound in a single displacement or substitution reaction. What does the metal atom replace?
   A) the anion
   (B) the cation
   C) either the anion or the cation
   D) the less electronegative atom, if the compound contains a complex anion

(handwritten: B)

11. When the following skeleton equation is correctly balanced, what is the coefficient in front of silicon tetrachloride?

$$4\ C_6H_5Cl_{(l)} + SiCl_{4(l)} + 8Na(s) \rightarrow (C_6H_5)_4Si_{(l)} + 8NaCl_{(s)}$$

   (A) 1
   B) 2
   C) 4
   D) 6

(handwritten: A)

12. Which equation represents the decomposition reaction that occurs during the electrolysis of molten aluminum oxide?
   A) $AlO_{(l)} \rightarrow Al_{(l)} + O_{2(g)}$
   (B) $2Al_2O_{3(l)} \rightarrow 4Al_{(l)} + 3O_{2(g)}$
   C) $Al_2O_{3(l)} \rightarrow 2Al_{(l)} + 3O_{(g)}$
   D) $2AlO_{(l)} \rightarrow 2Al_{(l)} + O_{2(g)}$

(handwritten: B)

13. According to the activity series for metals, which three elements are correctly listed in order of decreasing reactivity?
   (A) Hg, Cu, Pt *(handwritten: 1.88, 1.90, 2.2)*
   B) Mn, Fe, Pb *(handwritten: 1.55, 1.83, 1.8)*
   C) Al, Ca, Li *(handwritten: 1.61, 1.00, 0.98)*
   D) Sn, Fe, H2 *(handwritten: 1.96, 1.83, 2.20)*

(handwritten: A)
(handwritten: Sn 1.96   Fe 1.83)

14. Consider the following reaction:
   $$Sn(s) + FeSO_4(aq) \rightarrow SnSO_4(aq) + Fe(s)$$
   Which statement about this reaction is correct?
   A) It is an example of a double displacement reaction.
   B) It is incorrect because one of the formulas is incorrect.
   (C) It cannot occur because Sn is below Fe in the activity series for metals.
   D) It cannot occur because FeSO4 is insoluble.

(handwritten: C)

15. Magnesium has three naturally occurring isotopes in the following ratios: 79% magnesium-24, 10% magnesium-25, and 11% magnesium-26. If a 60.0 g sample of magnesium is massed out, how many grams are magnesium-25?
   A) 54 g
   B) 47 g
   C) 6.6 g
   (D) 6.0 g

(handwritten: D)
(handwritten: 60g × 10% = 6g)

16. What is the molar mass of $Ca_3(PO4)_2$?
   A) 87.05 g/mol
   B) 215.20 g/mol
   (C) 309.97 g/mol
   D) 430.39 g/mol

(handwritten: C)
(handwritten: $\frac{Ca}{3(40.08)} + \frac{P}{2(30.97)} + \frac{O}{8(16)}$)

17. How many molecules of sulfur dioxide are present in 1.60 mol of sulfur dioxide?
   (A) 9.63×10^{23}
   B) 1.54×10^{23}
   C) 3.76×10^{23}
   D) 2.65×10^{24}

(handwritten: A)
(handwritten: $N = n \times N_A = (1.60)(6.02 \times 10^{23})$)

18. Which statement explains why chemists do not count atoms and molecules individually?
   (A) Atoms and molecules are extremely small.
   B) Matter is neither created nor destroyed in a chemical reaction.
   C) All of the relationships in a chemical reaction can be expressed as mass ratios.
   D) Reactions take place one atom at a time.

(handwritten: A)

19. How many moles are in 2.55 g of sodium?

   A) 58.6 mol
   B) 0.111 mol
   C) 0.0554 mol
   D) 9.02 mol

   B

   $n = \dfrac{m}{M}$

   $= \dfrac{2.55g}{22.99 g/mol}$

20. What is the average atomic mass of neon?

   A) 18.184 u
   B) 20.124 u
   C) 20.179 u
   D) 20.180 u

21. The average of the total mass of all an element's isotopes is called:

   A) the isotopic abundance
   B) the weighted average
   C) the average molar mass
   D) the average atomic mass

   D

22. What is the empirical formula for benzene, C_6H_6?

   A) C_3H_3
   B) C_6H_6
   C) CH
   D) C_2H_2

   C

23. What is the empirical formula of a compound that is 25.9% nitrogen and 74.1% oxygen?

   A) NO
   B) N_2O_5
   C) NO_2
   D) N_2O

   B

   Assume a 100g sample

   $n_N = \dfrac{m}{M}$ $n_O = \dfrac{m}{M}$

   $= \dfrac{25.9}{14}$ $= \dfrac{74.1}{16}$

   $= \dfrac{1.85}{1.85}$ $= \dfrac{4.63}{1.85}$

   1 : 2.5 (×2)

   2 : 5

24. Diethyl oxalate is a solvent that is used in some perfumes. Its empirical formula is $C_3H_5O_2$, and its molecular mass is 146.14 u. What is the molecular formula of diethyl oxalate?

   A) $C_{12}H_2O_8$
   B) $C_9H_{15}O_6$
   C) $C_6H_5O_4$
   D) $C_6H_{10}O_4$

   D

   $M_{EF} = 73.08 g/mol$

   $multiple = \dfrac{M_{MF}}{M_{EF}}$

   $= \dfrac{146.14}{73.08}$

   → 2

25. What is the mass percent of water in the compound $BaCl_2 \cdot H_2O$?

   A) 33.3%
   B) 17.3%
   C) 14.8%
   D) 7.96%

   D

   Assume a 1mol sample

   $m\%_{H_2O} = \dfrac{18.02}{226.22} \times 100$

26. What is the percent composition of phosphorus in ammonium phosphate? $(NH_4)_3PO_4$

   A) 63.2%
   B) 36.4%
   C) 28.2%
   D) 20.8%

   D

   Assume a 1 mol sample

   $\%P = \dfrac{30.97}{149.09} \times 100$

27. A sample of the hydrate of thallium(III) chloride has a mass of 64.5 g. The sample is found to contain 12.1 g of water. What is the formula of the hydrate?

   A) $TlCl_3 \cdot 5H_2O$
   B) $TlCl_3 \cdot 2H_2O$
   C) $TlCl_3 \cdot 3H_2O$
   D) $TlCl_3 \cdot 4H_2O$

   D

   $n_{TlCl_3} = \dfrac{m}{M}$ $n_{H_2O} = \dfrac{m}{M}$

   $= \dfrac{(64.5-12.1)}{310.75}$ $= \dfrac{12.1}{18.02}$

   $= \dfrac{0.169 mol}{0.169}$ $= \dfrac{0.671}{0.169}$

   1 : 4

28. Consider the following balanced chemical equation:

   $2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$

   If 4.12 mol of chlorine react with sodium metal, how many moles of sodium metal are consumed?

   A) 23.0 mol
   B) 8.24 mol
   C) 4.12 mol
   D) 2.06 mol

   B

   $1 mol\ Cl_2 : 2 mol\ Na$

   $\dfrac{4.12}{} \quad \dfrac{X}{}$

29. In an experiment, the total mass of all the reactants is 4.20 g. Three products are formed. The masses of two of the products add to 3.65 g. What is the mass of the third product?

   A) 7.85 g
   B) 4.20 g
   C) 3.65 g
   D) 0.55 g

   D

   $4.2 - 3.65 =$

30. The results of a precipitation reaction are given below:
    Theoretical mass of precipitate = 1.62 g
    Mass of filter paper = 0.85 g
    Mass of filter paper and dry precipitate = 2.42 g
    Calculate the percentage yield for these results.
    A)   100%
    B)   96.9%
    C)   66.9%
    D)   52.5%

[Handwritten: B]

[Handwritten right side:
$AY = 2.42 - 0.85$
$= 1.57$

$\%Y = \dfrac{AY}{TY} \times 100$

$= \dfrac{1.57}{1.62} \times 100$ *]*

31. The percentage yield of a particular reaction needs to be 82% for the reaction to be cost efficient. If the theoretical yield is 950 kg, what does the actual yield need to be?
    A)   171 kg
    B)   779 kg
    C)   950 kg
    D)   1158 kg

[Handwritten: B]

[Handwritten right side:
$AY = \dfrac{(TY)(\%Y)}{100}$

$= \dfrac{(950)(82)}{100}$ *]*

32. Which term means the amount of product that is predicted by stoichiometry?
    A)   theoretical yield
    B)   actual yield
    C)   percentage purity
    D)   percentage yield

[Handwritten: A]

33. Water has a special type of attraction between its molecules. What is this attraction called?
    A)   dipole-dipole attraction
    B)   hydrogen bonding
    C)   ion-ion attraction
    D)   dipole-ion attraction

[Handwritten: B]

34. 67.2 g of copper(II) chloride is dissolved in enough water to make 250 mL of solution. What is the molar concentration of the solution?
    A)   2.5 mol/L
    B)   2.0 mol/L
    C)   1.0 mol/L
    D)   0.50 mol/L
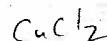
[Handwritten: B]

[Handwritten right side:
$C = \dfrac{n}{V}$

$= \dfrac{0.5}{0.25}$

$= 2$

$n = \dfrac{m}{M}$

$= \dfrac{67.2}{134.45}$

$= 0.5 \, mol$

$CuCl_2$ *]*

35. Which factor does not affect the rate of dissolving?
    A)   agitation
    B)   amount of solvent
    C)   particle size
    D)   temperature

[Handwritten: B]

36. Which term describes a substance that is able to conduct electricity in an aqueous solution?
    A)   miscible
    B)   immiscible
    C)   electrolyte
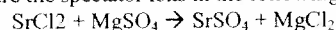   D)   non-electrolyte

[Handwritten: C]

37. What is the general equation for a double displacement reaction?
    A)   A + B → AB
    B)   CD → C + D
    C)   A + XY → AY + X
    D)   AB + XY → AY + XB

[Handwritten: D]

38. What type of reaction is a precipitation reaction?
   A)   synthesis reaction
    B)   decomposition reaction
    C)   single displacement reaction
    D)   double displacement reaction

[Handwritten: D]

39. What are the spectator ions in the following reaction?
    $SrCl2 + MgSO_4 \rightarrow SrSO_4 + MgCl_2$
    A) Sr^{2+} and Cl^-
    B) Mg^{2+} and SO_4^{2-}
    C) Mg^{2+} and Cl^-
    D) Sr^{2+} and SO_4^{2-}

[Handwritten: C]

40. In the following unbalanced equation, 2 mol of aluminum sulfate are mixed with an excess of sodium phosphate:

$$Al_2(SO4)_3 + 2Na_3PO_4 \rightarrow 3Na_2SO_4 + 2AlPO_4 (s)$$
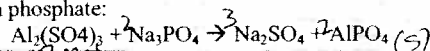
How many moles of precipitate are formed?

- A) 2 mol
- B) 3 mol
- C) 4 mol
- D) 6 mol

(Handwritten: C marked; circled C. Work: $\dfrac{1\ mol\ Al_2(SO4)_3}{2\ mol} : \dfrac{2\ mol\ AlPO_4}{x}$)

41. Which oxide is most likely to form a basic solution?

- A) NO
- B) MgO
- C) SO₃
- D) CO₂

(Handwritten: B; circled B)

42. Which compound is an oxyacid?

- A) H₂S
- B) Na₂CO₃
- C) HCl
- D) H₂SO₃

(Handwritten: D; circled D)

43. What should you do when handling acids and bases?

- A) Wear gloves.
- B) Wear safety glasses.
- C) Wear an apron.
- D) Wear gloves, safety glasses, and an apron.

(Handwritten: D; circled D)

44. If a sealed 1 L jar is cooled, what happens to the gas molecules?

- A) They move more slowly.
- B) They collide more often with the walls of the jar.
- C) Their vibration increases.
- D) They move farther apart.

(Handwritten: A; circled A)

45. Which statement best accounts for the fact that gases can be easily compressed?

- A) Molecules occupy space.
- B) The collisions of molecules are elastic.
- C) Molecules of gases are in constant motion.
- D) Molecules of gases are relatively far from each other

(Handwritten: D; circled D)

46. A particular gas occupies 15 L at 0°C. What volume will the gas occupy at -35°C, assuming that the pressure remains constant?

- A) 13 L
- B) 17 L
- C) 2 L
- D) 10 L

(Handwritten: A; circled A. Work: $\dfrac{V_1}{T_1} = \dfrac{V_2}{T_2}$ $V_2 = \dfrac{V_1 T_2}{T_1} = \dfrac{(15)(238)}{(273)}$ $T_2 = 273-35 = 238$)

47. What is the mass of 5.6 L of gaseous ammonia, NH₃, at STP?

- A) 0.25 g
- B) 4.3 g
- C) 8.5 g
- D) 22.4 g

(Handwritten: B; circled B. Work: $n = \dfrac{PV}{RT} = \dfrac{(101.3)(5.6)}{(8.314)(273)}$ $n = 0.25\ mol$ $m = nM = (0.25)(17.03) = 4.3g$)

48. The density of a gas is 1.23 g/L at STP. What is the molar mass of the gas?

- A) 27.6 g/mol
- B) 3.76 g/mol
- C) 37.6 g/mol
- D) 17.6 g/mol

(Handwritten: A; circled A. Work: $n = \dfrac{PV}{RT} = \dfrac{(101.3)(1)}{(8.314)(273)}$ $n = 0.04463$ $M = \dfrac{m}{n} = \dfrac{1.23}{0.04463}$ $m = DV = (1.23)(1) = 1.23$)

49. Which of the following relationships represent Boyle's Law?

- A) P α1/T
- B) V α T
- C) V α 1/P
- D) P α T

(Handwritten: C; circled C)

50. 358 Torr is equivalent to ____ atm?

- A) 358 atm
- B) 85 atm
- C) 0.471 atm
- D) 0.358 atm

(Handwritten: C; circled C. Work: $358\ torr \times \dfrac{1\ atm}{760}$)

5

Part B: Quicks 20 marks

Place your answer in the space provided. Rough work is NOT required.

51. The name of the shape of ammonia, NH_3 is _pyramidal_

52. In order to have hydrogen bonding which three types of polar bonds must there be? H-F, H-O, H-N

53. Magnesium oxide plus water will produce _$Mg(OH)_2$ magnesium hydroxide_

54. Water, a precipitate, or bubbles are three clues that which type of reaction has occurred? _double displacement_

55. What type of solvent would be necessary for carbon tetrachloride to be dissolved? _non-polar solvent_

56. On a shipment of 10000kg of oranges, 50 g of mould was found. Express this in ppm. _5 ppm_

57. In order to make a 50 mL solution of 0.1 M NaOH, how much of a 2.5 M solution is needed? _0.002 L_

58. During a titration, the point at which the indicator changes colour is called the _endpoint_

59. The conjugate acid of $H_2PO_4^-$ is _H_3PO_4_

60. A Bronsted-Lowry base is a proton _acceptor_

61. What is the pH of a 0.010 M HCl solution? _2_ $pH = -\log[H_3O^+]$

62. A compound is found to be 26.12% C, 5.05% H, and 68.93% O. What is the empirical formula? $C_4H_9O_8$

63. If the multiple of the EF in question 12 is 2, what is the molecular formula mass? $C_8H_{18}O_{16}$

64. 0.86 atm is equivalent to how many mm Hg? _653.6 mm H_2_ $0.86\, atm \times \frac{760\, mm\, Hg}{1\, atm}$

65. Weak intermolecular forces between non-polar molecules are called _dispersion forces_

66. How much ~~solvent~~ solute was used in a 12.5 v/v% solution that contained 10 mL of solvent? _1.25 mL_

67. What is the actual yield in a 72% yield that should have recovered 80 g or product? _57.6 g_

68. A closed cylinder contains 2.0 mol O_2, 5 mol CO_2, and 3 mol N_2. If the total pressure is 1 atm, what is the partial pressure of CO_2? _0.5 atm_ $\frac{5}{10} CO_2 = 0.5 \times P_{tot}$

69. The volume of 1 mol of an ideal gas at STP is _22.4 L/mol_

70. What is the limiting reactant in a synthesis reaction between 2 mol of silver and 3 mol of chlorine _silver_

56. $ppm = \frac{m_{solute}}{m_{solvent}} \times 10^6$

$= \frac{50}{10000000} \times 10^6$

$= 5\, ppm$

57. $C_1V_1 = C_2V_2$

$V_1 = \frac{C_2V_2}{C_1}$

$= \frac{(0.1)(0.05)}{(2.5)}$

$= 0.002\, L$

acid   base   conj acid   conj base
59. $H_2O + H_2PO_4^- \longrightarrow H_3PO_4 + OH^-$

62. Assume a 100g sample

$n_C = \frac{26.12}{12.01}$ $n_H = \frac{5.05}{1.01}$ $n_O = \frac{68.93}{16}$

$= 2.175\, mol\, C$ $= \frac{5\, mol\, H}{2.175}$ $= 4.308\, mol\, O$

$\frac{}{2.175}$ $\frac{}{2.175}$

$= 1 : 2.25 : 2$ (×4)

$4 : 9 : 8$

66. $V_{solute} = \frac{(V_{solution})(v/v\%)}{100}$

$= \frac{(10)(12.5)}{100}$

$= 1.25\, mL$

67. $AY = \frac{(PY)(TY)}{100}$

$= \frac{(72)(80)}{100}$

$= 57.6 g$

70. $2Ag_{(s)} + Cl_{2(g)} \rightarrow 2AgCl_{(s)}$

2 mol   3 mol
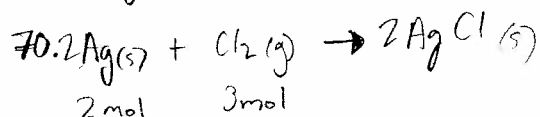
$\frac{2\, mol\, Ag}{2\, mol} : \frac{2\, mol\, AgCl}{X}$

$X = 2\, mol\, AgCl$

$\frac{1\, mol\, Cl_2}{3\, mol} : \frac{2\, mol\, AgCl}{X}$

$V = 6\, mol\, AgCl$

PART C SHORT ANWER 80 Marks

Answer the following questions in the space provided. Remember to include the equation used and units for all calculations. Show all of your work!

71. Explain what type of solvent would be required in order to make a solution of carbon tetrachloride solution. (3 marks).
    → non-polar solvent
    → like-dissolves like
    → non polar solute can be dissolved by non-polar solvents by dispersion forces

72.   Complete the following chart (9 marks)

Compound	Lewis line structure (include $\varsigma^{+/-}$ if appropriate)	3-D Drawing	Polarity of Molecule and name of 3-D shape
CBr_4	$\delta^+ C - \ddot{Br}^{\delta-}$ ΔEN Br 2.96 C 2.55 / 0.41	Br, Br, C, Br, Br	non-polar tetrahedral
O_2	$\ddot{O} = \ddot{O}$	$\ddot{O} = O$	non-polar linear
H_2O	$\delta^+ H - \ddot{O}^{\delta-} - H^{\delta+}$ ΔEN O 3.44 H 2.22 / 1.22	$\delta^+ H - \overset{\delta-}{O} - H^{\delta+}$	polar bent

73. Identify the most reactive metal and non-metal on the periodic table. Explain why each element is the most reactive (6 marks).

metal: Francium
  ↳ lowest I.E. & E.N.
  ↳ metals want to lose e⁻
  ∴ lowest I.E. allows loss of e⁻ easiest

non-metal: Fluorine
  ↳ highest I.E. & E.N.
  ↳ non-metals want to gain e
  ∴ highest EN pulls valence e from other elements to become stable

74. Write the molecular formulae for each of the following: (5 marks)

a) magnesium hydroxide $Mg(OH)_2$ b) potassium sulfite K_2SO_3

c) silver iodide AgI d) boron tetrabromide BBr_4

e) iodic acid $HIO_3 (aq)$

75. Write the names for each of the following compounds (5 marks)
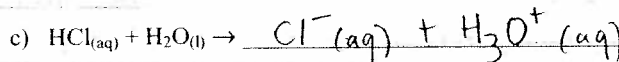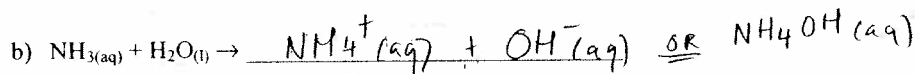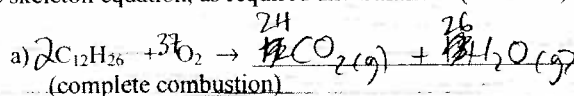
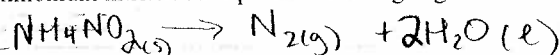a) $H_2SO_{2(aq)}$ hyposulphurous acid   b) Ca_2C calcium carbide

c) KCl potassium chloride   d) Al_2O_3 aluminum oxide
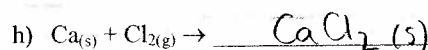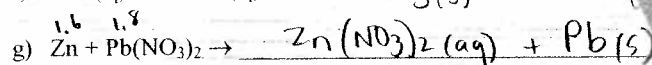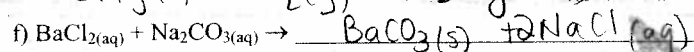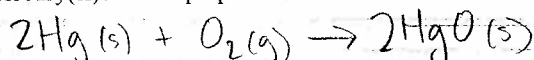
e) CO carbon monoxide

28

7

76. **Complete** the following chemical equations by filling in the blanks or writing out the skeleton equation, as required and **balance**. (10 marks)
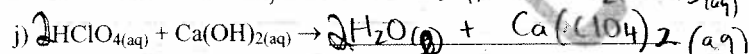
a) $2C_{12}H_{26} + 37O_2 \rightarrow 24CO_{2(g)} + 26H_2O_{(g)}$
   (complete combustion)

b) $NH_{3(aq)} + H_2O_{(l)} \rightarrow$ _____ $NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$ $\underline{OR}$ $NH_4OH_{(aq)}$

c) $HCl_{(aq)} + H_2O_{(l)} \rightarrow$ _____ $Cl^-{}_{(aq)} + H_3O^+{}_{(aq)}$

d) Ammonium nitrite decomposes into nitrogen gas and water.
   $NH_4NO_{2(s)} \rightarrow N_{2(g)} + 2H_2O_{(l)}$

e) Mercury(II)oxide is prepared from its elements.
   $2Hg_{(s)} + O_{2(g)} \rightarrow 2HgO_{(s)}$

f) $BaCl_{2(aq)} + Na_2CO_{3(aq)} \rightarrow$ _____ $BaCO_{3(s)} + 2NaCl_{(aq)}$

g) $Zn + Pb(NO_3)_2 \rightarrow$ _____ $Zn(NO_3)_{2(aq)} + Pb_{(s)}$

h) $Ca_{(s)} + Cl_{2(g)} \rightarrow$ _____ $CaCl_{2(s)}$

i) Aluminum metal reacts with zinc sulfate (write out the complete balanced equation)
   $2Al_{(s)} + 3ZnSO_{4(aq)} \rightarrow Al_2(SO_4)_{3(aq)} + 3Zn_{(s)}$

j) $2HClO_{4(aq)} + Ca(OH)_{2(aq)} \rightarrow 2H_2O_{(l)} + Ca(ClO_4)_{2(aq)}$

77. Write the net ionic equation for the reaction between aqueous solutions of barium chloride and sodium sulfate. Be sure to include the state of each reactant and product. (3 marks)

$BaCl_{2(aq)} + Na_2SO_4{}_{(aq)} \rightarrow BaSO_{4(s)} + 2NaCl_{(aq)}$

$Ba^{2+}{}_{(aq)} + 2Cl^-{}_{(aq)} + 2Na^+{}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow BaSO_{4(s)} + 2Na^+{}_{(aq)} + 2Cl^-{}_{(aq)}$

✓✓✓ $Ba^{2+}{}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow BaSO_{4(s)}$
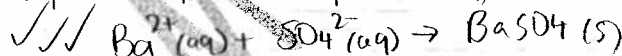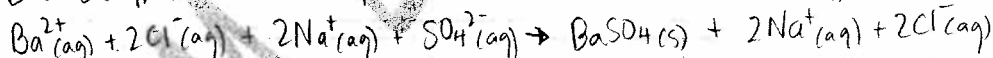
78. Explain the trend for first ionization energy across a period and down a group on the periodic table (4 marks)

✓✓* I.E. ↑ moving across a period b/c atomic radius ↓ across a period due to more p^+ in the nucleus, valence e^- are pulled more tightly towards the nucleus. Thus, more energy is required to remove a valence e^-.

✓✓* I.E. ↓ down a group. The size of the energy level increases as you go down a group ∴ valence e^- are located further from the nucleus and so less energy is required to remove a valence e^-
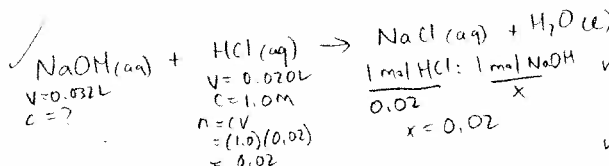
79. How many milliliters of sodium hydroxide solution are required to neutralize 20 ml of 1.0 mol/L acetic acid if 32 mL of the same sodium hydroxide solution neutralized 20 mL of 1.0 mol/L hydrochloric acid? (6 marks)

✓ $NaOH_{(aq)} + HCH_3CO_{2(aq)} \rightarrow NaCH_3CO_{2(aq)} + H_2O_{(l)}$
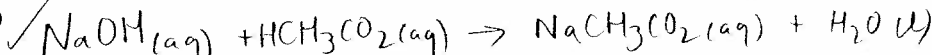
$V = ?$ $C = 1.0M$
$C = ? \; 0.625$ $V = 0.020L$

$n = CV$
$= (1.0)(0.02)$
$= 0.02\,mol$

$\dfrac{1\,mol\,HCH_3CO_2 : 1\,mol\,NaOH}{0.02} = \dfrac{}{x}$

$x = 0.02\,mol\,NaOH$

$V = \dfrac{n}{C}$

$= \dfrac{0.02}{0.625}$

$= 0.032\,L$

✓ $NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

$V = 0.032L$ $V = 0.020L$
$c = ?$ $C = 1.0M$

$n = CV$
$= (1.0)(0.02)$
$= 0.02$

$\dfrac{1\,mol\,HCl : 1\,mol\,NaOH}{0.02} = \dfrac{}{x}$

$x = 0.02$

✓ $c = \dfrac{n}{V}$

$= \dfrac{0.02}{0.032}$

$= 0.625$

∴ 0.032L of NaOH ✓ is required

8

23

80. What is the difference between a strong acid and a weak acid? Can they have the same pH value?
   (3 marks)

   ✓ strong acid fully ionizes in water

   ✓ weak acid partially (small) ionizes in water.

   ✓ Yes, they can have the same pH

81. Using the appropriate gas law, explain why it is important to add air to your car tires in the winter time and
   sometimes to deflate some air in the summer time (4 marks)

   ✓ Gay-Lusac's law $P \propto T$, V constant

   ✓ Pressure is directly proportional to temperature.

   ✓ ∴ as temp ↓ in winter, you should add air to your tires
   to maintain the proper pressure

   ✓ as temp ↑ in summer, you should let some
   air out to lower the pressure to the appropriate
   level.

82. Pryidine, C_5H_5N, is a slightly yellow liquid with a nauseating odour. It is flammable
   and toxic by ingestion and inhalation. Pyridine is used in the synthesis of vitamins and drugs, and has many
   other uses in industrial chemistry. Determine the percentage composition of pyridine. (5 marks)

   ✓ Assume a 1 mol sample

   $✓ \% C = \dfrac{m_C}{m_{C_5H_5N}} \times 100$ $\% H = \dfrac{m_H}{m_{C_5H_5N}} \times 100$ $\% N = \dfrac{m_N}{m_{C_5H_5N}} \times 100$

   $= \dfrac{60.05 g}{79.1 g} \times 100$ $= \dfrac{5.05 g}{79.1 g} \times 100$ $= \dfrac{14 g}{79.1 g} \times 100$

   $\doteq 75.92 \% C$ $\doteq 6.38 \% H$ ✓ $= 17.70 \% N$

   ∴ pyridine is $75.92 \% C$, $6.38 \% H$, $\doteq 17.70 \% N$ by mass

83. Calculate the percentage by mass of water in potassium sulfite dehydrate, $K_2SO_3 \cdot 2H_2O$. (4 marks)

   ✓ Assume a 1 mol sample

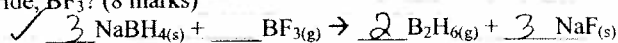 $✓ \% H_2O = \dfrac{m_{H_2O}}{m_{K_2SO_3 \cdot 2H_2O}} \times 100$

   $= \dfrac{36.04 g}{194.3 g} \times 100$

   $✓ = 18.55 \%$

   $✓ ∴ K_2SO_3 \cdot 2H_2O$ is 18.55% water by mass $\overline{16}$

   9

84. If the following reaction proceeds with a 75% yield, how much diborane, B_2H_6, will be produced when 23.5 g of sodium borohydride, $NaBH_4$ reacts with 50.0 g of boron trifluoride, BF_3? (8 marks)

$$3\ NaBH_{4(s)} + \underline{\quad}\ BF_{3(g)} \rightarrow 2\ B_2H_{6(g)} + 3\ NaF_{(s)}$$

$m = 23.5g \qquad m = 50g$

$n_{NaBH_4} = \dfrac{m}{M} \qquad\qquad n_{BF_3} = \dfrac{m}{M}$

$= \dfrac{23.5g}{37.84 g/mol} \qquad = \dfrac{50g}{67.81 g/mol}$

$\doteq 0.6210\ mol\ NaBH_4 \qquad \doteq 0.7374\ mol\ BF_3$

$\dfrac{3\ mol\ NaBH_4}{0.6210\ mol} : \dfrac{2\ mol\ B_2H_6}{x} \qquad\qquad \dfrac{1\ mol\ BF_3}{0.7374\ mol} : \dfrac{2\ mol\ B_2H_6}{x}$
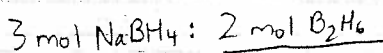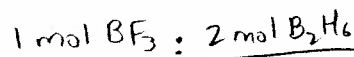
$\boxed{x = 0.414\ mol\ B_2H_6} \qquad\qquad x \doteq 1.475\ mol\ B_2H_6$

$m = nM \qquad\qquad\qquad \%Y = \dfrac{AY}{TY} \times 100$

$= (0.414)(27.68) \qquad\quad AY = \dfrac{(\%Y)(TY)}{100}$

$\doteq 11.46g\ B_2H_6 \qquad\qquad = \dfrac{(75)(11.46)}{100}$

$\qquad\qquad\qquad\qquad\qquad\quad \doteq 8.59g$

$\therefore$ in a 75% yield, 8.59g of B_2H_6 should be produced

85. A 3.34 g sample of a hydrate has the formula $SrS_2O_3 \cdot xH_2O$, and contains 2.30 g of SrS_2O_3. Find the value of x. (10 marks)

$n_{SrS_2O_3} = \dfrac{m}{M} \qquad\qquad n_{H_2O} = \dfrac{(m_{hydrate} - m_{anhydrous})}{M}$

$= \dfrac{(2.30g)}{(199.76 g/mol)} \qquad\qquad = \dfrac{(3.34g - 2.30g)}{(18.02 g/mol)}$

$= 0.01151\ mol\ SrS_2O_3 \qquad\qquad \doteq 0.05771\ mol$

$\dfrac{0.01151\ mol}{\ } \qquad\qquad\qquad\qquad \dfrac{0.05771\ mol}{0.01151\ mol}$

$1 : 5$

$\therefore$ the formula is $SrS_2O_3 \cdot 5H_2O$