Chemistry 20 - Unit C - Review Booklet

Name: _____

1. Identify the solvent and the ~~solute~~ in the following solutions
   a. 18 mL of water in 38 mL of methanol

   solute Solvent } the substance with more moles.

   b. 0.283 g of sugar in 100 mL of water

   solute Solvent

2. Write dissociation equations for each of the following solid ionic compounds
   a. Sodium sulfate

   $Na_2SO_4 \rightarrow 2Na^+ + SO_4^{2-}$

   b. Calcium chloride

   $CaCl_2 \rightarrow Ca^{2+} + 2Cl^-$

   c. Zinc sulfate

   $ZnSO_4 \rightarrow Zn^{2+} + SO_4^{2-}$

   d. Alumium sulfate

   $Al_2(SO_4)_3 \rightarrow 2Ag^{3+} + 3SO_4^{2-}$

   e. Magnesium iodide

   $MgI_2 \rightarrow Mg^{2+} + 2I^-$

3. Write ionization equations for each of the following compounds (acids….)
   a. $HI_{(g)}$

   $HI \rightarrow H^+ + I^-$

   b. $HNO_{3(aq)}$

   $HNO_3 \rightarrow H^+ + NO_3^-$

   c. $HClO_{3(aq)}$

   $HClO_3 \rightarrow H^+ + ClO_3^-$

d. $H_2SO_{4(aq)}$

$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$ or $H^+ + HSO_4^-$

4. Write dissociation equations for the following ionic solids dissolving in water (bases….)
   a. Sodium hydroxide

$NaOH \rightarrow Na^+ + \underline{OH^-}$ Base

   b. Potassium carbonate

$K_2CO_4 \rightarrow 2K^+ + CO_4^{2-}$ No OH^- produced yet – add water to the – ion.

$CO_4^{2-} + 2H_2O \rightarrow H_2CO_4 + 2OH^-$

   c. Aluminium nitrate

$Al(NO_3)_3 \rightarrow Al^{3+} + 3NO_3^-$

$NO_3^- + H_2O \rightarrow HNO_3 + OH^-$

5. Predict whether the following solutes will be electrolytes or nonelectrolytes
   a. Potassium chloride

Electrolyte … ionic

   b. Hydrogen chloride

Electrolyte … acid

   c. Carbon dioxide

Non electrolyte … non polar

   d. Sulfur dioxide

Non electrolyte … not acid or ionic.

6. Calculate the concentration of the following solutions
   a. 29.8 g of NaCl in 250 mL of solution.

$\frac{mol}{L} NaCl = 29.8g \times \frac{1mol}{58.44g} \times \frac{1}{0.250L} = \boxed{2.02M}$

b. 49.29 g of $C_{12}H_{22}O_{11}$ in 3.3 L of solution

$$\frac{mol}{L} C_{12}H_{22}O_{11} = 49.29g \times \frac{1mol}{342.34g} \times \frac{1}{3.3L} = \boxed{0.044M}$$

7. Calculate the number of moles of solute needed to make the following solutions
   a. 45.0 mL of 1.15 M KCl

$$n_{KCl} = 0.0450L \times \frac{1.15mol}{1L} = \boxed{0.0518mol}$$

   b. 250.0 mL of 0.350 M $CH_3COOH_{(aq)}$

$$n_{CH_3COOH} = 0.2500L \times \frac{0.350mol}{1L} = \boxed{0.0875\ mol}$$

8. Calculate the mass of solute needed to make the following solutions
   a. 30.0 mL of 0.485 M $Na_2CO_{3(aq)}$

$$m\ Na_2CO_3 = 0.0300L \times \frac{0.485mol}{1L} \times \frac{105.99g}{1mol} = \boxed{1.54g}$$

   b. 125 mL of 0.573 M $Na_2S_{(aq)}$

$$m_{Na_2S} = \frac{0.573mol}{1L} \times 0.125L \times \frac{78.05g}{1mol} = \boxed{5.59g}$$

9. Determine the concentration of the solution when
   a. 50.0 mL of 1.95 M HCl is diluted to 115.0 mL

$C_1V_1 = C_2V_2$

$$(1.95M)(50.0mL) = C_2(115.0mL)$$

$$C_2 = \boxed{0.848M}$$

   b. 250.0 mL of 1.48 M $HNO_{3(aq)}$ is diluted to 750.0 mL

$C_1V_1 = C_2V_2$

$$(1.48M)(250.0mL) = C_2(750.0mL)$$

$$C_2 = \boxed{0.493M}$$

   c. 50.0 mL of 7.90 M KOH is distilled to on 1.0 mL

$$(7.90M)(50.0mL) = C_2(1.0mL)$$

$$\boxed{4.0 \times 10^1 M}$$

10. Calculate the volume of the original solution needed to make the NEW solution $C_1V_1 = C_2V_2$

a. 2.50 M NaOH is used to make 490 mL of 1.23 M solution

$(2.50M)(V_1) = (1.23M)(490mL)$

$V_1 = 241mL$

b. 10.0 M $AgNO_3$ is used to make 990 mL of 2.38 M solution.

$(10.0M)(V_1) = (2.38M)(990mL)$

$V_1 = 236mL$

11. If 29.7 g of sodium chloride dissolves to make 200.0 mL of a saturated solution at 0C, what is the solubility of sodium chloride at 0C?

$\frac{mol}{L}NaCl = 29.7g \times \frac{1mol}{58.44g} \times \frac{1}{0.2000L} = 2.54M$

12. Use your solubility table to predict the solubility of the following solids

a. $NaNO_3$

(aq)

b. AgI

(s)

c. $CuBr_2$

(aq)

d. $BaCl_2$

(aq)

Double Replacement

$AB + CD \rightarrow AD + CB$

13. Predict what the precipitate will be, if any, when aqueous solutions of the following compounds are mixed.

a. lead(ii) nitrate with potassium sulfide

$\underset{A}{Pb}\underset{B}{(NO_3)_2} + \underset{C}{K_2}\underset{D}{S} \rightarrow PbS_{(aq)} + 2KNO_{3(aq)}$

None

b. Sodium phosphate with calcium chloride

$Na_3PO_4 + CaCl_2 \rightarrow \boxed{Ca_3(PO_4)_{2(s)}} + NaCl_{(aq)}$

Precipitate

c. Ammonium acetate with mercury(i) nitrate

$NH_4CH_3COO + HgNO_3 \rightarrow HgCH_3COO_{(aq)} + NH_4NO_{3(aq)}$

d. Zinc nitrate with lithium hydroxide

$Zn(NO_3)_2 + 2LiOH \rightarrow 2LiNO_{3(aq)} + \boxed{Zn(OH)_{2(s)}}$

Precipitate.

14. Define the following terms:

a. Acid solution

Produces H_3O^+ in solution

b. Base solution

Produces OH^- in solution.

15. The following properties were observed for 5 solutions. From the properties, identify the acids and bases (some might be neither.

Solution	Conductivity	Taste	Reaction with Zinc Metal	Type of Solution
V	Yes	Sour	Gas produced	Acid
W	Yes	Bitter	None	Base
X	Yes	Salty	None	Ionic (salt)
Y	No	Sweet	None	Covalent...
Z	Yes	Sour	Gas produced	Acid

16. State the Arrhenius definition for an acid and base

Acid $\rightarrow H^+$

Base $\rightarrow OH^-$

17. Explain how a hydronium ion is formed in aqueous solution.

Water surround H^+ ions to make H_3O^+

18. Calculate the [OH-] in 0.050 M HCl solution

$HCl + H_2O \rightarrow H_3O^+ + Cl^-$

0.050M 0.050M

$[OH^-] = 1.0\times10^{-14} \div [H_3O^+]$

0.050M

$[OH^-] = \boxed{2.0\times10^{-13}M}$

19. What is the pH of the solution in question 5.

$pH = -\log(0.050M) = \boxed{1.30}$

20. Complete the following table:

Concentration of Hydronium Ions	pH	Nature of the solution
0.010M	2.0	Acid
1.00x10-11 M	11.000	Base
1.0×10^{-8}	8.00	Base
1.0x10-4 M	4.00	Acid
1.0×10^{-7}	7.00	neutral
1.0×10^{-12}	12.00	Base
1.0x10-9 M	9.00	Base
1.0×10^{-3}	3.00	Acid

21. Tomato juice has a pH of approximately 4.20. Find the $[H_3O+]$, [OH-] and pOH of the tomato juice.

$[H_3O^+] = 10^{-4.20}$

$[H_3O^+] = 6.3\times10^{-5}M$

$pOH = 14 - 4.20$

$= 9.80$

$[OH^-] = 10^{-9.80}$

$\boxed{1.6\times10^{-10}M}$

22. A solution of $Ba(OH)_2$ was prepared by adding 1.00 g into 1.00 L of water. Find the $[H_3O+]$, [OH-], pH and pOH of the solution.

$\frac{Ba(OH)_2}{mol/L} = 1.00g \times \frac{1mol}{171.35g} \times \frac{1}{1.00L}$

$= 0.00584M$

$Ba(OH)_2 \rightarrow Ba^{2+} + 2OH^-$

0.00584M $\boxed{0.0117M}$

$[H_3O^+] = 10^{-12.067}$

$\boxed{8.57\times10^{-13}M}$

$pOH = -\log 0.0117M$

$= \boxed{1.933}$

$pH = 14 - 1.933$

$= \boxed{12.067}$

23. Separate samples of a solution of unknown pH turn phenolphthalein pink, indigo carmine blue and 1,3,5 trinitrobenzene colourless. What is the pH of the solution?

Phenolphthalein >10
Indigo carmine <11.4
1,3,5 TNB <12

Range 10-11.4

24. Separate samples of a solution of unknown pH turn thymol blue yellow, methyl orange red and chlorophenol red. What is its pH?

Thymol Blue 2.8-8
Methyl Orange <3.2
Chlorophenol >2.6

Chlorophenol Range
Y 1.8 - 2.6 R

Range 2.6-3.2

25. Calculate the $[H_3O+]$, [OH-], pH and pOH of the solutions described below:

a. A solution of HF diluted from 100 mL of 4.5M standard solution to a volume of 900 mL.

$(4.5M)(100mL) = C_2(900mL)$

$C_2 = 0.50M$

$[H_3O^+] = 0.50M$

$pH = -\log(0.50)$
$= 0.30$
$pOH = 14 - 0.301$
$= 13.70$

$[OH^-] = 10^{-13.70}$
$= 2.0 \times 10^{-14} M$

b. A solution of HNO_3 created by adding 1.283 g of solid to 350 mL of water.

$\frac{mol}{L} = 1.283g \times \frac{1mol}{63.02g} \times \frac{1}{0.350L}$

$= 0.0582M\ ([H_3O^+])$

$pH = -\log(0.0582)$
$= 1.235$
$pOH = 14 - 1.235$
$= 12.765$

$[OH^-] = 10^{-12.765}$
$= 1.72 \times 10^{-13} M$

c. A solution of phosphoric acid diluted from 10 mL of 12.1 M solution diluted by adding 790 mL of solution.

polyprotic $H_3PO_4 + 3H_2O \rightarrow 3H_3O^+ + PO_4^{3-}$
0.15M 0.45M

$C_1V_1 = C_2V_2$
$(12.1M)(10mL) = C_2(800mL)$
$C_2 = 0.15M$
$[H_3O^+] = 0.45M$

$pH = -\log[0.45M]$
$= 0.34$
$pOH = 14 - 0.34$
$= 13.66$

$[OH^-] = 10^{-13.66}$
$= 2.2 \times 10^{-14} M$

d. A solution of $Ba(OH)_2$ created by adding 0.39 g of solid to 15.00 L of solution.

polyprotic

$\frac{mol}{L} = 0.39g \times \frac{1mol}{171.35g} \times \frac{1}{15.00L} = 1.5 \times 10^{-4} M$

$[OH^-] = 3.0 \times 10^{-4} M$

$pOH = -\log(3.0 \times 10^{-4}) = 3.52$

$pH = 14 - 3.52 = 10.48$

$[H_3O^+] = 10^{-10.48} = 3.3 \times 10^{-11} M$