Name: ___________________________

Solutions Unit Assessment Review

1. A student has 7 unlabeled solutions: hydroiodic acid, sucrose, potassium iodide, potassium iodate, iodic acid, iron (II) iodide and iron (III) iodide. Choose qualitative tests to identify each. Create a table of expected results to verify that you have determined tests to effectively classify each compound. *You may find it helpful to list the major entities present in each compound to pick tests.* ***[SAB1]***

2. Write the dissociation / ionization equation for each of the following substances when introduced to water, identify the major entities, and indicate whether the solution would be considered an electrolyte (✓), or a non-electrolyte (✗) ***[SAB2]***

Dissociation / Ionization equation	***Major Entities***	***✓ or ✗***
sodium dichromate		
methane		
chloric acid		
calcium carbonate		
elemental nitrogen		
perchloric acid		
ammonium hydroxide		
methanol		
aluminum		

3. Calculate the mass of magnesium bromide that must be dissolved to make a 1.50L solution with a bromide ion concentration of 0.30 mol/L. **(41 g)** ***[SAB4]***

4. The concentration of cyanide in Canadian drinking water should never exceed 0.25 ppm. Find the maximum mass of cyanide that can be dissolved in 65 L of water while not exceeding this limit. **(16 mg)** ***[SAB3]***

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5. You and your lab partners are given 45 mL of a 2.75 mol/L solution of iron (II) sulfate solution.

    a. How would you prepare this standard solution from a solid? ***[SAB5]***

    b. How much water must you **ADD** in order to dilute the solution to a concentration of 0.25 mol/L? **(450 mL)** ***[SAB5]***

    c. What steps would you take to perform this dilution? ***[SAB5]***

6. Define exothermic and endothermic. Describe how dissolving solutes can result in the observation of a beaker undergoing a temperature change. (bonds breaking/bonds forming). ***[SAB6]***

7. Determine the mass of arsenic in a 100 mL sample of blood that is suspected of arsenic poisoning that contains 0.050 ppm of arsenic. **(0.0050 mg)** ***[SAB3]***

8. Salt is essential for fish health. Koi and goldfish need salt to control their electrolyte balance. Salt also enhances the natural slime coating on Koi which fights off fungus and disease. Salt in the water also kills most parasitic infestations. Salt(NaCl) is typically maintained by Koi enthusiasts at a concentration of 0.18% $_{m/v}$. What is the salt concentration, expressed in molar concentration? **(0.031 mol/L)** ***[SAB3]***

9. 75 mL of orange juice concentrate was added to 1.50 L of water. Calculate the % v/v for the orange juice. **(4.8%)** ***[SAB3]***

10. A sample of aluminum acetate contains an acetate ion concentration of 5.367×10^{-4} mol/L when 7.21 g of aluminum acetate is dissolved in water. What is the volume of the solution? **(197 L)** ***[SAB4]***

11. If you continuously added $Mg(NO_3)_2$ to water until crystals remained on the bottom of the beaker, what would this indicate? How would you represent this situation with a chemical equation? ***[SAB6]***

12. Write an Arrhenius reaction to help describe the litmus result for the following compounds when added to water. ***[SAB9]***

Reaction of the following compound added to water:	***Neutral Litmus Result***
a. sodium iodide	
b. benzoic acid	
c. potassium carbonate	
d. magnesium nitrate	
e. ammonia	

13. Complete the following chart… **SIGNIFICANT DIGITS** are important!!!

$[H_3O^+_{(aq)}]$ (mol/L)	***pH***	***Acid, Base, or Neutral***
1.0×10^{-4}		

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	11.23	
[OH$^-$ $_{(aq)}$] (mol/L)	***pOH***	***Acid, Base, or Neutral***
7.4 x 10^{-8}		
	0.563	

(4.00, A; 5.9x10^{-12} mol/L, B; 7.13, ~N; 0.274, B) ***[SAB8]***

14. **A.** When 47 mg of barium hydroxide are placed in 250 mL of water, what would be the expected pH of the solution? **(11.34)** ***[SAB8]***
    B. What happens to the concentration of hydroxide ions if this solution is diluted to a final volume of 1.00 L? **(decreases by 4x)** ***[SAB8]***
    C. What would be the resulting pH? **(10.74)** ***[SAB8]***

15. **A.** Explain how dilution would affect the pH of:
    i. acidic solutions ***[SAB5&8]***
    ii. basic solutions***[SAB5&8]***

    B. Explain the relationship between pH and the hydronium ion concentration in words or graphically ***[SAB8]***

16. **A.** Explain the differences between samples of sodium hydroxide and sodium iodate if both solutions have the same concentration ***[SAB10]***
    B. Explain the differences between monoprotic and polyprotic substances. ***[SAB10]***
    C. Write the appropriate chemical equations to explain the BASIC properties of the phosphate ion.***[SAB10]***
    D. Explain why the phosphate ion doesn't produce three hydroxide ions***[SAB10]***

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Answer Key

1. A student has 7 unlabeled solutions: hydroiodic acid, sucrose, potassium iodide, potassium iodate, iodic acid, iron (II) iodide and iron (III) iodide. Choose qualitative tests to identify each. Create a table of expected results to verify that you have determined tests to effectively classify each compound. *You may find it helpful to list the major entities present in each compound to pick tests.*

	Litmus Result	***Conductivity***	***Solution Colour***	***Precipitate formed with $Cu(NO_3)_2(aq)$***
$HI(aq)$	Red	Yes	Clear	No
$C_{12}H_{22}O_{11}(aq)$	No Change	No	Clear	No
$KI(aq)$	No Change	Yes	Clear	No
$KIO_{3,}(aq)$	No Change	Yes	Clear	Yes
$HIO_3(aq)$	Red	Yes	Clear	Yes
$FeI_2(aq)$	No Change	Yes	lime-green	No
$FeI_3(aq)$	No Change	Yes	orange-yellow	No

2. Write the dissociation / ionization equation for each of the following substances when introduced to water, identify the major entities, and indicate whether the solution would be considered an electrolyte (✓), or a non-electrolyte (✗)

Dissociation / Ionization equation	***Major Entities***	***✓ or ✗***
sodium dichromate $Na_2Cr_2O_7(s) \rightarrow 2\ Na^+(aq) + Cr_2O_7^{2-}(aq)$	$H_2O(l)$, $Na^+(aq)$, $Cr_2O_7^{2-}(aq)$	✓
methane $CH_{4,}(g) \rightarrow$ No equation	$H_2O(l)$, $CH_{4,}(g)$	✗
chloric acid $HClO_3(aq) \rightarrow H^+(aq) + ClO_3^-(aq)$	$H_2O(l)$, $HClO_3(aq)$	✓
calcium carbonate $CaCO_3(s) \rightarrow$ No Equation	$H_2O(l)$, $CaCO_3(s)$	✗
elemental nitrogen $N_2(g) \rightarrow$ No Equation	$H_2O(l)$, $N_2(g)$	✗

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perchloric acid $HClO_4(aq) \rightarrow H^+(aq) + ClO_4^-(aq)$	$H_2O(l)$, $H^+(aq)$, $ClO_4^-(aq)$	✓
ammonium hydroxide $NH_4OH(s) \rightarrow NH_4^+(aq) + OH^-(aq)$	$H_2O(l)$, $NH_4^+(aq)$, $OH^-(aq)$	✓
methanol $CH_3OH(l) \rightarrow$ no equation	$H_2O(l)$, $CH_3OH(aq)$	✗
aluminum $Al(s) \rightarrow$ No equation	$H_2O(l)$, $Al(s)$	✗

5a.

- calculate the mass of solid required to prepare the standard solution
- measure the mass of solid in a weigh boat
- dissolve the solid in about 20 mL of water (half the final volume) in a beaker. Use distilled water to rinse out the weigh boat into the beaker
- Transfer the solution to a 45 mL volumetric flask. Rinse out beaker with distilled water into the volumetric flask
- fill to the calibration line with distilled water
- stopper and invert to mix

c.

- calculate the volume of stock solution required to prepare the standard solution
- fill the volumetric flask about half full with distilled water
- using a volumetric pipette, transfer 45 mL of stock solution to the volumetric flask
- add distilled water to the calibration line
- stopper and invert to mix

6. Exothermic - the system (substance being dissolved) releases energy when new bonds form to the surroundings (the water it is being dissolved in).

Endothermic - the system (substance being dissolved) requires energy to break the original bonds from the system (the water it is being dissolved in)

if more energy is required to break the original bonds than is released when the new bonds formed, the energy required is absorbed from the surroundings, aka the water. This makes the water cold.

If more energy is released when new bonds form than was required to break the original bonds in the solute and solvent, the additional energy is released to the surroundings (the water). This makes the water warm.

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11. It is a saturated solution because the solution is "full" of dissolved ions. At the bottom of the beaker the undissolved and dissolved ions are switching spots at the same rate (crystallizing and dissolving), also known as dynamic equilibrium. this can be represented as:

$Mg(NO_3)_2(s) \leftrightharpoons Mg^{2+}(aq) + 2\ NO_3^-(aq)$

12.

a) $NaI_{(s)} \rightarrow Na^+_{(aq)} + I^-_{(aq)}$

↳ $I^- + H_2O_{(l)} \not\rightarrow HI_{(aq)} + OH^-_{(aq)}$

won't happen
SA produced

neutral (no change)

b) $C_6H_5COOH_{(aq)} \xrightarrow{+H_2O_{(l)}} C_6H_5COO^-_{(aq)} + H_3O^+_{(aq)}$

B→R (acidic)

c) $K_2CO_{3(s)} \rightarrow 2K^+_{(aq)} + CO_3^{2-}{}_{(aq)}$

$CO_3^{2-}{}_{(aq)} + H_2O_{(l)} \rightarrow OH^-_{(aq)} + HCO_3^-{}_{(aq)}$

would react again (polyprotic)
but 1 rxn is sufficient to show production of OH^-

R→B
basic.

d) $Mg(NO_3)_{2(s)} \rightarrow Mg^{2+}_{(aq)} + 2NO_3^-{}_{(aq)}$

↳ $NO_3^-{}_{(aq)} + H_2O_{(l)} \not\rightarrow HNO_{3(aq)} + OH^-$

SA!

neutral (no change)

e) $NH_{3(g)} + H_2O_{(l)} \rightarrow NH_4^+{}_{(aq)} + OH^-_{(aq)}$

R→B
basic

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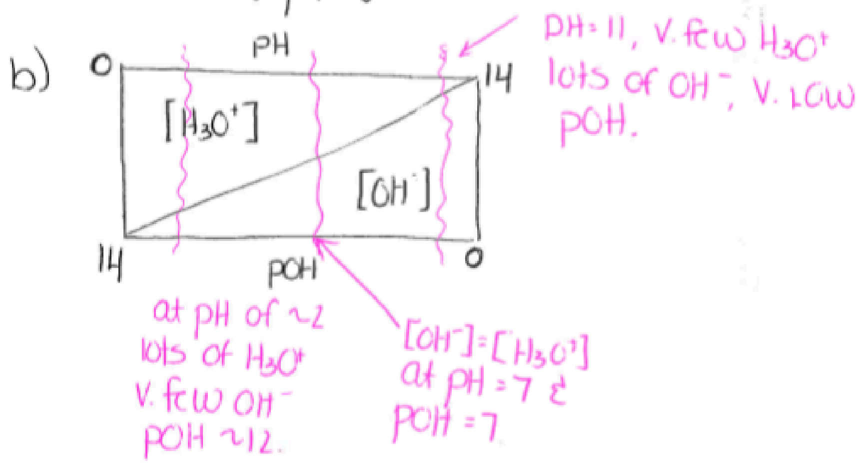
15.

a) i) diluting an acidic sol'n $\downarrow [H_3O^+]$ & $\uparrow [OH^-]$ (coming from H_2O ionization)
∴ pH ↑

ii) diluting a basic sol'n $\downarrow [OH^-]$ & $\uparrow [H_3O^+]$
∴ pH ↓

b)



16.

a) monoprotic, only reacts once w/ water (or dissociates to make OH^-). Typically only one H^+ in acid or 1- charge on basic ion
polyprotic, reacts multiple tims w/ water. has more than one H^+ or a charge 2- / 3- on basic ion.

b) $PO_4^{3-}{}_{(aq)} + H_2O_{(l)} \rightleftharpoons HPO_4^{2-}{}_{(aq)} + OH^-_{(aq)}$

$HPO_4^{3-}{}_{(aq)} + H_2O_{(l)} \rightarrow H_2PO_4^-{}_{(aq)} + OH^-_{(aq)}$

$H_2PO_4^-{}_{(aq)} + H_2O_{(l)} \rightarrow H_3PO_{4(aq)} + OH^-_{(aq)}$

becomes a weake base w/ each rxn.

c) b/c it is a weak base (has to react w/ water) and it gets weaker w/ each rxn w/ water. each reaction ~~has a~~ goes <50% to completion, therefore the $[OH^-]$ will not even be the same conc. as $[PO_4^{3-}]$, nevermind 3x as much