General Chemistry 1 *(CHEM 1141)*

Shawnee State University – Fall 2018

October 25, 2018

Exam # 2D

Name KEY

Please write your full name, and the exam version (2D) that you have on the scantron sheet !
(Bubble in the best answer choice for each question on the green & white scantron sheet in pencil !)

Please ☑ check the box next to your correct section number.

Section #:

❐ 1. (Monday Lab, 10:00 AM – 12:53 PM)

❐ 2. (Wednesday Lab, 10:00 AM – 12:53 PM)

❐ 3. (Monday Lab, 2:00 PM – 4:53 PM)

❐ 4. (Wednesday Lab, 2:00 PM – 4:53 PM)

❐ 6. (Tuesday Lab, 12:30 PM – 3:23 PM)

Multiple Choice:	______________	/ 50
Q21:	______________	/ 10
Q22:	______________	/ 10
Q23:	______________	/ 10
Q24:	______________	/ 10
Q25:	______________	/ 10
BONUS:	______________	/ 5
TOTAL:	______________	/ 100

Each problem in this section (multiple choice) is worth 2.5 points !

Q1. The percentage (by mass) of carbon in C_3H_8O is:

A) 8.33 %

B) 60.0 %

C) 38.5 %

D) 52.1 %

$$\%C = \frac{3\times C}{3\times C + 8\times H + 1\times O} \times 100 = \frac{3\times 12.01}{3\times 12.01 + 8\times 1.008 + 16.00} \times 100 = 60.0\%$$

Q2. Calculate the number of CO_2 molecules contained in 65.5 g of CO_2 :

A) 8.96 x 10 [23] CO_2 molecules

B) 1.71 x 10 [24] CO_2 molecules

C) 4.04 x 10 [24] CO_2 molecules

D) 1.92 x 10 [24] CO_2 molecules

$$65.5\,g\,CO_2 \times \frac{1\,mol\,CO_2}{44.01\,g\,CO_2} \times \frac{6.022\times10^{23}\,molecules\,CO_2}{1\,mol\,CO_2} = 8.96\times10^{23}\,molecules\,CO_2$$

Q3. Identify the compound that would be classified as a **strong acid as well as a strong electrolyte:**

A) HF

B) HNO_3

C) CH_3COOH

D) HNO_2

$$HNO_3(aq) \xrightarrow{100\%} H^+(aq) + NO_3^-(aq)$$

nitric acid

Q4. When dissolved in water, KOH behaves as:

A) an acid that forms K^+ and OH^- ions

B) an acid that forms KO^- and H^+ ions

C) a base that forms K^+ and OH^- ions

D) a base that forms KO^- and H^+ ions

$$KOH(aq) \rightarrow K^+(aq) + \underline{\underline{OH^-(aq)}}$$

basic

Q5. The correct formula for the ammonium, bicarbonate, and sulfite ion (respectively) is:

A) NH_3^+, CO_3^{2-}, and SO_4^{2-}

B) NH_4^+, CO_3^{2-}, and SO_4^{2-}

C) NH_3^+, HCO_3^-, and SO_3^{2-}

D) NH_4^+, HCO_3^-, and SO_3^{2-}

Q6. The molecular formula of trinitrobenzene is $C_6H_3N_3O_6$. What is its empirical formula?

A) $C_6H_3N_3O_6$

B) C_4HNO_4

C) C_2HNO_2

D) CHNO

÷3

$C_2H_1N_1O_2$

Q7. An example of an element that exists as a diatomic molecule would be:

A) iron $Fe(s)$

B) sulfur $S_8(s)$

C) iodine $I_2(s)$

D) helium $He(g)$

Q8. Calculate the molar mass of $Ca_3(PO_4)_2$.

A) 87.05 g/mol

B) 215.21 g/mol

C) 310.18 g/mol

D) 279.21 g/mol

3×Ca = 3×40.08

2×P = 2×30.97

8×O = 8×16.00

310.18 g/mol

Q9. Determine the stoichiometric coefficient for oxygen when the following equation is balanced using the lowest, whole-number coefficients.

$$\underline{2}\ CH_4O\ (l) + \underline{3}\ O_2(g) \rightarrow \underline{2}\ CO_2(g) + \underline{4}\ H_2O\ (l)$$

A) 9

B) 7

C) 5

D) 3

C: 2 H: 8 O: 8

C: 2 H: 8 O: 8

Q10. The oxidizing agent in the reaction:

$$\overset{(+3)}{2Al^{3+}(aq)} + \overset{(0)}{2Fe(aq)} \longrightarrow \overset{(0)}{2Al(s)} + \overset{(+3)}{2Fe^{3+}(aq)}$$

red

ox

is

A) Al^{3+}

B) Fe

C) Al

D) Fe^{3+}

Al^{3+} "caused" Fe to be oxidized

Q11. Determine the concentration (in molarity, M) for a solution that contains 20.8 g of CaCl2 dissolved in 0.500 L of water.

A) 0.167 M

B) 0.375 M

C) 0.667 M

D) 1.50 M

$$20.8 g\ CaCl_2 \times \frac{1 mol\ CaCl_2}{110.98 g\ CaCl_2} = 0.1874 \text{ mol } CaCl_2$$

$$[CaCl_2] = \frac{\# mol\ CaCl_2}{\# L\ soln} = \frac{0.1874 mol}{0.500 L} = 0.375 M$$

0.500L

Q12. Calculate the volume (in mL) needed to make 525 mL of a 1.20 M $NaNO_3$ solution from a 6.00 M $NaNO_3$ stock solution.

V_2 M_2 M_1

A) 13.7 mL

B) 87.5 mL

C) 105 mL

D) 2600 mL

$$M_1V_1 = M_2V_2 \Rightarrow V_1 = \frac{M_2V_2}{M_1}$$

$$= \frac{1.20M \times 525 mL}{6.00M}$$

$$= 105 mL$$

Q13. The gas law that states that pressure is inversely proportional to volume is:

A) Avogadro's law

B) Boyle's law

C) Charles's law

D) Torricelli's law

Q14. Which of the following solution combinations will form a precipitate when mixed?

A) $NaNO_3(aq) + LiCl(aq)$ → $NaCl(aq) + LiNO_3(aq)$

B) $KC_2H_3O_2(aq) + (NH_4)_2SO_4$ → $NH_4C_2H_3O_2(aq) + K_2SO_4(aq)$

C) $HNO_3(aq) + NaOH(aq)$ → $H_2O(l) + NaNO_3(aq)$ (unbalanced)

D) $Na_2S(aq) + Mg(NO_3)_2(aq)$ → $\underline{MgS(s)\downarrow}$ + $NaNO_3(aq)$

Q15. Which of the following solution combinations will form a gas when mixed?

A) $LiHCO_3(aq) + NaNO_3(aq)$

B) $K_2CO_3(aq) + HCl(aq)$ → "$\cancel{H_2CO_3}$" $H_2O(l) + CO_2(g)\uparrow + KCl(aq)$

C) $Pb(NO_3)_2(aq) + NaI(aq)$

D) $NaOH(aq) + H_2SO_4(aq)$

Q16. For the reaction that occurs between HBr(aq) and NH4OH(aq) identify the equation shown below that correctly identifies the net-ionic equation.

A) $NH4^+(aq) + Br^-(aq) \longrightarrow NH4Br(s)$

B) $H^+(aq) + OH^-(aq) \longrightarrow H_2O(l)$

C) $NH4^+(aq) + Br^-(aq) + H^+(aq) + OH^-(aq) \longrightarrow NH4Br(s) + H^+(aq) + OH^-(s)$

D) $H^+(aq) + Br^-(aq) \longrightarrow HBr(s)$

Mol: $HBr(aq) + NH_4OH(aq) \rightarrow H_2O(l) + NH_4Br(aq)$

Full: $H^+(aq) + Br^-(aq) + NH_4^+(aq) + OH^-(aq) \rightarrow H_2O(l) + NH_4^+(aq) + Br^-(aq)$

Net: $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

Q17. The oxidation state of the sulfur atom in SO_3^{2-} ion is:

A) −2

B) +2

C) +4

D) +6

$\overset{(+4)(-2)}{SO_3^{2-}}$

Σ ox. state = charge.

O = −2 in most cpds.

Q18. The oxidation state of the phosphorus atom in K_3PO_4 is:

A) +5

B) −5

C) +3

D) −3

K_3PO_4 = K^+ K^+ K^+ ⊕ $\overset{(+5)(-2)}{PO_4^{3-}}$

+5 −8 = 3−

V_1 298K T_1

Q19. A sample of gas with a volume of 25.0 mL at a temperature of 25°C is cooled down to

248K T_2 −25°C. Assuming no change in pressure, its final volume will be: V_2?

A) −25.0 mL

B) 20.8 mL

C) 18.4 mL

D) 27.3 mL

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

$$= \frac{25.0\,mL \times 248K}{298K}$$

$$= 20.8\,mL$$

Q20. The pressure of 0.500 mol of He(g) at a temperature of 133°C, and a volume of 4.00 L is predicted to be: 406K

A) 2.45 atm

B) 3.95 atm

C) 4.17 atm

D) 0.953 atm

$$pV = nRT$$

$$\Rightarrow p = \frac{nRT}{V} = \frac{0.500\,mol \times 0.08206\,\frac{atm \cdot L}{mol \cdot K} \times 406K}{4.00\,L}$$

$$= 4.17\,atm \quad (406.15K)$$

Each problem in this section (short answer) is worth 10 points !

All work must be show in order to receive credit !

You must use the factor–label (conversion–factor) method for all conversions !

Be sure to include units where applicable !

All numeric answers must be rounded to the correct number of significant figures !

Q21. The reaction between $C_3H_6(g)$ and $O_2(g)$ forms $CO_2(g)$ and $H_2O(g)$.

A) Write out a balanced chemical equation for this reaction, using the lowest set of whole number coefficients. $2C_3H_6(g) + 9O_2(g) \rightarrow 6CO_2(g) + 6H_2O(g)$

B) Predict the mass of $H_2O(g)$ formed from the complete reaction of 14.0 g $C_3H_6(g)$ and 18.0 g $O_2(g)$

$$14.0\,g\ C_3H_6 \times \frac{1\,mol\ C_3H_6}{42.08\,g\ C_3H_6} \times \frac{6\,mol\ H_2O}{2\,mol\ C_3H_6} \times \frac{18.02\,g\ H_2O}{1\,mol\ H_2O} = 18.0\,g\ H_2O$$

XS

$$18.0\,g\ O_2 \times \frac{1\,mol\ O_2}{32.00\,g\ O_2} \times \frac{6\,mol\ H_2O}{9\,mol\ O_2} \times \frac{18.02\,g\ H_2O}{1\,mol\ H_2O} = \underline{6.76\,g\ H_2O}\ (*)$$

LR

Theoretical yield

C) If the actual mass of $H_2O(g)$ formed was 5.40 g, then calculate the ~~theoretical~~ percent yield of this reaction.

$$\%\ yield = \frac{actual}{theorethical} \times 100 = \frac{5.40\,g}{6.76\,g} \times 100 = 79.9\%$$

Q22. One of the ingredients in Bufferin tables is composed of 28.83 % Mg, 14.25 % C, and 56.93% O (percentages are by mass). Show how to determine (by calculation) the empirical formula for this compound and then provide the correct name of this compound.

Assume 100.g

$28.83 g\ Mg \times \frac{1\ mol\ Mg}{24.31 g\ Mg} = 1.186\ mol\ Mg$

$14.25 g\ C \times \frac{1\ mol\ C}{12.01 g\ C} = 1.187\ mol\ C$

$56.93 g\ O \times \frac{1\ mol\ O}{16.00 g\ O} = 3.558\ mol\ O$

$\div 1.186\ mol$

1.000 Mg ≈ 1 Mg

1.001 C ≈ 1 C

3.000 O ≈ 3 O

⇒ $MgCO_3$

magnesium carbonate!

Q23. Provide the correct name or formula for each of the following compounds.

A) O_3F_2 trioxygen difluoride

B) $Fe(NO_3)_3 \cdot 9\ H_2O$ iron (III) nitrate nonahydrate

C) sodium bicarbonate $NaHCO_3$

D) chromium (III) sulfate $Cr_2(SO_4)_3$

E) $(NH_4)_2CO_3$ ammonium carbonate

Q24. Write correctly the balanced molecular, complete ionic, and net ionic equation for the reaction:

molecular: $\underline{3}\,Pb(NO_3)_2(aq) + \underline{2}\,K_3PO_4(aq) \rightarrow 6\,KNO_3(aq) + Pb_3(PO_4)_2(s)\downarrow$

complete ionic: $3\,Pb^{2+}(aq) + 6\,NO_3^-(aq) + 6\,K^+(aq) + 2\,PO_4^{3-}(aq) \rightarrow 6\,K^+(aq) + 6\,NO_3^-(aq) + Pb_3(PO_4)_2(s)\downarrow$

net ionic: $3\,Pb^{2+}(aq) + 2\,PO_4^{3-}(aq) \rightarrow Pb_3(PO_4)_2(s)\downarrow$

Q25. In a titration, it is found that 43.0 mL of 0.100 M NaOH(aq) is required to fully neutralize 20.00 mL of a sample of $H_3PO_4(aq)$ (phosphoric acid) of unknown concentration. What must the molar concentration of this sample of phosphoric acid be?

$$3\,NaOH(aq) + H_3PO_4(aq) \longrightarrow 3H_2O(l) + Na_3PO_4(aq).$$

$$43.0\,mL \times \frac{1\,L}{1000\,mL} \times \frac{0.100\,mol\ NaOH}{1\,L} \times \frac{1\,mol\ H_3PO_4}{3\,mol\ NaOH} = 1.43 \times 10^{-3}\,mol\ H_3PO_4$$

$$[H_3PO_4] = \frac{\#mol\ H_3PO_4}{\#L\ H_3PO_4\ sol^{n}}$$

$$20.00\,mL \times \frac{1\,L}{1000\,mL} = 0.02000\,L$$

$$\Rightarrow [H_3PO_4] = \frac{1.43\underline{3} \times 10^{-3}\,mol}{0.02000\,L} = 0.0717\,M \ (3\,s.f.)$$

5 Point Bonus Question

15.0 mL of 1.25 M sodium sulfate(aq) is mixed with 25.0 mL of 3.20 M calcium nitrate(aq). Predict the mass of the precipitate that is expected to form.

chem eq: $Na_2SO_4(aq) + Ca(NO_3)_2(aq) \rightarrow \underset{ppt}{\underline{\underline{CaSO_4(s)}}} + 2NaNO_3(aq)$

LR

$$15.0\,mL \times \frac{1\,L}{1000\,mL} \times \frac{1.25\,mol\ Na_2SO_4}{1\,L} \times \frac{1\,mol\ CaSO_4}{1\,mol\ Na_2SO_4} \times \frac{136.15\,g\ CaSO_4}{1\,mol\ CaSO_4} = 2.55\,g\ CaSO_4$$

(*) theoretical yield.

$$25.0\,mL \times \frac{1\,L}{1000\,mL} \times \frac{3.20\,mol\ Ca(NO_3)_2}{1\,L} \times \frac{1\,mol\ CaSO_4}{1\,mol\ Ca(NO_3)_2} \times \frac{136.15\,g\ CaSO_4}{1\,mol\ CaSO_4} = 10.9\,g\ CaSO_4$$

XS