General Chemistry 1 (CHEM 1141)

Shawnee State University – Autumn 2023

October 20, 2023

Exam # 2 A

Name KEY

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

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

Section #:

- ❒ 1. (Mon Lab, 11:10 AM – 1:55 PM) } **Fleeman**
- ❒ 2. (Wed Lab, 11:10 AM – 1:55 PM) } **Fleeman**
- ❒ 3. (Tue Lab, 11:00 AM – 1:50 PM) } **Napper**
- ❒ 4. (Thu Lab, 11:00 AM – 1:50 PM) } **Napper**

Multiple Choice:	_____	**/ 50**
Q21:	_____	**/ 10**
Q22:	_____	**/ 10**
Q23:	_____	**/ 10**
Q24:	_____	**/ 10**
Q25:	_____	**/ 10**
BONUS:	_____	**/ 3**
TOTAL:	_____	**/ 100**

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

Q1. Which process involves the transfer of electrons?

A) double-replacement

B) oxidation-reaction OX = loss e^-

C) acid-base neutralization

D) condensation

Q2. How many moles of $C_{12}H_{22}O_{11}$ are needed to prepare 2.50 L of 0.300 M $C_{12}H_{22}O_{11}$ solution?

$2.50\,L \times \frac{0.300\,mol}{L} = 0.750\,mol$

A) 0.430 mol

B) 0.750 mol

C) 8.33 mol

D) 0.120 mol

Q3. Using the following equation:

$$Fe_2O_3(s) + 3\,H_2(g) \rightarrow 2\,Fe(s) + 3\,H_2O(l)$$

$6\,mol\,H_2 \times \frac{2\,mol\,Fe}{3\,mol\,H_2} = 4\,mol\,Fe$

How many moles of Fe can be made from 6 moles of H_2?

A) 4 B) 9 C) 6 D) 2

Q4. Which of the following substances is not an electrolyte?

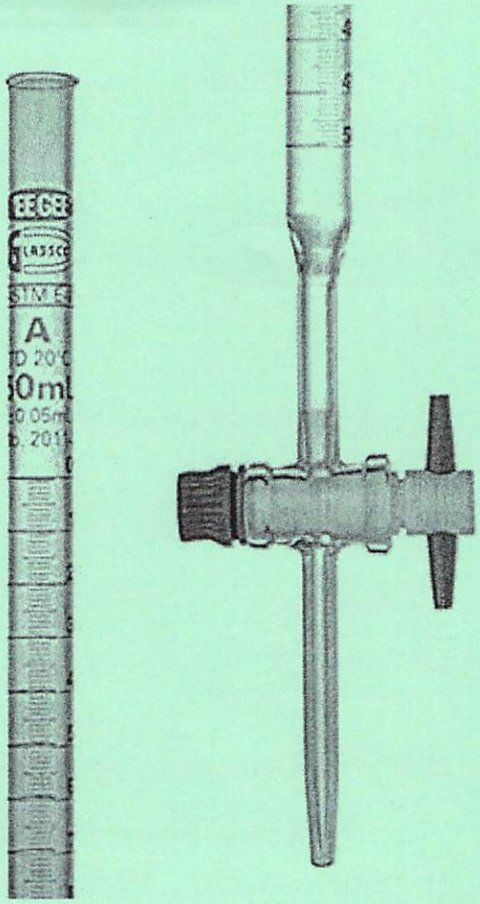
A) $LiNO_3$ Ionic, sol

B) CH_4 — molecule (C, H are non-metals)

C) KCl Ionic, sol

D) $MgBr_2$ Ionic, sol

Q5. This piece of glassware to the right is called a :



A) volumetric pipet

B) Erlenmeyer flask

C) volumetric flask

D) buret

Q6. A student inflates a balloon with helium and then places it into the freezer. The student should expect

A) the balloon's volume to increase

B) the balloon's number of moles to increase

C) the balloon's volume to decrease

D) the balloon's number of moles to decrease

Charles' law: $V \propto T$

Q7. How do you make a diluted solution from a stock solution?

A) add more solute to the stock solution

B) add solvent to the volume of the stock solution

C) remove solute from the stock solution

D) remove solvent from the volume of the stock solution

Q8. The combustion reaction of triethylene glycol is shown below. Determine the coefficient in front of O_2 when the equation is balanced using the lowest set of whole number coefficients.

$$2\ C_6H_{14}O_4 + 15\ O_2 \rightarrow 12\ CO_2 + 14\ H_2O$$

A) 6

B) 12

C) 14

D) 15

Q9. The _____ yield is the maximum amount of product that can be produced from a chemical reaction.

A) percent

B) actual

C) theoretical

D) experimental

Q10. Which of the following compounds is insoluble in water?

A) $AgNO_3$

B) KOH

C) Na_2SO_4

D) $CaCO_3$

Q11. Given the balanced chemical equation:

$$N_2(g) + 3\ H_2(g) \longrightarrow 2\ NH_3(g)$$

How many moles of NH_3 could you form by reacting 2.0 mol of nitrogen with 3.0 mol of hydrogen?

$2.0\ mol\ N_2 \times \frac{2\ mol\ NH_3}{1\ mol\ N_2} = 4.0\ mol\ NH_3$ (XS)

$3.0\ mol\ H_2 \times \frac{2\ mol\ NH_3}{3\ mol\ H_2} = 3.0\ mol\ NH_3$ (LR) (✓)

A) 2.0 mol NH_3

B) 3.0 mol NH_3

C) 4.0 mol NH_3

D) 9.0 mol NH_3

Q12. Which combination of reactants would form a precipitate when mixed?

A) $AgNO_3(aq) + Mg(NO_3)_2(aq)$

B) $Ca(HCO_3)_2(aq) + HCl(aq)$

C) $Pb(NO_3)_2(aq) + 2KI(aq) \longrightarrow PbI_2(s)\downarrow + 2KNO_3(aq)$

D) $H_2SO_4(aq) + LiOH(aq)$

Q13. What color would litmus turn if a drop of $H_2SO_4(aq)$ was placed upon it?

Sulfuric ACID

A) Red

B) Yellow

C) Green

D) Blue

Q14. The oxidation number of sulfur in H_2SO_3 is:

A) +2

B) +4

C) −6

D) −8

Q15. A solution is made by quantitatively transferring 25 g of NaCl(s) into a 100. mL volumetric flask and adding deionized water until it comes to volume (with stirring). What is the molar concentration of the solution?

A) 0.25 M

B) 0.43 M

C) 2.5 M

D) 4.3 M

Q16. Which of the following is a diatomic gas at 1 atm and 25 °C?

A) helium

B) fluorine

C) bromine

D) lithium

Q17. The gas law that states that increasing the number of moles of a gas, increases its volume (all other things being constant) is:

A) Gay-Lussac

B) Boyle

C) Avogadro

D) Charles

Q18. A 45.0 mL sample of gas at 425 K is placed into an insulated box until its volume is 25.0 mL. What temperature must it now be at? Assume pressure & number of moles haven't changed.

A) 236 K

B) 380 K

C) 765 K

D) 905 K

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

$$= \frac{25.0\,mL \times 425\,K}{45.0\,mL}$$

$$= 236\,K$$

Q19. Standard temperature and pressure (STP) corresponds to:

A) 0 atm, 0K

B) 100 mmHg, 100 °C

C) 760 mmHg, 25 °C

D) 1 atm, 0 °C

Q20. The density of Freon-12, dichlorodifluoromethane (CF_2Cl_2), a previously common refrigerant gas, would be equal to _____ at 22 °C and 1.08 atm?

A) 5.39 g/L

B) 6.54 g/L

C) 8.03 g/L

D) 9.78 g/

$$pM = dRT$$

$$\rightarrow d = \frac{pM}{RT} = \frac{1.08\,atm \times 120.91\,g/mol}{0.08206\,\frac{atm \cdot L}{mol \cdot K} \times 295\,K}$$

$$= 5.399\,g/L$$

Each problem in this section (short answer) is worth 10 points! All work must be shown to receive credit! You must use the factor-label 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. A student measures out 24.0 mL of a H_2SO_4 solution with an unknown concentration. The student titrates this solution by adding 17.4 mL of a 1.50 M KOH solution and phenolphthalein indicator. Determine the concentration (molarity) of the unknown H_2SO_4 solution.

$$H_2SO_4 + 2\,KOH \longrightarrow K_2SO_4 + 2H_2O$$

#mol ← ? mol (②)

? mol ↑ (①)

17.4 mL

$$[H_2SO_4] = \frac{\#\text{mol } H_2SO_4}{\#\text{L } H_2SO_4}$$

$$\frac{17.4\text{ mL}}{1000\text{ mL}} \left| \frac{1\text{ L}}{1} \right| \frac{1.50\text{ mol KOH}}{1\text{ L}} \left| \frac{1\text{ mol } H_2SO_4}{2\text{ mol KOH}} \right. = 0.01305\text{ mol } H_2SO_4$$

(① 1.50 mol KOH / 1 L ; ② 1 mol H_2SO_4 / 2 mol KOH)

$$\frac{24.0\text{ mL}}{1000\text{ mL}} \left| \frac{1\text{ L}}{1} \right. = 0.0240\text{ L}$$

$$\rightarrow [H_2SO_4] = \frac{0.01305\text{ mol}}{0.0240\text{ L}} = \boxed{0.544\text{ M}}$$

Q22. Solid sulfur and oxygen gas react to form sulfur trioxide gas which is used to produce sulfuric acid.

$$S_8(s) + 12\,O_2(g) \rightarrow 8\,SO_3(g)$$

a) Balance the equation.

see above!

b) In a certain reaction, 5.0 g of O_2 reacts with 6.0 g of S_8. Determine the theoretical yield of SO_3 for this reaction.

(LR)

$$5.0\,g\,O_2 \left|\frac{1\,mol\,O_2}{32.00\,g\,O_2}\right|\frac{8\,mol\,SO_3}{12\,mol\,O_2}\left|\frac{80.07\,g\,SO_3}{1\,mol\,SO_3}\right. = \boxed{8.3\,g\,SO_3}$$

(*) theor. yield.

(XS)

$$6.0\,g\,S_8 \left|\frac{1\,mol\,S_8}{256.56\,g\,S_8}\right|\frac{8\,mol\,SO_3}{1\,mol\,S_8}\left|\frac{80.07\,g\,SO_3}{1\,mol\,SO_3}\right. = 14.98\,g = 15.\,g\,SO_3$$

c) Calculate the percent yield of this reaction if 7.9 g of SO_3 is collected?

$$\%\ yield = \frac{act}{theor} \times 100 = \frac{7.9\,g}{8.3\,g} \times 100 = \boxed{95\%}$$

Q23. Write out the balanced molecular, full-ionic, and net-ionic equation for the reaction between:

Molecular: $\_\_H_2SO_4(aq) + \underline{2}\,NaHCO_3(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l) + 2CO_2(g)$

Full-ionic:

$2H^+(aq) + SO_4^{2-}(aq) + 2Na^+(aq) + 2HCO_3^-(aq) \rightarrow 2Na^+(aq) + SO_4^{2-}(aq) + 2H_2O(l) + 2CO_2(g)$

Net-ionic:

$2H^+(aq) + 2HCO_3^-(aq) \rightarrow 2H_2O(l) + 2CO_2(g)$

... or can $\div 2$ to simplify!

Q24. Assign oxidation numbers to each atom in the following chemical equation:

$$\overset{+2\ -2}{PbO} + \overset{+4\ -2}{CO_2} \longrightarrow \overset{+4\ -2}{PbO_2} + \overset{+2\ -2}{CO}$$

Identify:

i) The species which was oxidized: PbO

ii) The species which was reduced: CO_2

iii) The oxidizing agent: CO_2

iv) The reducing agent: PbO

Q25. *For these problems, assume no other variable is changing except for the ones specified in the question!*

(a) A 100. mL sample of an ideal gas at 425 mmHg is squeezed until its final volume is 20.0 mL. What is the final pressure of the gas in units of atm?

$P_1V_1 = P_2V_2 \rightarrow P_2 = \frac{P_1V_1}{V_2} = \frac{425\ mmHg \times \frac{1\ atm}{760\ mmHg} \times 100.\ mL}{20.0\ mL} = 2.80\ atm$

(b) 45.0 g of chlorine gas is placed into an empty vessel with a volume of 1.25 L. If the temperature of the vessel is 59.00 °C, what will the pressure inside be?

$PV = nRT \rightarrow P = \frac{nRT}{V} = \frac{0.635\ mol \times 0.08206 \frac{atm \cdot L}{mol \cdot K} \times 332.15\ K}{1.25\ L} = \boxed{13.8\ atm}$

(n) $45.0\ g\ Cl_2 \times \frac{1\ mol\ Cl_2}{70.90\ g\ Cl_2} = 0.635\ mol$, (T) $59.00 + 273.15 = 332.15\ K$

(c) 98.0 mL of helium gas at 120. torr and 192 °C is cooled down to 24 °C while simultaneously being pressurized to 10,500 torr. What will its final volume be?

(T_2) $24 + 273.15 = 297\ K$

$192 + 273.15 = 465\ K$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \rightarrow V_2 = \frac{P_1V_1}{T_1} \times \frac{T_2}{P_2}$

$= \frac{120.\ torr \times 98.0\ mL \times 297\ K}{465\ K \times 10,500\ torr}$

$= \boxed{0.715\ mL}$

3 Point Bonus Question

1. Name the instrument used to measure atmospheric pressure. barometer

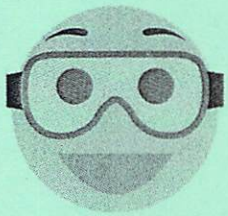
2. Name **two** (and only two) strong inorganic acids.
   sulfuric acid ($H_2SO_{4(aq)}$) and hydrochloric acid ($HCl_{(aq)}$)

Exam checklist:

(Check the boxes to certify the following:)

- ☐ My full name is written legibly on the front page
- ☐ My correct lab section has been indicated on the front page
- ☐ My full name is written legibly on the scantron sheet
- ☐ My exam version (A, B, C, or D) is written on the scantron sheet
- ☐ I have shown work for all problems (where appropriate), paying attention to
  - Significant figures / decimal places
  - Units
- ☐ I have used the conversion-factor method for all conversions
- ☐ If I have torn off the back page (periodic table), I will not turn it in with my exam!

Thank you from the Chemistry Professors and Good Luck!



Useful information:

Partial List of Solubility Rules

TABLE 4.2 Solubility Rules for Common Ionic Compounds in Water at 25°C

Soluble Compounds	Exceptions
Halides (Cl^-, Br^-, I^-)	Halides of Ag^+, Hg_2^{2+}, and Pb^{2+}
Sulfates (SO_4^{2-})	Sulfates of Ag^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, Hg_2^{2+}, and Pb^{2+}

Insoluble Compounds	Exceptions
Carbonates (CO_3^{2-}), phosphates (PO_4^{3-}), chromates (CrO_4^{2-}), and sulfides (S^{2-})	Compounds containing alkali metal ions and the ammonium ion
Hydroxides (OH^-)	Compounds containing alkali metal ions and the Ba^{2+} ion

$M_1V_1 = M_2V_2$ $N_A = 6.022 \times 10^{23}\ mol^{-1}$

1 atm = 101,325 Pa = 760 mmHg = 760 torr

$R = 0.08206$ L·atm/mol·K

$$p_1V_1 = p_2V_2 \qquad \frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2} \qquad \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$pV = nRT \qquad p\mathcal{M} = dRT$$

Periodic Table of the Elements

IA	IIA											IIIA	IVA	VA	VIA	VIIA	VIIIA
1																	*18*
1 **H** 1.008	*2*											*13*	*14*	*15*	*16*	*17*	2 **He** 4.003
3 **Li** 6.941	4 **Be** 9.012											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.31	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.87	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.39	31 **Ga** 69.72	32 **Ge** 72.61	33 **As** 74.92160	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** [98]	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.60	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba*** 137.3	71 **Lu** 175.0	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.8	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** [210]	85 **At** [210]	86 **Rn** [222]
87 **Fr** [223]	88 **Ra**** [226]	103 **Lr** [262]	104 **Rf** [261]	105 **Db** [262]	106 **Sg** [266]	107 **Bh** [264]	108 **Hs** [265]	109 **Mt** [268]	110 [269]	111 [272]	112 [277]	113	114 [285]	115	116 [289]	117	118 [293]

*	57 **La** 138.9	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** [145]	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.50	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0
**	89 **Ac** [227]	90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** [237]	94 **Pu** [244]	95 **Am** [243]	96 **Cm** [247]	97 **Bk** [247]	98 **Cf** [251]	99 **Es** [252]	100 **Fm** [257]	101 **Md** [258]	102 **No** [259]