General Chemistry 1 *(CHEM 1141)*

Shawnee State University – Fall 2021

October 21, 2021

Exam 2A

Name KEY

Please write 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 green & white scantron sheet in pencil !)

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

Section #:

- ❒ 1. (Mon Lab, 11:10 AM – 1:55 PM)
- ❒ 2. (Wed Lab, 11:10 AM – 1:55 PM)

Fleeman

- ❒ 3. (Mon Lab, 2:30 PM – 5:20 PM)
- ❒ 4. (Wed Lab, 2:30 PM – 5:20 PM)

Napper

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

You are only allowed to use a TI30–XIIS or equivalent non–programmable calculator on this exam !

(This means no cell phones, no smart phones, no smart watches, no iPads, or any other such devices will be allowed !)

Q1. The atomic mass unit is defined as being equal to:

a) the mass of a hydrogen-1 atom
b) ¼ the mass of a helium-4 atom
c) 1/12 the mass of a carbon-12 atom
d) 1/16 the mass of an oxygen-16 atom
e) 1 gram (exactly)

12u = mass ^{12}C
1u = $\frac{1}{12}$ mass ^{12}C

Q2. What is the mass of one atom of sulfur?

a) 16 g
b) 32.07 g
c) 16 u
d) 32.07 u

Q3. What is the molar mass of $Ca_3(PO_4)_2$?

3×Ca + 2×P + 8×O

a) 87.05 g
b) 279.21 g
c) 310.18 g
d) 430.42 g
e) 560.21 g

Q4. What is the mass percent of hydrogen in C_2H_4O?

$\%H = \frac{4\times1.008}{2\times12.01+4\times1.008+1\times16.00}\times100$

a) 9.17 %
b) 2.29 %
c) 57.1 %
d) 36.1 %
e) 1.01 %

Q5. When the following chemical equation is balanced using the LOWEST set of WHOLE NUMBER coefficients, what is the coefficient in front of H_2O?

1 $C_4H_9OH(l)$ + 6 $O_2(g)$ ⟶ 4 $CO_2(g)$ + 5 $H_2O(l)$

a) 2
b) 3
c) 5
d) 10
e) 12

Q6. Given the following balanced chemical equation:

$2AgHCO_3(aq) + CaCl_2(aq) \longrightarrow 2AgCl(s) + Ca(HCO_3)_2(aq)$

How many moles of AgCl can be formed from 4.0 mol $CaCl_2$ and 5.0 mol $AgHCO_3$?

(XS) $4.0\,mol\,CaCl_2 \times \frac{2\,mol\,AgCl}{1\,mol\,CaCl_2} = 8.0\,mol\,AgCl$

(LR) $5.0\,mol\,AgHCO_3 \times \frac{2\,mol\,AgCl}{2\,mol\,AgHCO_3} = 5.0\,mol\,AgCl$ (*)

a) 8.0 mol
b) 2.0 mol
c) 13 mol
d) 4.0 mol
e) 5.0 mol

Q7. Suppose only 0.80 mol of AgCl was formed in the previous reaction. What is the percent yield of this reaction?

a) 10 %
b) 40. %
c) 6.2 %
d) 20. %
e) 16 %

$\frac{0.80}{5.0}\times100$

Q8. What **precipitate** will form when a solution of $HNO_3(aq)$ is mixed with a solution of $Ca(HCO_3)_2(aq)$?

a) $Ca(NO_3)_2$
b) $H(HCO_3)_2$
c) H_2CO_3
d) CaH_2
e) No precipitate will be formed

$2HNO_3(aq) + Ca(HCO_3)_2(aq) \rightarrow Ca(NO_3)_2(aq) + \underbrace{2CO_2(g) + 2H_2O(l)}_{2\text{ "}H_2CO_3\text{"}}$

Q9. Which of the following is NOT a strong acid?

a) HF
b) HBr
c) H_2SO_4
d) $HClO_4$
e) HNO_3

Q10. The oxidation number of the sulfur atom in $Al_2(SO_4)_3$ is:

(+6)(-2) → SO_4^{2-} → -2

a) +12
b) +6
c) 0
d) –6
e) –12

Q11. What volume of 0.200 M HCl(aq) contains 0.100 mol HCl?

$0.100\,mol \times \frac{1\,L}{0.200\,mol} = 0.500\,L = 500\,mL$

a) 100. mL
b) 200. mL
c) 500. mL
d) 1000. mL
e) 2000. mL

Q12. 25.0 mL of 2.40 M $LiNO_3(aq)$ is mixed with 75.0 mL of water. What is the final concentration of $LiNO_3(aq)$?

$M_1V_1 = M_2V_2 \rightarrow M_2 = \frac{M_1V_1}{V_2}$

$= \frac{2.40\,M \times 25.0\,mL}{100.0\,mL}$

25+75 → =0.600 M

a) 0.600 M
b) 0.800 M
c) 0.0240 M
d) 0.00240 M
e) 240. M

Q13. Which substance is the reducing agent in the following chemical equation:

(0)(-1)(-2) (0) (+4)(-2) (+1)(-2)

$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$

a) $C_6H_{12}O_6$ (was ox'ed so caused O_2 to be red.)
b) O_2
c) CO_2
d) H_2O

Q14. What mass would 0.16 mol CH_2O weigh?

a) 1.2 g
b) 2.4 g
c) 4.8 g
d) 9.2 g
e) 30. g

C = 12.01
2H = 2×1.008
O = 1×16.00
30.03

$0.16\,mol\,CH_2O \times \frac{30.03\,g\,CH_2O}{1\,mol\,CH_2O} = 4.8\,g\,CH_2O$

Q15. If 0.66 moles of a substance has a mass of 99 g, what is the molar mass of the substance?

a) 120.0 g/mol b) 150 g/mol c) 170 g/mol d) 180 g/mol
e) 65.34 g/mol

$M = \frac{\#g}{\#mol} = \frac{99g}{0.66mol} = 150 g/mol$ (2 s.f.)

Q16. The element oxygen consists of three naturally occurring isotopes: ^{16}O, ^{17}O, ^{18}O. The atomic mass of oxygen is 16.0 amu. What can be implied about the relative abundances of these isotopes?

a) almost all O atoms are ^{18}O b) almost all O atoms are ^{17}O
c) the isotopes have the same abundance, i.e., 33% d) the abundances of ^{17}O and ^{18}O are very small
e) none of the above

Q17. What is the mass (in grams) of 4.50×10^{22} Cu atoms?

a) 7.47×10^{-2} g b) 4.75 g c) 63.55 g d) 74.73 g e) 0.211 g

$4.50\times10^{22}\ \text{atoms Cu} \times \frac{1\ \text{mol}}{6.022\times10^{23}\ \text{atoms}} \times \frac{63.55\ \text{g Cu}}{1\ \text{mol Cu}} = 4.75\ \text{g Cu}$

Q18. What of the following represents a combustion reaction? reacts w/ O_2 : all C → CO_2, H → H_2O

a) $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(l)$ b) $LiOH(aq) + HNO_3(aq) \rightarrow LiNO_3(aq) + H_2O(l)$
c) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ d) $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$
e) $2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$

Q19. The common constituent in all acid solutions is

a) H_2 b) H^+ c) OH^- d) H_2SO_4 e) Cl^-

Q20. Which substance is acting as a Bronsted acid in the following reaction?

$$HSO_4^- + NH_4^+ \rightarrow H_2SO_4 + NH_3$$

a) HSO_4^- b) NH_4^+ c) H_2SO_4 d) NH_3 e) both HSO_4^- and NH_4^+

donates H^+

Short Response.

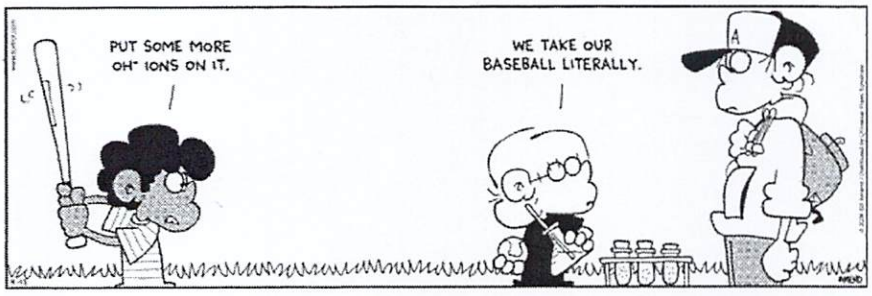
Show all work to receive credit. You must use the factor-label (conversion-factor) method for all conversions. Be sure to show all units and write your answers using the correct number of significant figures or decimal places.

Q21. [10 pts.] Write the balanced molecular, full-ionic, and net-ionic chemical equations for the following reaction: Be sure to include state symbols and charges where necessary.

Molecular: $\_(NH_4)_2SO_4(aq) + \underline{2}\,AgNO_3(aq) \longrightarrow 2NH_4NO_3(aq) + Ag_2SO_4(s)$

Full-Ionic: $2NH_4^+(aq) + SO_4^{2-}(aq) + 2Ag^+(aq) + 2NO_3^-(aq) \rightarrow 2NH_4^+(aq) + 2NO_3^-(aq) + Ag_2SO_4(s)$

Net-Ionic: $2Ag^+(aq) + SO_4^{2-}(aq) \longrightarrow Ag_2SO_4(s)$



Q22. [10 pts.] An organic compound is found to contain 63.1 % C, 7.43 % H, and 29.5 % N by mass. Calculate its empirical formula?

Assume 100.g sample:

$63.1\,g\,C \times \frac{1\,mol\,C}{12.01\,g\,C} = 5.25\,mol\,C$

$7.43\,g\,H \times \frac{1\,mol\,H}{1.008\,g\,H} = 7.37\,mol\,H$

$29.5\,g\,N \times \frac{1\,mol\,N}{14.01\,g\,N} = 2.11\,mol\,N$

$\div 2.11$ mol

2.49 C → ≈ 5C

3.49 H → ≈ 7H

1.00 N → 2N

$\times 2$

So: $C_5H_7N_2$

Q23. [10 pts.] In a titration experiment, what volume (in mL) of 0.520 M LiOH would be required to neutralize 35.0 mL of 1.50 M H_2SO_4?

Hint: start by writing out a balanced chemical equation!

$$H_2SO_4(aq) + 2LiOH(aq) \rightarrow Li_2SO_4(aq) + 2H_2O(l)$$

$35.0\,mL \times \frac{1\,L}{1000\,mL} \times \frac{1.50\,mol\,H_2SO_4}{1\,L} \times \frac{2\,mol\,LiOH}{1\,mol\,H_2SO_4} \times \frac{1\,L}{0.520\,mol\,LiOH} \times \frac{1000\,mL}{1\,L} = 202\,mL\,LiOH$

Q24. [10 pts.] Answer each of the questions listed below the reaction equation.

$$2\,Al + Cr_2O_3 \rightarrow Al_2O_3 + 2\,Cr$$

Provide a correctly balanced equation for this reaction by writing the correct coefficients in front of each reactant and product.

Show how to determine *(by calculation)* the theoretical yield (in grams) of Cr that could be produced by the reaction of 40.0 g of Cr_2O_3 with 8.00 g of Al.

(XS)

$$40.0\,g\ Cr_2O_3 \times \frac{1\,mol\ Cr_2O_3}{152.00\,g\ Cr_2O_3} \times \frac{2\,mol\ Cr}{1\,mol\ Cr_2O_3} \times \frac{52.00\,g\ Cr}{1\,mol\ Cr} = 104\,g\ Cr$$

$$8.00\,g\ Al \times \frac{1\,mol\ Al}{26.98\,g\ Al} \times \frac{2\,mol\ Cr}{2\,mol\ Al} \times \frac{52.00\,g\ Cr}{1\,mol\ Cr} = \boxed{15.4\,g\ Cr}$$ (LF)

(LR)

The limiting reactant for this equation is Al.

Given the above conditions, a CHEM 1141 student carries out this reaction and obtains 12.5 g of Cr. Show how to determine *(and then calculate)* the percent yield for this reaction.

$$\%\ yield = \frac{actual}{theoretical} \times 100$$

$$= \frac{12.5\,g}{15.4\,g} \times 100 = 81.2\%\ (3s.f.)$$

Q25. [10 pts.] From the given list of possible answers, choose the correct answer for each of the questions below.

Possible Answers

Arrhenius acid	**Arrhenius base**	**solute**	**solvent**	**dilute**
$NaNO_3$	Ag_2SO_4	$CaCl_2$	$KMnO_4$	$FeSO_4$

A species that produces hydrogen ions when dissolved in water? Arrhenius acid

Which is an ionic compound that is insoluble in water? Ag_2SO_4

Which compound contains an atom with an oxidation state of +7? $KMnO_4$ (+7)

Which compound contains an atom with an oxidation state of –1? $CaCl_2$

Which is usually the smaller component present in a solution? Solute

BONUS QUESTIONS

Give a definition for the term, "electrolyte"

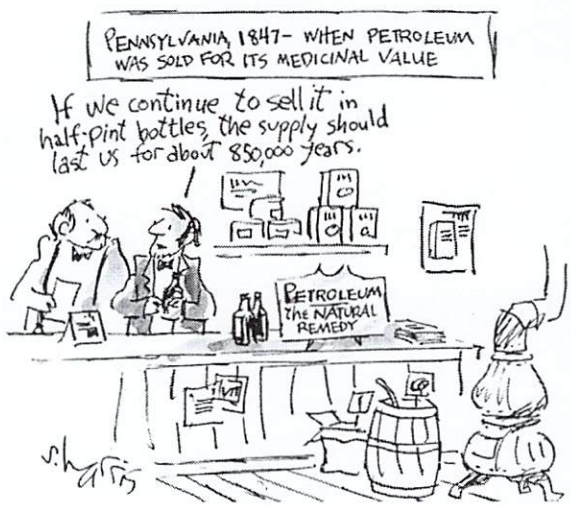
Soluble solute that forms elec. conductive solution when dissolved in water. Typically sol. ionic compound.

Give an example of a strong base:

NaOH

Give an example of a weak base:

NH_3 (ammonia)



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

Useful Information:

$M_1V_1 = M_2V_2$

$N_A = 6.022 \times 10^{23}$

Periodic Table

1 IA												13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1 **H** 1.01	2 IIA																2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											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 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	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** 39.1	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.88	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** 74.92	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** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.29
55 **Cs** 132.9	56 **Ba** 137.3	57 **La*** 138.9	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.9	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	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 **Ac^** (227)	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (264)	108 **Hs** (265)	109 **Mt** (268)	110 **Ds** (271)	111 **Rg** (272)							

*	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** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
^	90 **Th** 232.0	91 **Pa** (231)	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)	103 **Lr** (260)