Chem 1141
Fall 2011
Exam 2A

Name: KEY

Please write your full name, and which exam version (2A) you have on the scantron sheet.

Multiple Choice. [3 points each.] Record your answers to the multiple choice questions on the scantron sheet.

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)

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 $Ca_3(PO_4)_2$?
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?
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?

$$\_C_4H_9OH(l) + \underline{6}\,O_2(g) \longrightarrow \underline{4}\,CO_2(g) + \underline{5}\,H_2O(l)$$

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 $AgHCO_3$?
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 %

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

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:
a) +12 b) +6 c) 0 d) –6 e) –12

Q11. What volume of 0.200 M HCl(aq) contains 0.100 mol HCl?
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 $LiNO_3(aq)$?
a) 0.600 M b) 0.800 M c) 0.0240 M d) 0.00240 M e) 240. M

Q13. What type of chemical equation is given below:

$$Zn(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$$

a) Double-Replacement
b) Single-Replacement
c) Decomposition
d) Combustion

Q14. Which substance is the oxidizing agent in the following chemical equation:

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

a) $C_6H_{12}O_6$ b) O_2 c) CO_2 d) H_2O

Q15. How many grams 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

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.

Q16. [15 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: $\_(NH_4)_2CO_3(aq) + \underline{2}\,HBr(aq) \longrightarrow 2NH_4Br(aq) + H_2O(l) + CO_2(g)$

Full-Ionic: $2NH_4^+(aq) + CO_3^{2-}(aq) + 2H^+(aq) + 2Br^-(aq) \rightarrow 2NH_4^+(aq) + 2Br^-(aq) + H_2O(l) + CO_2(g)$

Net-Ionic: $2H^+(aq) + CO_3^{2-}(aq) \longrightarrow H_2O(l) + CO_2(g)$

Q17. [10 pts.] An organic compound is found to contain 63.1 % C, 7.43 % H, and 29.5 % N. What is its empirical formula?

Assume 100g sample.

$\frac{63.1\text{g C}}{}\left|\frac{1\text{ mol C}}{12.0\text{g C}}\right. = 5.25\text{ mol C}$

$\frac{7.43\text{g H}}{}\left|\frac{1\text{ mol H}}{1.01\text{g H}}\right. = 7.36\text{ mol H}$

$\frac{29.5\text{g N}}{}\left|\frac{1\text{ mol N}}{14.0\text{g N}}\right. = 2.11\text{ mol N}$

$\Rightarrow \frac{5.25\text{ mol C}}{2.11\text{mol}} : \frac{7.36\text{ mol H}}{2.11\text{mol}} : \frac{2.11\text{ mol N}}{2.11\text{ mol}}$

$\Rightarrow 2.49\text{ C} : 3.49\text{ H} : 1.00\text{ N}$ (×2)

$4.98\text{ C} : 6.98\text{H} : 2.00\text{N}$

$\approx 5\text{ C} \quad \approx 7\text{H}$

$\Rightarrow \boxed{C_5H_7N_2}$

Q18. [10 pts.] How many milliliters of 0.520 M LiOH would be required to neutralize 35.0 mL of 1.50 M H_2SO_4?

Chemical Equation: $H_2SO_4 + 2LiOH \longrightarrow Li_2SO_4 + 2H_2O$

$\frac{35.0\text{mL}}{}\left|\frac{1\text{L}}{1000\text{mL}}\right.\left|\frac{1.50\text{mol }H_2SO_4}{1\text{L}}\right.\left|\frac{2\text{mol LiOH}}{1\text{mol }H_2SO_4}\right.\left|\frac{1\text{L}}{0.520\text{ mol LiOH}}\right.\left|\frac{1000\text{mL}}{1\text{L}}\right. = 135\text{mL}$

Q19. [10 pts.] Name the following compounds:

a) Li_2SO_4 lithium sulfate

b) $Cu(NO_2)_2$ copper(II) nitrite

c) N_4Br_9 tetranitrogen nonabromide

d) $FeSO_4 \cdot 3H_2O$ iron(II) sulfate trihydrate

e) S_3O_7 trisulfur heptoxide

Q20. [6 pts.] How many protons, neutrons, and electrons are in a single **ion** of bromine-81?

Br^-

$Z = 35 \Rightarrow \boxed{35p^+}$

atom: $35e^-$

anion has 1 more $e^- \Rightarrow \boxed{36e^-}$

$A = 81 = \#p^+ + \#n^\circ = 35 + \#n^\circ$

$\Rightarrow \#n^\circ = 81 - 35 = \boxed{46n^\circ}$

Q21. [4 pts.] How many significant figures do the following measurements contain?

a) 0.0300 m 3

b) 2.0020 kg 5

c) 5.10×10^{-19} s 3

d) 1200 mol 2

BONUS QUESTIONS

What is the difference between an *intensive* property and an *extensive* property?

intensive properties do not depend on the amount of material. extensive properties DO!

What is an electrolyte?

A substance that dissolves in water, forming an electrically conductive solution.

Exam 2A

Multiple choice answers/solutions.

Q1. (c). We *define* the mass of the $^{12}_{6}C$ atom to be 12u.

Q2. (d)

atomic # = #p⁺ (=#e⁻ for ATOM)

average atomic mass: mass of 1 atom in u
mass of 1 mol of atoms in g

Q3. (c)

$Ca_3(PO_4)_2$ = $3\times Ca = 3\times 40.08$
$2\times P = 2\times 30.97$
$8\times O = 8\times 16.00$
310.18

Molar mass = mass of 1 mole = 310.18 g

Q4. (a)

C_2H_4O ⇒ $2\times C = 2\times 12.01 = 24.02$
$4\times H = 4\times 1.01 = 4.04$
$1\times O = 1\times 16.00 = 16.00$
44.06

$\Rightarrow \%H = \frac{4.04}{44.06}\times 100 = 9.17\%$

Q5. (c)

Q6. (e) $2AgHCO_3(aq) + CaCl_2(aq) \longrightarrow 2AgCl(s) + Ca(HCO_3)_2(aq)$

XS $\frac{4.0\,mol\ CaCl_2 \mid 2\,mol\ AgCl}{1\,mol\ CaCl_2} = 8.0\,mol\ AgCl$

LR $\frac{5.0\,mol\ AgHCO_3 \mid 2\,mol\ AgCl}{2\,mol\ AgHCO_3} = 5.0\,mol\ AgCl$

Q7. (e) $\%\ yield = \frac{Actual}{Theoretical}\times 100\% = \frac{0.80\,mol}{5.0\,mol}\times 100\% = 16\%$

Q8 (e) $2HNO_3(aq) + Ca(HCO_3)_2(aq) \longrightarrow Ca(NO_3)_2(aq) + 2H_2O(l) + 2CO_2(g)$

$H^+ NO_3^-$ $Ca^{2+} HCO_3^-$ $Ca^{2+} NO_3^-$ $H^+ HCO_3^-$

~~H_2CO_3~~ → $H_2O + CO_2$

No PPT!
$Ca(NO_3)_2$ is soluble (all nitrates are soluble...)
H_2O is a liquid
CO_2 is a gas.

Q9. (a) 6 strong acids: HCl, HBr, HI, HNO_3, H_2SO_4, $HClO_4$.

Q10. (b)

$Al_2(SO_4)_3 = Al^{3+}, SO_4^{2-}$

$SO_4^{2-} = \overset{+6\ -2\ -2\ -2\ -2}{SOOOO}{}^{2-}$ (must sum to −2)

all cpds of O are −2 (unless peroxide, etc...)

Q11. (c)

$\frac{0.100\,mol \mid 1\,L \mid 1000\,mL}{0.200\,mol \mid 1\,L} = 500.\,mL$

Q12. (a)

25.0 mL of 2.40 M $LiNO_3(aq)$ is mixed w/ 75.0 mL H_2O
⇒ Final volume = 25+75 = 100.0 mL
What's final conc? $M_1V_1 = M_2V_2$ (dilution equation)

2.40 M | 25.0 mL | ? | 100.0 mL

$\Rightarrow M_2 = \frac{M_1V_1}{V_2} = \frac{2.40\,M\times 25.0\,mL}{100.0\,mL} = 0.600\,M$

(or, volume is now 4× as large, #mol is same ⇒ [ ] is 4× smaller)

Q8. (b) $Zn(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$

Zn replaces the H (only 1 swap ⇒ single replacement)

Q14. (b) $C_6H_{12}O_6 + \overset{(0)}{6O_2} \longrightarrow 6\overset{(-2)}{CO_2} + 6\overset{(-2)}{H_2O}$

Oxygen goes from ox# of $0 \rightarrow -2$ ⇒ was reduced
⇒ is ox. agent.

Q15. (c)

CH_2O

$1 \times C = 1 \times 12.01$
$2 \times H = 2 \times 1.01$
$1 \times O = 1 \times 16.00$
30.02

$$\Rightarrow \frac{0.16 \text{ mol } CH_2O}{} \left| \frac{30.02 \text{ g } CH_2O}{1 \text{ mol } CH_2O} \right. = 4.8 \text{ g } CH_2O$$

Exam 2B

Q1	on 2B	was	Q8	on 2A
Q2	"		Q9	"
Q3	"		Q10	"
Q4	"		Q11	"
Q5	"		Q12	"
Q6	"		Q13	(change of Mg ↔ Zn)
Q7	"		Q14	"
Q8	"		Q15	"
Q9	"		Q1	"
Q10	"		Q2	"
Q11	"		Q3	"

Q12 on exam 2B was (b)

$C_2H_4O \rightarrow$

$2 \times C = 2 \times 12.01 = 24.02$
$4 \times H = 4 \times 1.01 = 4.04$
$1 \times O = 1 \times 16.00 = 16.00$
44.06

$$\%C = \frac{24.02}{44.06} \times 100\% = 54.5\%$$

Q13	on exam 2B	was	Q5	on exam 2A
Q14	"		Q6	"
Q15	"		Q7	"

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Exam 2B

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Multiple Choice. [3 points each.] Record your answers to the multiple choice questions on the scantron sheet.

Q1. 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

Q2. Which of the following is NOT a strong acid?
a) HF b) HI c) H_2SO_4 d) $HClO_4$ e) HNO_3

Q3. The oxidation number of the sulfur atom in $Al_2(SO_4)_3$ is:
a) +12 b) +6 c) 0 d) –6 e) –12

Q4. What volume of 0.200 M HCl(aq) contains 0.100 mol HCl?
a) 100. mL b) 200. mL c) 500. mL d) 1000. mL e) 2000. mL

Q5. 25.0 mL of 2.40 M $LiNO_3(aq)$ is mixed with 75.0 mL of water. What is the final concentration of $LiNO_3(aq)$?
a) 0.600 M b) 0.800 M c) 0.0240 M d) 0.00240 M e) 240. M

Q6. What type of chemical equation is given below:
$Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$
a) Double-Replacement b) Single-Replacement
c) Decomposition d) Combustion

Q7. Which substance is the oxidizing agent in the following chemical equation:
$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$
a) $C_6H_{12}O_6$ b) O_2 c) CO_2 d) H_2O

Q8. How many grams 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

Q9. 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)

Q10. What is the mass of one atom of sulfur?
a) 16 g b) 32.07 g c) 16 u d) 32.07 u

Q11. What is the molar mass of $Ca_3(PO_4)_2$?
a) 87.05 g b) 279.21 g c) 310.18 g d) 430.42 g e) 560.21 g

Q12. What is the mass percent of carbon in C_2H_4O?
a) 9.17 % b) 54.5 % c) 57.1 % d) 36.1 % e) 12.0 %

Q13. When the following chemical equation is balanced using the LOWEST set of WHOLE NUMBER coefficients, what is the coefficient in front of H_2O?
$\_\_C_4H_9OH(l) + \_6\_O_2(g) \longrightarrow \_4\_CO_2(g) + \_5\_H_2O(l)$
a) 2 b) 3 c) 5 d) 10 e) 12

Q14. 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 $AgHCO_3$?
a) 8.0 mol b) 2.0 mol c) 13 mol d) 4.0 mol e) 5.0 mol

Q15. 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 %

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.

Q16. [4 pts.] How many significant figures do the following measurements contain?

a) 2.0300 m 5
b) 0.00120 kg 3
c) 510 s 2
d) 1.200×10^{-9} mol 4

Q17. [10 pts.] How many milliliters of 0.320 M KOH would be required to neutralize 25.0 mL of 1.05 M H_3PO_4?

$H_3PO_4 + 3KOH \longrightarrow K_3PO_4 + 3H_2O$

$$25.0\,mL \left|\frac{1\,L}{1000\,mL}\right| \left|\frac{1.05\,mol\,H_3PO_4}{1\,L}\right| \left|\frac{3\,mol\,KOH}{1\,mol\,H_3PO_4}\right| \left|\frac{1\,L}{0.320\,mol\,KOH}\right| \left|\frac{1000\,mL}{1\,L}\right| = 246\,mL$$

Q18. [10 pts.] An organic compound is found to contain 47.3 % C, 10.6 % H, and 42.0 % O. What is its empirical formula?

Assume 100g sample

$47.3\text{g C} \left| \frac{1\text{ mol C}}{12.01\text{g C}} \right. = 3.94\text{ mol C}$

$10.6\text{g H} \left| \frac{1\text{ mol H}}{1.01\text{g H}} \right. = 10.5\text{ mol H}$

$42.0\text{g O} \left| \frac{1\text{ mol O}}{16.00\text{g O}} \right. = 2.63\text{ mol O}$

$\Rightarrow \frac{3.94\text{mol C}}{2.63\text{ mol}} : \frac{10.5\text{mol H}}{2.63\text{mol}} : \frac{2.63\text{mol O}}{2.63\text{mol}}$

1.50 C : 3.99 H : 1.00 O

3 C : 7.98 H : 2 O (×2)

$\approx$ 8

$\Rightarrow C_3H_8O_2$

Q19. [15 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: $2NH_4HCO_3(aq) + H_2SO_4(aq) \longrightarrow (NH_4)_2SO_4(aq) + 2H_2O(l) + 2CO_2(g)$

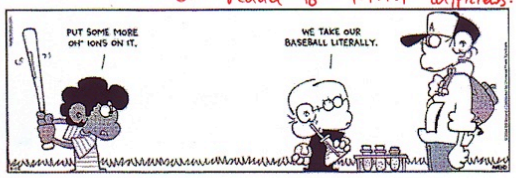
Full-Ionic:

$2NH_4^+(aq) + 2HCO_3^-(aq) + 2H^+(aq) + SO_4^{2-}(aq) \longrightarrow 2NH_4^+(aq) + SO_4^{2-}(aq) + 2H_2O(l) + 2CO_2(g)$

Net-Ionic:

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

or reduce to 1:1:1:1 coefficients!



Q20. [10 pts.] Name the following compounds:

a) K_2SO_3 potassium sulfite

b) $CuNO_3$ copper(I) nitrate

c) N_5Cl_{10} pentanitrogen decachloride

d) $FeCO_3 \cdot 4H_2O$ iron(II) carbonate tetrahydrate

e) P_2O_7 triphosphorus heptoxide

Q21. [6 pts.] How many protons, neutrons, and electrons are in a single **ion** of potassium-39?

$Z = 19 \Rightarrow$ 19p⁺

$A = 39 = \#p^+ + \#n^\circ = 19 + \#n^\circ$

$\Rightarrow \#n^\circ = 39 - 19 =$ 20n°

ion: $K^+ \Rightarrow$ one less e⁻ than atom.

atom: 19e⁻ ion: 18e⁻

BONUS QUESTIONS

What is the difference between an *chemical* property and a *physical* property?

When a chemical property is measured, it changes the identity of the substance

When a physical " _____ " does not " _____ ".

What is a non-electrolyte?

A substance that dissolves in water, but whose solution will not conduct electricity.