Chem 1141
Fall 2014
Exam 2A

Name: KEY

Section #:

- ❒ 1. (Tuesday Lab, 4 – 6:50 pm)
- ❒ 2. (Thursday Lab, 4 – 6:50 pm)
- ❒ 3. (Monday Lab, 11 – 1:50 pm)
- ❒ 4. (Wednesday Lab, 11 – 1:50 pm)
- ❒ 5. (Wednesday Lab, 2 – 4:50 pm)

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

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

Multiple Choice:	_____/30
Q11:	_____/10
Q12:	_____/10
Q13:	_____/10
Q14:	_____/10
Q15:	_____/10
Q16:	_____/10
Q17:	_____/10
BONUS:	_____/3
TOTAL:	_____/100

$7.45\text{g } C_6H_{12}O_6 \left| \frac{1\text{mol } C_6H_{12}O_6}{180.18\text{g } C_6H_{12}O_6} \right| \frac{12\text{mol H}}{1\text{mol } C_6H_{12}O_6} \left| \frac{6.022\times10^{23}}{1\text{mol}} \right. = 2.99\times10^{23}$

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

Q1. Calculate the number of hydrogen atom in 7.45 grams of glucose, $C_6H_{12}O_6$?

a) 2.99×10^{23} b) 4.49×10^{24} c) 2.51×10^{22}
d) 2.68×10^{-20} e) 0.496

Q2. The element oxygen consists of three naturally occurring isotopes: oxygen-16, oxygen-17, and oxygen-18. The atomic mass of oxygen is 16.00 amu. What can be implied about the relative abundances of these isotopes?

a) more than 50% of all O-atoms are oxygen-17
b) almost all O-atoms are oxygen-17
c) the isotopes all have about the same abundance
d) almost all O-atoms are oxygen-18
e) the abundance of oxygen-17 and oxygen-18 are very small

if avg mass ≈ mass of ^{16}O then abundance of ^{17}O and ^{18}O must be tiny!!

Q3. When the following equation is balanced, using the least set of whole numbers, what is the coefficient for O_2?

$$\_\_C_2H_6O(l) + \underline{3}\,O_2(g) \longrightarrow \underline{2}\,CO_2(g) + \underline{3}\,H_2O(l)$$

(Don't forget the 'O' already present in C_2H_6O)

a) 3 b) 4 c) 5 d) 6 e) 7

Q4. Phosphorus forms many oxoacids. Indicate the compound which has the lowest oxidation number for phosphorus:

a) HPO_3 (+1 +5 -2) b) H_3PO_3 (+1 +3 -2) c) $H_5P_3O_{10}$ (+1 +5 -2) d) $H_4P_2O_7$ (+1 +5 -2) e) H_3PO_4 (+1 +5 -2)

Q5. 15.0 mL of water is added to 25.0 mL of 12.0 M HCl(aq). What is the final concentration of HCl?

tot. vol after dilution = 40.0mL

a) 20.0 M b) 7.20 M c) 4.50 M d) 7.50 M e) 0.300 M $M_1V_1 = M_2V_2$

$M_2 = \frac{M_1V_1}{V_2} = \frac{12.0\text{M} \times 25.0\text{mL}}{40.0\text{mL}} = 7.50\text{M}$

Q6. Which of the following compounds will **not dissolve** in water?

a) Li_3PO_4 b) NH_4NO_3 c) $CaSO_4$
d) $(NH_4)_2SO_4$ e) Na_2CO_3

Q7. How many moles of NaOH are in 23.4 mLof a 0.475 M NaOH solution?

$23.4\text{mL} \left| \frac{1\text{L}}{1000\text{mL}} \right| \frac{0.475\text{ mol}}{1\text{L}} = 0.0111 \text{ mol NaOH}$

a) 0.00493 moles b) 11.1 moles c) 7.49 moles
d) 0.0111 moles e) 0.0203 moles

Q8. A gas at 600 K and 380 mmHg is contained in a flexible vessel. Its volume is halved, and the pressure remains unchanged. The temperature is:

a) 1200 K b) 600 K c) 300 K d) 150 K e) 75 K $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

if V_2 is $V_1 \times \frac{1}{2}$ then T_2 is $T_1 \times \frac{1}{2}$ for $\frac{V}{T}$ to be constant

Q9. The conditions corresponding to STP are:

a) 1 °C and 0 atm b) 760 mmHg and 25 °C c) 0°C and 1 atm
d) 0 K and 1 atm e) 1 K and 0 atm

Q10. Which law states that pressure is inversely proportional to the volume at constant temperature for a fixed amount of gas?

a) Charles's b) Boyle's c) Gay-Lussac's d) Dalton's e) Avogadro's

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.

Q11. [10 pts.] A compound was found to contain 58.07 % carbon, 3.249 % hydrogen, and 38.68 % oxygen by mass. Determine its empirical formula.

Assume 100 g

$$58.07\text{ g C} \left| \frac{1\text{ mol C}}{12.01\text{ g C}} \right| = 4.835\text{ mol C}$$

$$3.249\text{ g H} \left| \frac{1\text{ mol H}}{1.01\text{ g H}} \right| = 3.22\text{ mol H}$$

$$38.68\text{ g O} \left| \frac{1\text{ mol O}}{16.00\text{ g O}} \right| = 2.418\text{ mol O}$$

$\xrightarrow{\div\ 2.418\text{ mol}}$ 2.000 C, 1.33 H, 1.000 O $\xrightarrow{\times\ 3}$ 6C : 4H : 3O

or

$C_6H_4O_3$

Q12. [10 pts.] Complete and balance the following chemical equations. Be sure to include charges and state symbols wherever necessary.

Molecular: $2\,Li_3PO_4(aq) + 3\,Ca(NO_3)_2(aq) \longrightarrow Ca_3(PO_4)_2(s) + 6LiNO_3(aq)$

$Li^+\ PO_4^{3-}$ $Ca^{2+}\ NO_3^-$ $Ca^{2+}\ PO_4^{3-}$ $Li^+\ NO_3^-$

Full Ionic: $6Li^+(aq) + 2PO_4^{3-}(aq) + 3Ca^{2+}(aq) + 6NO_3^-(aq) \rightarrow Ca_3(PO_4)_2(s) + 6Li^+(aq) + 6NO_3^-(aq)$

Spectator Ions

Net Ionic: $3Ca^{2+}(aq) + 2PO_4^{3-}(aq) \longrightarrow Ca_3(PO_4)_2(s)$

Q13. [10 pts.] One commercial method used to peel potatoes is to soak them in a solution of NaOH for a short period of time, remove them and spray off the peel. The concentration of NaOH is normally in the range of 2 to 6 M. The NaOH is analyzed periodically. In one such analysis, 45.7 mL of 0.500 M H_2SO_4 is required to neutralize a 20.0 mL sample of NaOH solution. What is the concentration of the NaOH solution?

titration $H_2SO_4(aq) + 2NaOH(aq) \longrightarrow Na_2SO_4(aq) + 2H_2O(l)$.

$$[NaOH] = \frac{\#mol\ NaOH}{\#L\ NaOH}$$

0.0200 L (20.0 mL)

$$45.7\,mL \left|\frac{1\,L}{1000\,mL}\right| \left|\frac{0.500\,mol\ H_2SO_4}{1\,L}\right| \left|\frac{2\,mol\ NaOH}{1\,mol\ H_2SO_4}\right| = 0.0457\,mol\ NaOH$$

$$\Rightarrow [NaOH] = \frac{0.0457\,mol}{0.0200\,L} = 2.285\,M$$

Q14. [10 pts.] Assign oxidation numbers to every atom in the following chemical equation.

(0) (+2) (+6) (−2) (0) (+2) (+6) (−2)

$$Fe + CuSO_4 \longrightarrow Cu + FeSO_4$$

red ox

Which substance was oxidized? Fe (contained an atom whose ox # ↑)

Which substance was reduced? $CuSO_4$ (contained an atom whose ox # ↓)

Q15. [10 pts.] A student reacts benzene (C_6H_6) with bromine (Br_2) to yield bromobenzene (C_6H_5Br) and hydrogen bromide (HBr).

i) What is the theoretical yield of bromobenzene in this reaction if 30.0 g of benzene reacts with 65.0 g of bromine?

ii) What is the percent yield if the actual recovery of bromobenzene was 56.7 g?

chem eq: $C_6H_6 + Br_2 \longrightarrow C_6H_5Br + HBr$

Theoretical yield

← Limiting Reagent (LR)

(i) $30.0\,g\ C_6H_6 \times \frac{1\,mol\ C_6H_6}{78.06\,g\ C_6H_6} \times \frac{1\,mol\ C_6H_5Br}{1\,mol\ C_6H_6} \times \frac{157.0\,g\ C_6H_5Br}{1\,mol\ C_6H_5Br} = \boxed{60.3\,g\ C_6H_5Br}$

C_6H_6: $6\times C = 6\times 12.01$, $6\times H = 6\times 1.01$, 78.06

Excess Reagent (XS)

$65.0\,g\ Br_2 \times \frac{1\,mol\ Br_2}{159.8\,g\ Br_2} \times \frac{1\,mol\ C_6H_5Br}{1\,mol\ Br_2} \times \frac{157.0\,g\ C_6H_5Br}{1\,mol\ C_6H_5Br} = 63.9\,g\ C_6H_5Br$

Br_2: $2\times Br = 2\times 79.90$, 159.8

(ii) $\%\ yield = \frac{actual}{theoretical} \times 100 = \frac{56.7\,g}{60.3\,g} \times 100 = \boxed{94.0\%}$ 3 s.f.

C_6H_5Br: $6\times C = 6\times 12.01$, $5\times H = 5\times 1.01$, $1\times Br = 1\times 79.90$ } 157.0

Q16. [10 pts.] Hydrogen gas is collected into a 50 mL container at 32 °C by the following reaction of zinc metal with 60.0 mL of 0.100 M HCl? What is the pressure of the gas in the container?

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

$pV = nRT$

$\Rightarrow p = \frac{nRT}{V}$

n = #mol gas ($H_2(g)$)

$60.0\,mL \times \frac{1\,L}{1000\,mL} \times \frac{0.100\,mol\ HCl}{1\,L} \times \frac{1\,mol\ H_2(g)}{2\,mol\ HCl} = 0.00300\,mol\ H_2(g)$

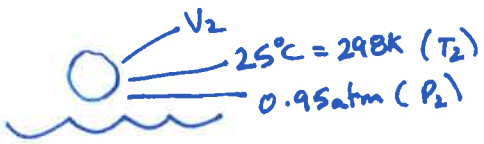
$T = 32 + 273.15 = 305\,K$ (od.p.)

$V = 50\,mL = 0.05\,L$ (1 s.f.)

$$\Rightarrow p = \frac{0.00300\,mol \times 0.0821\,\frac{atm \cdot L}{mol \cdot K} \times 305\,K}{0.05\,L}$$

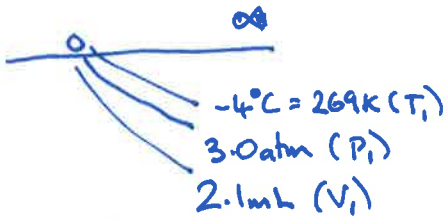
$= 1.5\,atm$ $\boxed{2\,atm}$ 1 s.f.

Q17. [10 pts.] A small bubble rises from the bottom of a lake, where the temperature and pressure are −4 °C and 3.0 atm, to the water's surface, where the temperature is 25 °C and the pressure is 0.95 atm. Calculate the final volume of the bubble if its initial volume was 2.1 mL.



$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

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



$$= \frac{3.0\text{atm} \times 2.1\text{mL} \times 298\text{K}}{269\text{K} \times 0.95\text{atm}}$$

$$= \boxed{7.3\text{mL}} \quad 2\text{s.f.}$$

BONUS: [3 pts.]

1.325 g sample of an unknown vapor occupies 368 mL at 114 °C and 946 mmHg. The empirical formula of the compound is NO_2. Determine the molecular formula of the compound.

$pV = nRT$

$n = m/M$

m = mass (g)

M = molar mass (g/mol)

$$\Rightarrow pV = \frac{mRT}{M}$$

$$\Rightarrow pM = \frac{m}{V} \cdot RT$$

$$pM = dRT$$

$$\Rightarrow M = \frac{dRT}{p}$$

$$d = \frac{1.325\text{g}}{0.368\text{L}} = 3.60\text{g/L}$$

$$p = 946\text{mmHg} \left| \frac{1\text{atm}}{760\text{mmHg}} \right| = 1.24\text{atm}$$

$$T = 114 + 273.15 = 387\text{K}$$

$$\Rightarrow M = \frac{3.60\text{g/L} \times 0.0821 \frac{\text{atm}\cdot\text{L}}{\text{mol}\cdot\text{K}} \times 387\text{K}}{1.24\text{atm}}$$

$$= 92.2\text{g/mol}$$

Empirical formula = NO_2

E.F. molar mass = $14.01 + 2 \times 16.00$

$= 46.01\text{g/mol}$

Since EF has $\frac{1}{2}$ × molar mass,

then molecular formula must be 2× as large as EF

$\Rightarrow 2 \times NO_2 = \boxed{N_2O_4}$

Useful Information:

$PV = nRT$ $\quad R = 0.0821 \frac{L\,atm}{mol\,K}$ $\quad P_i = X_i P_T$

$P_1V_1/T_1 = P_2V_2/T_2$ $\quad P_1V_1 = P_2V_2$ $\quad P_1/T_1 = P_2/T_2$ $\quad V_1/T_1 = V_2/T_2$

$N_A = 6.022 \times 10^{23}$ $\quad V_1/n_1 = V_2/n_2$

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

Soluble Compounds	Insoluble 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	**Soluble 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

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)

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Fall 2014
Exam 2B

Name: KEY

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Q11: _____/10

Q12: _____/10

Q13: _____/10

Q14: _____/10

Q15: _____/10

Q16: _____/10

Q17: _____/10

BONUS: _____/3

TOTAL: _____/100

See Exam 2A key for details

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

Q1. When the following equation is balanced, using the lowest set of whole numbers, what is the coefficient for O_2?

$$\_C_2H_6O(l) + \underline{3}O_2(g) \longrightarrow \underline{2}CO_2(g) + \underline{3}H_2O(l)$$

a) 4 b) 5 c) 7 d) 3 e) 6

Q2. Which of the following compounds will **not dissolve** in water?

a) $(NH_4)_2SO_4$ b) $CaSO_4$ c) NH_4NO_3
d) Li_3PO_4 e) Na_2CO_3

Q3. Calculate the number of hydrogen atom in 7.45 grams of glucose, $C_6H_{12}O_6$?

a) 2.99×10^{23} b) 4.49×10^{24} c) 2.51×10^{22}
d) 2.68×10^{-20} e) 0.496

Q4. Which law states that pressure is inversely proportional to the volume at constant temperature for a fixed amount of gas?

a) Charles's b) Gay-Lussac's c) Dalton's d) Avogadro's e) Boyle's

Q5. The element oxygen consists of three naturally occurring isotopes: oxygen-16, oxygen-17, and oxygen-18. The atomic mass of oxygen is 16.00 amu. What can be implied about the relative abundances of these isotopes?

a) almost all O-atoms are oxygen-17
b) almost all O-atoms are oxygen-18
c) the abundance of oxygen-17 and oxygen-18 are very small
d) the isotopes all have about the same abundance
e) more than 50% of all O-atoms are oxygen-17

Q6. Phosphorus forms many oxoacids. Indicate the compound which has the lowest oxidation number for phosphorus:

a) H_3PO_4 b) HPO_3 c) $H_5P_3O_{10}$ d) $H_4P_2O_7$ e) H_3PO_3

$V \propto T$

Q7. A gas at 600 K and 380 mmHg is contained in a flexible vessel. Its volume is halved, and the pressure remains unchanged. The temperature is:

a) 600 K b) 150 K c) 75 K d) 600 K e) 300 K

Q8. How many moles of NaOH are in 23.4 mL of a 0.475 M NaOH solution?

a) 0.0111 moles b) 7.49 moles c) 11.1 moles
d) 0.00493 moles e) 0.0203 moles

Q9. 15.0 mL of water is added to 25.0 mL of 12.0 M HCl(aq). What is the final concentration of HCl?

a) 20.0 M b) 7.50 M c) 0.300 M d) 7.20 M e) 4.50 M

Q10. The conditions corresponding to STP are:

a) 760 mmHg and 25 °C b) 1 °C and 0 atm c) 0 K and 1 atm
d) 0 °C and 1 atm e) 1 K and 0 atm

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.

Q11. [10 pts.] A student reacts benzene (C_6H_6) with bromine (Br_2) to yield bromobenzene (C_6H_5Br) and hydrogen bromide (HBr).

i) What is the theoretical yield of bromobenzene in this reaction if 45.5 g of benzene reacts with 40.3 g of bromine?

eq: $C_6H_6 + Br_2 \longrightarrow C_6H_5Br + HBr$

ii) What is the percent yield if the actual recovery of bromobenzene was 16.9 g?

Excess Reagent (XS)

$$45.5\text{g } C_6H_6 \left| \frac{1\text{ mol } C_6H_6}{78.06\text{g } C_6H_6} \right| \frac{1\text{mol } C_6H_5Br}{1\text{mol } C_6H_6} \left| \frac{157.0\text{g } C_6H_5Br}{1\text{mol } C_6H_5Br} \right| = 91.5\text{g } C_6H_5Br$$

limiting reagent (LR)

$$40.3\text{g } Br_2 \left| \frac{1\text{mol } Br_2}{159.8\text{g } Br_2} \right| \frac{1\text{mol } C_6H_5Br}{1\text{mol } Br_2} \left| \frac{157.0\text{g } C_6H_5Br}{1\text{mol } C_6H_5Br} \right| = \boxed{39.6\text{g } C_6H_5Br}$$

theoretical yield

Q12. [10 pts.] Tums ® is an antacid made of mostly $CaCO_3$ (calcium carbonate) and is taken to neutralize stomach acid, HCl (hydrochloric acid). An average person has roughly 60.0 mL of 0.10 M HCl in their stomachs. If this average person takes enough antacid to completely neutralize all the acid within their stomach, what volume of CO_2 (g) will be produced? Assume 760 torr and body temperature of 37 °C.

$CaCO_3\,(aq) + 2\,HCl\,(aq) \longrightarrow CaCl_2\,(aq) + CO_2\,(g) + H_2O\,(l)$

$pV = nRT$; CO_2

$V = \frac{nRT}{P}$; $n = \#\text{mol GAS}$

$p = 760\text{ torr} = 1.0\text{ atm}$

$T = 37 + 273.15 = 310.\text{K}$

$$60.0\text{mL} \left| \frac{1\text{L}}{1000\text{mL}} \right| \frac{0.10\text{mol HCl}}{1\text{L}} \left| \frac{1\text{mol } CO_2}{2\text{mol HCl}} \right| = 0.0030\text{mol } CO_2(g)$$

$$\Rightarrow V = \frac{0.0030\text{mol} \times 0.0821 \frac{\text{atm}\cdot\text{L}}{\text{mol}\cdot\text{K}} \times 310\text{K}}{1.0\text{ atm}} = \boxed{0.076\text{L}}$$

or 76mL

Q13. [10 pts.] Ibuprofen has the following composition: 75.69% C, 8.80% H, and 15.51% O by mass. Determine its empirical formula.

Assume 100g sample:

$75.69\text{g C} \left| \frac{1\text{ mol C}}{12.01\text{g C}} \right| = 6.302\text{mol C}$

$8.80\text{g H} \left| \frac{1\text{mol H}}{1.01\text{g H}} \right| = 8.71\text{mol H}$

$15.51\text{g O} \left| \frac{1\text{mol O}}{16.00\text{g O}} \right| = 0.9694\text{mol O}$

$\div$ 0.9694 mol

6.501 C → ≈ 13 C

8.98 H → ≈ 18 H

1.00 'O' → 2 'O'

$\times 2$

$\Rightarrow C_{13}H_{18}O_2$

Q14. [10 pts.] Complete and balance the following chemical equations. Be sure to include charges and state symbols wherever necessary.

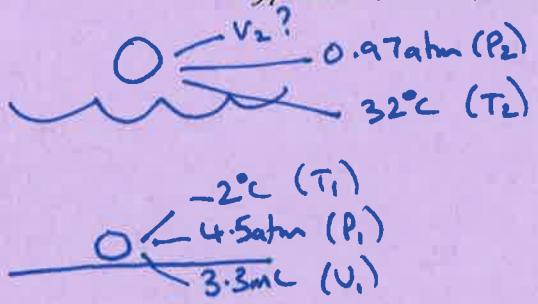
Molecular: $2\,(NH_4)_3PO_4(aq) + 3\,CaCl_2(aq) \longrightarrow Ca_3(PO_4)_2(s) + 6NH_4Cl(aq)$

Full Ionic: $6NH_4^+(aq) + 2PO_4^{3-}(aq) + 3Ca^{2+}(aq) + 6Cl^-(aq) \longrightarrow Ca_3(PO_4)_2(s) + 6NH_4^+(aq) + 6Cl^-(aq)$

Spectator ion

Net Ionic: $3Ca^{2+}(aq) + 2PO_4^{3-}(aq) \longrightarrow Ca_3(PO_4)_2(s)$

Q15. [10 pts.] A small bubble rises from the bottom of the ocean, where the temperature and pressure are −2 °C and 4.5 atm, to the water's surface, where the temperature is 32 °C and the pressure is 0.97 atm. Calculate the final volume of the bubble if its initial volume was 3.3 mL.



$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

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

$T_1 = -2 + 273.15 = 271\,K$

$T_2 = 32 + 273.15 = 305\,K$

$$= \frac{4.5\,atm \times 3.3\,mL \times 305\,K}{271\,K \times 0.97\,atm}$$

$$= \boxed{17\,mL} \quad 2\,sf.$$

Q16. [10 pts.] One commercial method used to peel potatoes is to soak them in a solution of NaOH for a short period of time, remove them and spray off the peel. The concentration of NaOH is normally in the range of 2 to 6 M. The NaOH is analyzed periodically. In one such analysis, 43.8 mL of 0.750 M H_2SO_4 is required to neutralize a 18.0 mL sample of NaOH solution. What is the concentration of the NaOH solution?

titration! chem eq: $H_2SO_4(aq) + 2NaOH(aq) \longrightarrow Na_2SO_4(aq) + 2H_2O$

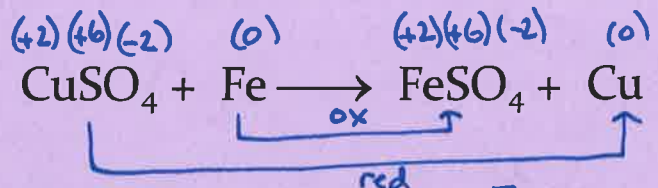
$$[NaOH] = \frac{\#\,mol\ NaOH\ (?)}{\#\,L\ NaOH}$$

$0.0180\,L\ (18.0\,mL)$

$$43.8\,mL \left|\frac{1\,L}{1000\,mL}\right| \frac{0.750\,mol\ H_2SO_4}{1\,L} \left|\frac{2\,mol\ NaOH}{1\,mol\ H_2SO_4}\right| = 0.0657\,mol\ NaOH$$

$$\Rightarrow [NaOH] = \frac{0.0657\,mol}{0.0180\,L} = \boxed{3.65\,M}$$

Q17. [10 pts.] Assign oxidation numbers to every atom in the following chemical equation.



Which substance was oxidized? Fe

Which substance was reduced? $CuSO_4$

BONUS: [3 pts.]

1.325 g sample of an unknown vapor occupies 368 mL at 114 °C and 946 mmHg. The empirical formula of the compound is NO_2. Determine the molecular formula of the compound.

See exam 2A.

Useful Information: $PV = nRT$ $R = 0.0821 \frac{L\ atm}{mol\ K}$ $P_i = X_i P_T$

$P_1V_1/T_1 = P_2V_2/T_2$ $P_1V_1 = P_2V_2$ $P_1/T_1 = P_2/T_2$ $V_1/T_1 = V_2/T_2$

$N_A = 6.022 \times 10^{23}$ $V_1/n_1 = V_2/n_2$

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

Soluble Compounds	Insoluble 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	**Soluble 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

Periodic Table

1 IA																	18 VIIIA
1 H 1.01	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	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)