The Periodic Table of the Elements

1 **H** Hydrogen 1.00794																	2 **He** Helium 4.003
3 **Li** Lithium 6.941	4 **Be** Beryllium 9.012182											5 **B** Boron 10.811	6 **C** Carbon 12.0107	7 **N** Nitrogen 14.00674	8 **O** Oxygen 15.9994	9 **F** Fluorine 18.9984032	10 **Ne** Neon 20.1797
11 **Na** Sodium 22.989770	12 **Mg** Magnesium 24.3050											13 **Al** Aluminum 26.981538	14 **Si** Silicon 28.0855	15 **P** Phosphorus 30.973761	16 **S** Sulfur 32.066	17 **Cl** Chlorine 35.4527	18 **Ar** Argon 39.948
19 **K** Potassium 39.0983	20 **Ca** Calcium 40.078	21 **Sc** Scandium 44.955910	22 **Ti** Titanium 47.867	23 **V** Vanadium 50.9415	24 **Cr** Chromium 51.9961	25 **Mn** Manganese 54.938049	26 **Fe** Iron 55.845	27 **Co** Cobalt 58.933200	28 **Ni** Nickel 58.6934	29 **Cu** Copper 63.546	30 **Zn** Zinc 65.39	31 **Ga** Gallium 69.723	32 **Ge** Germanium 72.61	33 **As** Arsenic 74.92160	34 **Se** Selenium 78.96	35 **Br** Bromine 79.904	36 **Kr** Krypton 83.80
37 **Rb** Rubidium 85.4678	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.90585	40 **Zr** Zirconium 91.224	41 **Nb** Niobium 92.90638	42 **Mo** Molybdenum 95.94	43 **Tc** Technetium (98)	44 **Ru** Ruthenium 101.07	45 **Rh** Rhodium 102.90550	46 **Pd** Palladium 106.42	47 **Ag** Silver 107.8682	48 **Cd** Cadmium 112.411	49 **In** Indium 114.818	50 **Sn** Tin 118.710	51 **Sb** Antimony 121.760	52 **Te** Tellurium 127.60	53 **I** Iodine 126.90447	54 **Xe** Xenon 131.29
55 **Cs** Cesium 132.90545	56 **Ba** Barium 137.327	57 **La** Lanthanum 138.9055	72 **Hf** Hafnium 178.49	73 **Ta** Tantalum 180.9479	74 **W** Tungsten 183.84	75 **Re** Rhenium 186.207	76 **Os** Osmium 190.23	77 **Ir** Iridium 192.217	78 **Pt** Platinum 195.078	79 **Au** Gold 196.96655	80 **Hg** Mercury 200.59	81 **Tl** Thallium 204.3833	82 **Pb** Lead 207.2	83 **Bi** Bismuth 208.98038	84 **Po** Polonium (209)	85 **At** Astatine (210)	86 **Rn** Radon (222)
87 **Fr** Francium (223)	88 **Ra** Radium (226)	89 **Ac** Actinium (227)	104 **Rf** Rutherfordium (261)	105 **Db** Dubnium (262)	106 **Sg** Seaborgium (263)	107 **Bh** Bohrium (262)	108 **Hs** Hassium (265)	109 **Mt** Meitnerium (266)	110 (269)	111 (272)	112 (277)	113	114				

58 **Ce** Cerium 140.116	59 **Pr** Praseodymium 140.90765	60 **Nd** Neodymium 144.24	61 **Pm** Promethium (145)	62 **Sm** Samarium 150.36	63 **Eu** Europium 151.964	64 **Gd** Gadolinium 157.25	65 **Tb** Terbium 158.92534	66 **Dy** Dysprosium 162.50	67 **Ho** Holmium 164.93032	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.93421	70 **Yb** Ytterbium 173.04	71 **Lu** Lutetium 174.967
90 **Th** Thorium 232.0381	91 **Pa** Protactinium 231.03588	92 **U** Uranium 238.0289	93 **Np** Neptunium (237)	94 **Pu** Plutonium (244)	95 **Am** Americium (243)	96 **Cm** Curium (247)	97 **Bk** Berkelium (247)	98 **Cf** Californium (251)	99 **Es** Einsteinium (252)	100 **Fm** Fermium (257)	101 **Md** Mendelevium (258)	102 **No** Nobelium (259)	103 **Lr** Lawrencium (262)

1995 IUPAC masses and Approved Names from http://www.chem.qmw.ac.uk/iupac/AtWt/
masses for 107-111 from C&EN, March 13, 1995, p 35
112 from http://www.gsi.de/z112e.html

TABLE 4.1 Solubility Rules for Ionic Compounds in Water

Compounds Containing the Following Ions Are Generally Soluble	Exceptions
Li^+, Na^+, K^+, and NH_4^+	None
NO_3^- and $C_2H_3O_2^-$	None
Cl^-, Br^-, and I^-	When these ions pair with Ag^+, Hg_2^{2+}, or Pb^{2+}, the resulting compounds are insoluble.
SO_4^{2-}	When SO_4^{2-} pairs with Sr^{2+}, Ba^{2+}, Pb^{2+}, Ag^+, or Ca^{2+}, the resulting compound is insoluble.
Compounds Containing the Following Ions Are Generally Insoluble	**Exceptions**
OH^- and S^{2-}	When these ions pair with Li^+, Na^+, K^+, or NH_4^+, the resulting compounds are soluble.
	When S^{2-} pairs with Ca^{2+}, Sr^{2+}, or Ba^{2+}, the resulting compound is soluble.
	When OH^- pairs with Ca^{2+}, Sr^{2+}, or Ba^{2+}, the resulting compound is slightly soluble.
CO_3^{2-} and PO_4^{3-}	When these ions pair with Li^+, Na^+, K^+, or NH_4^+, the resulting compounds are soluble.

$PV = nRT$

$q = mC\Delta T$

$R = .08206 \frac{L \cdot atm}{mol \cdot K}$

$K = °C + 273$

NAME Key

F2018/CHEM1450/Exam 4

December 6, 2018

Multiple Choice: Write the letter that corresponds to the correct answer in the blank provided to the left of each problem. (3 Points Each)

A **1. According to the following Complete Ionic Equation, list the spectator ion(s).**

$2\ Na^+(aq) + CO_3^{2-}(aq) + Cu^{2+}(aq) + 2Cl^-(aq) \rightarrow CuCO_3(s) + 2Na^+(aq) + 2\ Cl^-(aq)$

a. Na^+ and Cl^-
b. Na^+ and CO_3^{2-}
c. Cl^- only
d. Cu^{2+} and CO_3^{2-}
e. none of the above

C **2. Which of the following is <u>NOT</u> a strong electrolyte?**

a. LiOH
b. CaCl2
c. MgCO3
d. NaC2H3O2
e. Li2SO4

insoluble

These should all be subscripted! sorry!

$CaCl_2$ $MgCO_3$ $NaC_2H_3O_2$ Li_2SO_4

B **3. What precipitate is most likely formed from a solution containing Ba^{+2}, Na^{+1}, OH^{-1}, and $CO3^{-2}$.**

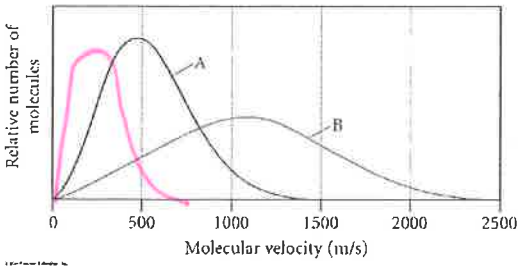
a. NaOH
b. $BaCO_3$
c. Na_2CO_3
d. $Ba(OH)_2$
e. There will not be a precipitate formed.

B **4. When the number of moles of gas present and the volume of the container remain constant, what happens to the pressure of a gas sample when the temperature is decreased?**

a. The pressure increases.
b. The pressure decreases.
c. The pressure stays the same.
d. It depends on the gas inside the sample
e. none of the above

P↑ T↑

A 5. **The graph shows the distribution of molecular velocities for two different molecules (A and B) at the same temperature. A third molecule, Molecule C, has a larger molar mass than A and B. Describe the position of the peak of the velocity distribution of Molecule C at this same temperature.**



a. The peak will be to the left of Molecule A.
b. The peak will be between that of Molecules A and B.
c. The peak will be to the right of Molecule B.
d. The peak is so far to the right of Molecule B, it can't be placed on the graph
e. You cannot determine this from the graph.

A 6. **A container has an initial volume of 2.75L which is filled with air at 1.05 atm. Without changing the temperature or amount of gas in the container, how would you increase the pressure to 1.85atm?**

a. Decrease the volume of the container to 1.56L
b. Decrease the volume of the container to 0.706L
c. Increase the volume of the container to 4.85L
d. Increase the volume of the container to 5.34L
e. none of the above

$P_1V_1 = P_2V_2$

$V_2 =$

A 7. **Which of the following processes is endothermic?**

a. the boiling of water
b. water freezing into ice
c. a neutralization reaction that warms the surroundings
d. melted chocolate hardening in a mold
e. more than one of the above

Heat in

B 8. **If a chemical reaction has a $\Delta H_{rxn} = +462kJ$, what do you know about the reaction?**

a. overall, the bonds of the products are more stable than the reactants
b. overall, the bonds of the products are less stable than the reactants
c. there are more bonds broken than made
d. no bonds were broken, only bonds were formed in the reaction
e. none of the above

C 9. **Calculate the change internal energy (ΔE) for a system that is giving off 45.0 kJ of heat and is performing 855 J of work on the surroundings.**

a. 44.1 kJ
b. -44.1 kJ
c. -45.9 kJ
d. 9.00 x 102 kJ
e. -9.00 x 102 kJ

A 10. **Which of the following (with specific heat capacity provided) would show the smallest temperature change upon gaining 200.0 J of heat?**

a. 50.0 g Al, C_{Al} = 0.903 J/g°C ← largest C + m
b. 50.0 g Cu, C_{Cu} = 0.385 J/g°C
c. 25.0 g granite, $C_{granite}$ = 0.79 J/g°C ←
d. 25.0 g Au, C_{Au} = 0.128 J/g°C
e. 25.0 g Ag, C_{Ag} = 0.235 J/g°C

B 11. **Calculate the amount of heat (in kJ) required to raise the temperature of a 79.0 g sample of ethanol from 298.0 K to 385.0 K. The specific heat capacity of ethanol is 2.42 J/g°C.**

a. 57.0 kJ
b. 16.6 kJ
c. 73.6 kJ
d. 28.4 kJ
e. 12.9 kJ

$q = 79.0g \cdot 2.42 \cdot 87K$

D 12. **Choose the reaction that illustrates $\Delta H°_f$ for $NaHCO_3$.**

a. $Na(s) + H_2(g) + C(s) + O_2(g) \rightarrow NaHCO_3(s)$
b. $Na^+(aq) + HCO_3^{-1}(aq) \rightarrow NaHCO_3(s)$
c. $Na^+(aq) + H2O(l) + CO_2(g) \rightarrow NaHCO_3(s)$
d. $Na(s) + 1/2\ H_2(g) + C(s) + 3/2\ O_2(g) \rightarrow NaHCO_3(s)$
e. $Na(s) + 2\ H(g) + C(s) + 3\ O(g) \rightarrow NaHCO_3(s)$

Short Answer/Problems: Show your work where needed. If no work or reasoning is given but is necessary, no credit will be given.

1. Write the **balanced <u>complete</u> ionic equation with phases** for the following balanced molecular equation:

$$2\ HNO_3(aq) + K_2S(aq) \rightarrow H_2S(g) + 2\ KNO_3(aq)$$

Complete Ionic Equation: (8 Points)
$4H^+(aq) + 2NO_3^-(aq) + 2K^+(aq) + S^{2-}(aq) \longrightarrow$ or $2H^+(aq)$ $H_2S(g) + 2K^+(aq) + 2NO_3^-(aq)$ Because of the typo, I didn't count off for coeff. for these 2 ions

2. Complete the reactions below. You **DO NOT** need to balance the equations. You **DO** need to include phases for each product!

   a. (4 Points) aqueous calcium nitrate reacts with aqueous magnesium sulfate

$$Ca(NO_3)_2(aq) + MgSO_4(aq) \rightarrow Mg(NO_3)_2(aq) + CaSO_4(s)$$

   b. (4 Points) $Mg(s) + O_2(g) \rightarrow$ $MgO(s)$ -3 if $MgO_2(s)$ -4 if $MgO(aq)$

   c. (4 Points) $NH_4Cl(aq) + KOH(aq) \rightarrow$ $NH_4OH(aq) + KCl(aq)$ (-2 if left this way)

$$\downarrow$$

$$NH_3(g) + H_2O(l) + KCl(aq)$$

3. (8 Points) Use the reaction below to complete the following questions:

$$2\ ZnS\ (s) + 3\ O_2\ (g) \rightarrow 2\ ZnO\ (s) + 2\ SO_2\ (g)$$

+2 -2 0 +2 -2 +4 -2

OIL RIG

a. What is the oxidation number for Zn in ZnS? +2

b. What is the oxidation number for S in SO_2? +4

c. Which element is oxidized? S

d. Which element is reduced? O

4. (10 Points) Sulfuric acid reacts with lithium sulfide according to the following balanced reaction:

$$H_2SO_4(aq) + Li_2S(aq) \rightarrow H_2S(g) + Li_2SO_4(aq)$$

What volume of 0.125M H_2SO_4 is needed to produce 58.5 mL of H_2S at 273K and 1.00atm?

$$n_{H_2S} = \frac{PV}{RT} = \frac{1.00atm \cdot .0585L}{.08206 \cdot 273K} = .00261mol\ H_2S$$

used mL (-2)

(+5)

$$.00261mol\ H_2S \left(\frac{1mol\ H_2SO_4}{1mol\ H_2S}\right)\left(\frac{1L}{.125mol\ H_2SO_4}\right) = .0209L\ H_2SO_4$$

(-3) (-2)

or 20.9mL

164 + 40r 6

2.8mL = 0 pts

5. (6 Points) A 21.8 g sample of ethanol (C_2H_5OH) is burned according to the following reaction. The molar mass of ethanol is 46.07 g/mol. How much heat is released from this reaction?

$C_2H_5OH(l) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 3\ H_2O(g) \quad \Delta H°_{rxn} = -1235\ kJ$

$21.8\,g\,C_2H_5OH\left(\frac{1\,mol}{46.07\,g}\right)\left(\frac{1235\,kJ}{1\,mol\,C_2H_5OH}\right) = 584.4\,kJ$ Released

(4 Points) The heat generated from the reaction above is used to heat a water sample. How much water in grams would I be able to heat from 20°C to 50°C with that energy?

$q = 584.4\,kJ = 5.84\times10^{6}\,J = m(4.18\,J/g\cdot°C)(30°C)$

$m = 4.66\times10^{3}\,g\,H_2O$

↑ ~5L of H_2O!

6. (8 Points) Given the following equations and $\Delta H°$ values, determine the heat of reaction (kJ) at 298 K for the reaction:

$B_2H_6(g) + 6\ Cl_2(g) \rightarrow 2\ BCl_3(g) + 6\ HCl(g)$

$BCl_3(g) + 3\ H_2O(l) \rightarrow H_3BO_3(g) + 3\ HCl(g) \quad \Delta H° = -112.5\,kJ$

$B_2H_6(g) + 6\ H_2O(l) \rightarrow 2\ H_3BO_3(s) + 6\ H_2(g) \quad \Delta H° = -493.4\,kJ$

$1/2\ H_2(g) + 1/2\ Cl_2(g) \rightarrow HCl(g) \quad \Delta H° = -92.3\,kJ$

-268.4

RXN 1 flip ×2 : $2H_3BO_3 + 6HCl \rightarrow 2BCl_3 + 6H_2O \quad \Delta H = (112.5\times2)$

RXN 2 : $B_2H_6 + 6H_2O \rightarrow 2H_3BO_3 + 6H_2 \quad \Delta H = -493.4$

RXN 3 ×12 : $6H_2 + 6Cl_2 \rightarrow 12HCl \quad \Delta H = -92.3\times12$

$B_2H_6 + 6Cl_2 \rightarrow 2BCl_3 + 6HCl \quad \Delta H = -1376\,kJ$

-2 units

7. (8 Points) Use the information provided to determine $\Delta H°_{rxn}$ for the following reaction:

$CH_4(g) + 4\ Cl_2(g) \rightarrow CCl_4(g) + 4\ HCl(g)$ $\Delta H°_{rxn} = ?$

$Cl_2(s) \rightarrow Cl_2(g)$ $\Delta H_f° = 0\ kJ/mol$

	$\Delta H°_f$ (kJ/mol)
$CH_4(g)$	-75
$CCl_4(g)$	-96
$HCl(g)$	-92

$$\sum \Delta H_f°(P) - \sum \Delta H_f°(R)$$

$$[4(-92kJ) + (-96kJ)] - [-75kJ]$$

$$= \boxed{-389kJ}$$