PRE AP CHEMISTRY REVIEW PROBLEMS Name:_____

Due the 3rd of class, January 26th, 2018

The following are problems that students entering AP Chemistry are expected to solve and answer without difficulty. You may use a scientific calculator. A periodic table and other helpful information are provided on the last page. If you are finding the need to refer to a textbook or other resources (e.g. notes or a tutor), or are spending an enormous amount of time on any problem, please review that topic thoroughly and seek assistance **BEFORE THE START OF CLASS**. Answer any explanation questions briefly using appropriate vocabulary. Complete work for computational problems should be shown, including with equation shown (if using a formula), all units shown for computations, and boxed answers with the correct number of significant figures. **THIS ASSIGNMENT WILL BE DUE THE THIRD DAY OF CLASS AS YOU WALK IN THE DOOR. IF YOU ARE UNABLE OR UNWILLING TO COMPLETE THIS ASSIGNMENT YOU SHOULD NOT ENROLL IN THE COURSE.**

NON COLLEGE BOARD (as in you do not get these for the AP Examination) REFERENCES

Solubility Rules - MUST BE MEMORIZED!!!

Always Soluble:

- alkali (Group I) ions; NH_4^+, NO_3^-, ClO_3^-, ClO_4^-, $C_2H_3O_2^-$, HCO_3^-

Generally Soluble:

- Cl^-, Br^-, I^- — Soluble except with Ag^+, Pb^{2+}, Hg_2^{2+}
- F^- — Soluble except with Pb^{2+}, Ca^{2+}, Ba^{2+}, Sr^{2+}, Mg^{2+}
- SO_4^{2-} — Soluble except with Pb^{2+}, Hg_2^{2+}, Ca^{2+}, Ba^{2+}, Sr^{2+}

Generally Inoluble:

- O^{2-}, OH^- — Insoluble except with Ca^{2+}, Ba^{2+}, Sr^{2+}, alkali ions, NH_4^+
- CO_3^{2-}, PO_4^{3-}, S^{2-} SO_3^{2-}, CrO_4^{2-}, $C_2O_4^{2-}$ — Insoluble except alkali ions and NH_4^+

Strong Acids (7) – MUST BE MEMORIZED!!!

HCl, HBr, HI

HNO_3, H_2SO_4, $HClO_3$, $HClO_4$

Gases that Form – MUST BE MEMORIZED!!!

- $\rightarrow H_2S_{(g)}$
- $\rightarrow H_2CO_{3\,(aq)} \rightarrow CO_{2\,(g)} + H_2O_{(l)}$
- $\rightarrow H_2SO_{3\,(aq)} \rightarrow SO_{2\,(g)} + H_2O_{(l)}$
- $\rightarrow NH_4OH_{(aq)} \rightarrow NH_{3\,(g)} + H_2O_{(l)}$

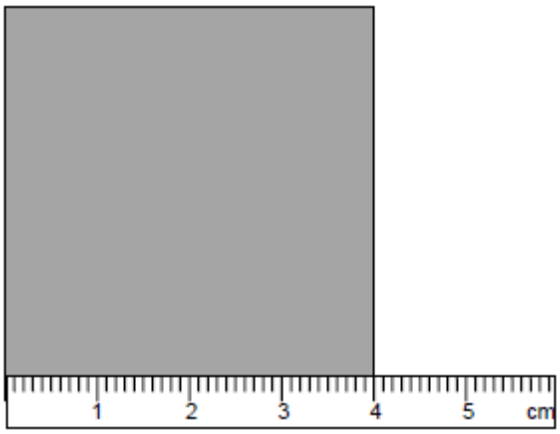
COMMON MONATOMIC ION LIST – Review HOW to get these from a PT

Aluminum	Al^{3+}	Iron (II)	Fe^{2+}	Nitride	N^{3-}
Barium	Ba^{2+}	Fluoride	F^-	Oxide	O^{2-}
Bromide	Br^-	Hydrogen	H^+	Phosphide	P^{3-}
Cadmium	Cd^{2+}	Hydride	H^-	Potassium	K^+
Calcium	Ca^{2+}	Iodide	I^-	Silver	Ag^+
Chloride	Cl^-	Lead (II)	Pb^{2+}	Sodium	Na^+
Chromium (VI)	Cr^{6+}	Lead (IV)	Pb^{4+}	Strontium	Sr^{2+}
Chromium (III)	Cr^{3+}	Lithium	Li^+	Sulfide	S^{2-}
Chromium (II)	Cr^{2+}	Magnesium	Mg^{2+}	Tin (IV)	Sn^{4+}
Cobalt (II)	Co^{2+}	Manganese (VII)	Mn^{7+}	Tin (II)	Sn^{2+}
Copper (II)	Cu^{2+}	Manganese (II)	Mn^{2+}	Titanium (II)	Ti^{2+}
Copper (I)	Cu^+	Mercury (I)	Hg_2^{2+}	Strontium	Sr^{2+}
Iodide	I^-	Mercury (II)	Hg^{2+}	Sulfide	S^{2-}
Iron (III)	Fe^{3+}	Nickel (II)	Ni^{2+}	Zinc	Zn^{2+}

COMMON POLYATOMIC ION LIST – MUST BE MEMORIZED!!! – KNOW the Systems

Acetate	$C_2H_3O_2^-$		Chromate	CrO_4^{2-}		Nitrite	NO_2^-
Ammonium	NH_4^+	*** cation**	Cyanide	CN^-		Oxalate	$C_2O_4^{2-}$
Bicarbonate	HCO_3^-		Dichromate	$Cr_2O_7^{2-}$		Perbromate	BrO_4^-
Bicarbonite	HCO_2^-		Hydronium	H_3O^+	*** cation**	Perchlorate	ClO_4^-
Bisulfate	HSO_4^-		Hydroxide	OH^-		Periodiate	IO_4^-
Bisulfide	HS^-		Hypobromite	BrO^-		Permangante	MnO_4^-
Bisulfite	HSO_3^-		Hypochlorite	ClO^-		Peroxide	O_2^{2-}
Bromate	BrO_3^-		Hypoiodite	IO^-		Phosphate	PO_4^{3-}
Bromite	BrO_2^-		Iodate	IO_3^-		Phosphite	PO_3^{3-}
Carbonate	CO_3^{2-}		Iodite	IO_2^-		Thiocyanate	SCN^-
Carbonite	CO_2^{2-}		Nitrate	NO_3^-		Thiosulfate	$S_2O_3^{2-}$

Topic 1 – Foundations of Chemistry



1. The side of a 169.3 g aluminum cube was measured by Group A with the ruler shown on the right.
   a. Record the measurement of the side of the cube.
   b. In the measurement in part a, circle the uncertain digit. Explain why that is the uncertain digit.
   c. Calculate the density of the aluminum cube. (Volume = $(\text{side})^3$)
   d. Convert the density calculated in part c to units of lb/ft^3. (1 kg = 2.2046 lb, 1 ft = 12 in, 1 in = 2.54 cm)
   e. If the accepted density of aluminum is 167 lb/ft^3, calculate the percent error of your calculated density.
   f. Group B determined the density of the aluminum block to be 164 lb/ft^3. Describe the accuracy and precision of this calculation, compared to that of Group A.
2. Suppose the figure in problem 1 shows the measurement of a square sheet of aluminum foil with a mass of 1.90×10^{-3} lb. Find the thickness of the aluminum foil in mm. Write your answer in scientific notation. (Use density of aluminum = 167 lb/ft^3 from part 1 part d.)

Topic 2 – Atomic Theory and Structure

3. Complete the following table:

Isotope	Atomic Number	Mass Number	Protons	Neutrons	Electrons	Charge
$^{63}Ni^{2+}$						
		32		17		–3
		1			0	
			38	51	36	

4. There are two naturally occurring isotopes of gallium: Ga-69 (mass = 68.92557 amu) and Ga-71 (mass = 70.92470 amu). If the atomic mass of gallium is 69.723 amu, find the percent abundance of each isotope.
5. Of the elements on the periodic table, list:
   a. The diatomic elements. (7) b. The elements that naturally exist as liquids: (2) c. The elements that naturally exist as gases: (11)
6. On the periodic table below, identify by shading and labeling the:
   a. alkali metals
   b. inner-transition metals
   c. other non-metals
   d. alkaline earth metals
   e. noble gases
   f. semi-metals
   g. halogens
   h. other metals
   i. transition metals

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn						

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

7. Write the formulas for the following ions. Remember charge # is $\mathbf{X}^{\#\,+/-}$ (USE YOUR PT BUT NO OTHER RESOURCE.)

a) hypobromite _____
b) hydrogen _____
c) dichromate _____
d) iodate _____
e) thiocyanate _____
f) nitrate _____
g) permanganate _____
h) perbromate _____
i) bromate _____
j) sodium _____
k) nitrite _____
l) bicarbonate _____
m) ammonium _____
n) hypoiodite _____
o) chromate _____
p) bisulfate _____
q) nickel (II) _____
r) hydronium _____
s) phosphite _____
t) chlorate _____
u) peroxide _____
v) iodite _____
w) tin (IV) _____
x) iron(III) _____
y) silver _____
z) oxide _____
aa) chloride _____
bb) copper (I) _____
cc) fluoride _____
dd) strontium _____
ee) phosphate _____
ff) cyanide _____
gg) periodate _____
hh) iodide _____
ii) thiosulfate _____
jj) potassium _____
kk) sulfite _____
ll) hydroxide _____
mm) chlorite _____
nn) lithium _____
oo) mercury (II) _____
pp) iron (II) _____
qq) calcium _____
rr) copper (II) _____
ss) bromide _____
tt) sulfide _____
uu) hypochlorite _____
vv) perchlorate _____
ww) acetate _____
xx) lead (IV) _____
yy) sulfate _____
zz) mercury (I) _____
aaa) tin(II) _____
bbb) zinc _____
ccc) bromite _____
ddd) lead(II) _____
eee) barium _____
fff) aluminum _____
ggg) carbonate _____
hhh) magnesium _____

8. For each of the following compounds, classify it as an Ionic **(= I)**, Compound **(= C)**, or Acidic Compound **(= A)**. Then write its name.

a) H_2SO_4 ____ _____
b) $LiNO_3$ ____ _____
c) Na_2S ____ _____
d) Fe_2O_3 ____ _____
e) $Pb(BrO_3)_2$ ____ _____
f) P_4O_{10} ____ _____
g) $BaBr_2$ ____ _____
h) HBr ____ _____
i) CaO ____ _____
j) $Zn(C_2H_3O_2)_2$ ____ _____
k) HNO_2 ____ _____
l) CuI ____ _____
m) N_2O ____ _____
n) $KClO_3$ ____ _____
o) H_3PO_3 ____ _____
p) PCl_5 ____ _____
q) $HBrO_4$ ____ _____
r) $Al_2(CO_3)_3$ ____ _____
s) Na_2SO_3 ____ _____
t) Hg_2Cl_2 ____ _____
u) SO_3 ____ _____
v) Cs_2O_2 ____ _____
w) $Sn_3(PO_3)_2$ ____ _____

9. For each of the following compounds, classify it as an Ionic **(= I)**, Compound **(= C)**, or Acidic Compound **(= A)**. Then write its formula:

a) hydrofluoric acid _____
b) silver nitrate _____
c) copper (II) cyanide _____
d) aluminum oxide _____
e) potassium dichromate _____
f) sulfurous acid _____
g) dinitrogen tetroxide _____
h) carbonic acid _____
i) hypobromous acid _____
j) manganese(IV) oxide _____
k) cobalt(III) sulfate _____
l) lithium bicarbonate _____
m) tin (IV) oxide _____
n) perioidic acid _____
o) iodine heptafluoride _____
p) oxygen difluoride _____
q) rubidium chloride _____
r) hydrocyanic acid _____
s) lead (IV) bromide _____
t) ammonium carbonate _____
u) magnesium fluoride _____
v) chromium(III) chloride _____
w) chlorous acid _____
x) potassium iodide _____

10. For each of the following compounds, calculate the % composition by mass of each element in the compound, and its molar mass.

a. diboron trioxide b. ammonium nitrate c. mercury (I) phosphate d. calcium acetate

11. Find the following.

a. How many moles are in a 3.55×10^{24} molecule sample of O_3?

b. What is the mass of a 12.5 L sample of nitrogen gas at STP?

c. What is the mass in grams of a 0.72 mol sample of sulfur dioxide?

d. How many moles are in a 30.5 L sample of carbon dioxide gas at STP?

e. What is the volume at STP of a sample that contains 4.00×10^{23} molecules of methane, CH_4?

f. How many molecules are in an 18.2 L sample of helium gas at STP?

g. How many molecules are in a 1.20 mol sample of oxygen gas? How many oxygen atoms are in this sample?

h. How many moles are in a 75.4 g sample of sulfur tetrachloride?

i. What is the volume at STP of a 102 g sample of propane gas, C_3H_8?

j. What is the mass of a sample that contains 1.22×10^{22} argon atoms?

k. What is the volume in liters of a 0.14 mol sample of chlorine gas at STP?

l. How many molecules are in a 65.0 g sample of water, H_2O?

12. A 30.15 g sample of a gas containing only N and O occupies 14.7 L at STP.

a. Find the molar mass of this compound.

b. If the compound is 30.4% N by mass, find the empirical and molecular formulas for this compound.

c. How many oxygen atoms are in this sample?

d. Write the balanced chemical equation for the formation of this compound. Include states.

13. An 80.50 g sample of an unknown oxide of chromium (Cr_xO_y) is heated until all of the oxygen is vaporized, leaving55.08 g of solid chromium metal. The molar mass of this unknown compound is between 150 and 160 g/mol.

a. Find the % composition of each element of the unknown compound.

b. Find the empirical formula and molecular formula of the unknown compound.

c. Write the balanced chemical equation for this decomposition. Include states.

d. Find the volume at STP of the oxygen gas that is vaporized.

e. Find the number of chromium atoms in this sample.

14. How many …

a. Electrons can fill all the orbitals in the 5^{th} shell ($n = 5$).

b. Orbitals are in the 4f subshell.

c. Half-filled orbitals are in the ground state electron configuration for Se.

15. Identify the number of valance electrons for each specie. Then write the short form and long form ground state electron configurations for the following species.

a. Ni c. Ar e. Au g. Ca^{2+}

b. Al d. As f. Zn^{2+} h. Br^-

16. For each of the following, determine the number of valence electrons, and the ion it is likely to form.

a. Sb b. Cs c. At d. S e. Ga

17. Draw the Lewis Structure for the following species.

a. Br c. F^- e. K+ g. S^{2-}

b. Ca d. He f. P h. Si

18. Rank the following and explain.

a. Increasing atomic radius: P, S, As

b. Increasing ionization energy: K, Ca, Rb

c. Increasing radius: Cl, Cl^-, Cl^{2-}

d. Increasing radius: Cl^-, Ar, K^+

Topic 3 – Inter- and Intramolecular Forces

19. Identify the type of bonding (nonpolar covalent, polar covalent, ionic, metallic) between the following elements.

a. Ca–P _____ c. Cu–Sn _____ e. N–O _____

b. O–H _____ d. C–H _____ f. S–F _____

20. For each of the following compounds, draw the Lewis Dot Structure.

a. CH_2Cl_2 d. NBr_3 g. CO_2 j. NO_3^-

b. BF_3 e. PCl_5 h. NH_4^+ k. C_2H_4

c. OF_2 f. SF_4 i. CN^- l. CO

21. Using the structures drawn in problem 20, describe the shape, and determine whether the molecule is polar for compounds

a. _____ Polar/Non-Polar
b. _____ Polar/Non-Polar
c. _____ Polar/Non-Polar
d. _____ Polar/Non-Polar
g. _____ Polar/Non-Polar
h. _____ Polar/Non-Polar
j. _____ Polar/Non-Polar
l. _____ Polar/Non-Polar

22. Rank the following:

a. In increasing bond energy: N_2, O_2, F_2 _____ _____ _____
b. In increasing C–C bond length: C_2H_6, C_2H_4, C_2H_2 _____ _____ _____
c. In increasing C–O bond energy: CH_3OH, CO, CO_2 _____ _____ _____

23. Rank the following in order of increasing melting point. Explain.

a. H_2, N_2, Cl_2 b. KBr, MgS, NaCl c. HF, HCl, HBr d. CO_2, CO, CH_3OH

24. Classify each of the following solids (i.e. molecular solid, metallic solid, ionic solid, network covalent solid), and identify the inter-molecular` forces involved.

a. SiO_2 _____ Hydrogen / Ion-Dipole / Dipole-Dipole / Dispersion
b. I_2 _____ Hydrogen / Ion-Dipole / Dipole-Dipole / Dispersion
c. Ca _____ Hydrogen / Ion-Dipole / Dipole-Dipole / Dispersion
d. KCl _____ Hydrogen / Ion-Dipole / Dipole-Dipole / Dispersion
e. CO_2 _____ Hydrogen / Ion-Dipole / Dipole-Dipole / Dispersion
f. $C_6H_{12}O_6$ _____ Hydrogen / Ion-Dipole / Dipole-Dipole / Dispersion
g. Zn _____ Hydrogen / Ion-Dipole / Dipole-Dipole / Dispersion
h. $C_{diamond}$ _____ Hydrogen / Ion-Dipole / Dipole-Dipole / Dispersion
i. H_2O _____ Hydrogen / Ion-Dipole / Dipole-Dipole / Dispersion
j. CaO _____ Hydrogen / Ion-Dipole / Dipole-Dipole / Dispersion

25. Using the Solubility Rules, determine which of the following are soluble in aqueous solution, and write their dissociation equations.

a. $Al(C_2H_3O_2)_3$ c. $Ba(OH)_2$ e. $CaSO_4$ g. K_2CrO_4 i. $SnCl_2$
b. $Al(OH)_3$ d. $Ca(ClO_3)_2$ f. Hg_2Cl_2 h. $Mg_3(PO_4)_2$ j. $ZnSO_4$

26. Find each of the following.

a. What is the concentration of a 1.50 L solution with 0.300 mol HCl?
b. What is the concentration when 42.6 g $CaBr_2$ is dissolved in 800 mL of water?
c. How many moles of KF are in 200 mL of a 0.400 M solution?
d. What is the mass required to prepare 500 mL of a 1.30 M solution of $NaNO_3$?
e. What is the volume of a 3.00 M solution containing 0.850 mol $Mg(ClO_3)_2$?
f. What is the volume of a 0.250 M solution in which 30.0 g $CaCl_2$ is dissolved?
g. What volume of a 3.00 M solution of HCl is required to prepare 200.0 mL of a 0.120 M solution?
h. What is the concentration of the solution when 300 mL of a 1.80 M NaI solution is diluted to 4.00 L?
i. What is the final volume of a 0.600 M KNO_3 solution prepared with 50.0 mL of a 1.50 M solution?
j. What is the concentration of a stock solution of $HC_2H_3O_2$ from which 20.0 mL was used to prepare a 200 mL sample of a 0.050 M solution?

27. Complete the following table:

	$[H^+]$	$[OH^-]$	pH	pOH	Acid/Base/Neutral
a.	1.0×10^{-5}				
b.		0.0500			
c.			5.00		
d.				–0.10	

28. State the key ideas of the Kinetic Molecular Theory of Gasses.

29. Convert 3.2 atm into mmHg, torr, and kPa.

30. The temperature of a sample of N_2 (g) is 10°C. To what temperature (in Celsius) must the sample be raised for it to have twice the average kinetic energy?

31. 20.0 g samples of H_2 (g), O_2 (g), and Cl_2 (g) are placed in separate 2.0 L containers at 25°C. Rank the gas samples:

a. By increasing molecular speed. _____ _____ _____

b. By increasing average kinetic energy. _____ _____ _____

c. By increasing pressure. _____ _____ _____

32. Find the following.

a. A sample of SO_2 (g) at 1.4 atm is placed in a 2.0 L container. What is the pressure if the volume is increased to 3.5 L at constant temperature?

b. A sample of Ar (g) at 500 torr is placed in a rigid 10.2 L container at 30°C. To what temperature should the sample be heated in order for the pressure to be raised to 800 torr?

c. A sample of O_2 (g) at 40°C is placed in a balloon with a volume of 1.20 L. If the volume is held constant, what is the volume of the balloon if the temperature is lowered to 0°C?

d. A sample of CO_2 (g) at 30°C and 98.5 kPa is placed in a 6.0 L container. Find the pressure if the temperature is raised to 60°C and the volume is changed to 3.0 L.

e. What is the volume of a 0.030 mol sample of NO_2 (g) placed in 2.0 L container if the pressure is 1.5 atm?

f. How many grams of He (g) must be placed in a 20.4 L container at 12°C in order for the pressure to be 2.4 atm?

33. A mixture containing 0.010 mol O_3 (g) and 0.080 mol O_2 (g) are placed in a container. What is the total pressure of the container if the partial pressure of O_3 (g) is 0.50 atm?

34. A 40.0 L container contains a mixture of 15.0 g N_2 (g) and 14.0 g Ne (g) at 30°C. Find the partial pressure of each gas in the container.

Topic 4 – Chemical Reactions

35. For each of the following reactions, identify the type of reaction (i.e. combustion, decomposition, double replacement, single replacement, or synthesis), write the balanced molecular equation, and write the net ionic equation. Include states when possible.

a. Silver metal is combined with oxygen gas.

b. Solutions of potassium chromate and silver nitrate are mixed.

c. Propane gas, C_3H_8 is burned in oxygen.

d. A gaseous sample of butane is burned in air.

e. Aluminum metal reacts completely with chlorine gas.

f. A piece of aluminum foil is dipped in a solution of cupric chloride.

g. A piece of zinc metal is placed in a solution of hydrochloric acid.

h. Water is electrolyzed.

i. Solutions of lead(II) acetate and hydrochloric acid are mixed.

j. Solid copper (II) oxide is strongly heated.

36. In problem 23 for reactions a, e, f, g, h, and j, write the oxidation states of the elements and identify the element that is oxidized and the element that is reduced.

37. Determine which pairs of the following solutions, when mixed, form precipitates. Write the balanced molecular and balanced net ionic equations for these mixtures.

Na_2CrO_4 $CaCl_2$ $AgNO_3$ K_2SO_4

38. Consider the combustion of 30.0 g of propane in excess oxygen.

a. Write the balanced molecular equation for this reaction.

b. Find the maximum mass of H_2O that can form.

c. Find the volume of CO_2 produced at STP.

39. A 58.0 g sample of $KClO_3$ (s) decomposed to form KCl (s) and O_2 (g).

a. Write the balanced molecular equation for this reaction.

b. Find the theoretical yield of O_2 (g).

c. If 14.5 L of O_2 (g) was produced at STP, find the percent yield.

40. Consider 1.35 g Mg placed in 100.0 mL of a 1.50 M HCl solution.

a. Write a balanced molecular equation for this reaction.

b. Find the maximum volume of H_2 (g) that can be produced at STP.

c. If 0.950 L of H_2 was produced at STP, find the percent yield.

41. In the reaction 8 P_4 (s) + 3 S_8 (s) → 8 P_4S_3 (s), 20.0 g of P_4 and 40.0 g of S_8 are combined.

a. What is the theoretical yield of P_4S_3? What are the limiting and excess reactants?

b. What is the mass of the excess reactant that remains if the reaction goes to completion?

c. If 30.0 g of P_4S_3 are actually produced, find the percent yield.

Topic 5 – Kinetics

42. Answer the following using ideas of Collision Theory.

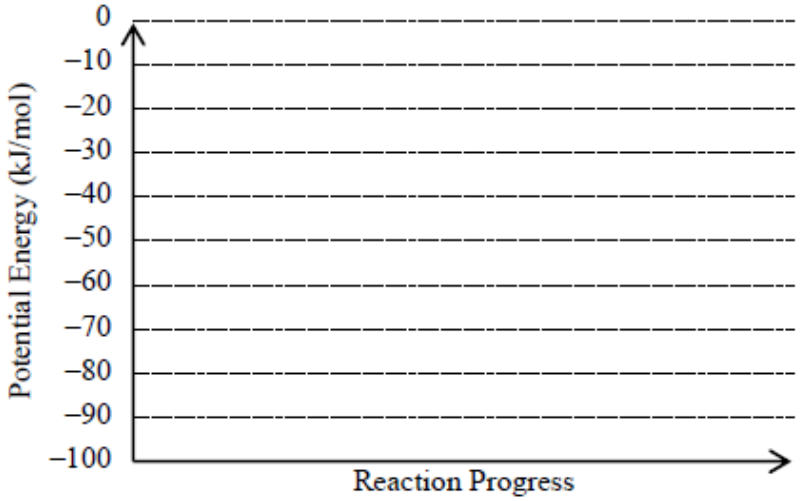
a. State the main ideas of Collision Theory: For a reaction to occur, molecules must with enough in the correct.

b. State five ways to increase the rate of a reaction.

c. The temperature of a system is related to the of the molecules.

d. A catalyst the rate of reaction by:

43. Sketch the Potential Energy graph and find the values missing given the following data.



$A \leftrightarrows B$

- $\Delta H_{f,A}$ =
- $\Delta H_{f,B}$ = –50 kJ/mol

$\Delta H_{f,T.S.\ uncat}$ =

$\Delta H_{f,T.S.\ cat}$ =

Forward Reaction:

- $E_{a,uncat}$ =
- $E_{a,cat}$ = 40 kJ/mol
- ΔH_{rxn} = +20 kJ/mol
- [endo | exo]

Reverse Reaction:

- $E_{a,uncat}$ = 30 kJ/mol
- $E_{a,cat}$ =
- ΔH_{rxn} =
- [endo | exo]

Topic 6 – Thermochemistry

44. Blocks A and B both have the same mass and are at 20°C, but are made of different metals.

a. If blocks A and B are heated with the 4500 J of energy, the temperatures of the blocks are 25°C and 40°C, respectively. Which block has the greater specific heat? Explain briefly.

b. If the specific heat of block A is larger than that of block B, which would require more energy to raise the temperature to 50°C? Explain briefly.

c. If the specific heat of block A is larger than that of block B, which would end up at a higher temperature when 3000 J is released? Explain briefly.

45. Find the following.

a. What is the mass of a sample of hexane if 500 J of energy increases the temperature from 15.1°C to 17.6°C? The specific heat of hexane is 2.26 J/g·°C.

b. What is the final temperature when 4500 J of energy is released from a 245 g piece of glass at 35°C? The specific heat of glass is 0.84 J/g·°C.

c. How much energy is required to heat up a 45.8 g of copper from 11.5°C to 26.1°C? The specific heat of copper is 0.39 J/g·°C.

d. What is the final temperature when a 32.0 g aluminum block that is 100°C is placed in 180.0 mL water at 22.4°C? The specific heats of aluminum and water are 0.900 J/g·°C and 4.18 J/g·°C. The density of water is 1.00 g/mL.

46. Sketch the part of the heating curve corresponding to each problem. Use the data below for water to find each of the following. ΔH_{fus} = 6.01 kJ/mol, ΔH_{vap} = 40.68 kJ/mol, C_{ice} = 2.10 J/ g·°C, C_{water} = 4.18 J/ g·°C, C_{steam} = 2.08 J/g·°C.

a. 50.0 g water at 80.0°C is vaporized completely to 100.0°C.

b. 4.50 g ice at –15.0°C is heated to 40.0°C.

c. 30.0 g vapor at 105°C is cooled to 50.0°C.

d. 15.0 g ice at 0°C is heated to 20°C.

47. What is the ΔH_{rxn} for the following reaction if 70.4 kJ of energy is absorbed when 28.2 L of NO (g) is produced at STP?

$$2\ NO_2\ (g) \rightarrow 2\ NO\ (g) + O_2\ (g)$$

48. Given the following reaction: $Fe_2O_3\ (s) + 3\ CO\ (g) \rightarrow 2\ Fe\ (s) + 3\ CO_2\ (g)$ ΔH_{rxn} = –26.74 kJ/mol

a. How many grams of Fe are produced if 50.8 kJ of energy is released?

b. How much energy is released if 50.2 L CO (g) at STP are used?

c. What is the ΔH_f for Fe_2O_3 (s) if ΔH_f of CO and CO_2 are –110.5 kJ/mol and –393.5 kJ/mol, respectively?

49. Given the following reaction: $2\ O_3\ (g) \rightarrow 3\ O_2\ (g)$ ΔH_{rxn} = –286 kJ/mol

a. What is the ΔH_{rxn} of the reaction $3\ O_2\ (g) \rightarrow 2\ O_3\ (g)$?

b. What is the ΔH_f of O_3?

c. The bond energy of O_2 (O=O) is 495 kJ/mol. What is the bond energy of the O--O bond in O_3 (O--O--O)?

Topic 7 – Equilibrium

50. Write the equilibrium constant expression and find the value for the following reactions. Determine whether the reaction is reactant-favored or product-favored.

a. $2\ NH_3\,(g) \leftrightarrows N_2\,(g) + 3\ H_2\,(g)$ $[NH_3]_{eq} = 5.0 \times 10^{-5}$ M, $[N_2]_{eq} = 0.096$ M, $[H_2]_{eq} = 0.29$ M

b. $PbCl_2\,(s) \leftrightarrows Pb^{2+}\,(aq) + 2\ Cl^-\,(aq)$ $[Pb^{2+}]_{eq} = 0.016$ M, $[Cl^-]_{eq} = 0.032$ M

51. Given the reaction $2\ NO_2\,(g) \leftrightarrows N_2O_4\,(g)$

a. Write the equilibrium constant expression for the reaction.

b. If only 0.500 mol of $NO_2\,(g)$ is placed in a 1.0 L container and the reaction is allowed to come to equilibrium,0.186 mol of $N_2O_4\,(g)$ is formed. Find the value of K_{eq}.

c. Using the value of K_{eq} from part a, if $[NO_2] = 0.090$ M and $[N_2O_4] = 0.205$ M, is the reaction at equilibrium? If not, in which direction will it shift to reach equilibrium?

d. Using the value of K_{eq} from part a, if $[NO_2] = 0.138$ M and $[N_2O_4] = 0.181$ M, is the reaction at equilibrium? If not, in which direction will it shift to reach equilibrium?

e. Using the value of K_{eq} from part a, in a reaction at equilibrium, $[N_2O_4]_{eq} = 0.102$ M. Find $[NO_2]_{eq}$.

52. Consider a system at equilibrium that undergoes the following reaction:

$$2\ SO_2\,(g) + O_2\,(g) \leftrightarrows 2\ SO_3\,(g) + \text{heat}$$

Determine the direction in which the reaction shifts when the following changes were made.

a. Some SO_3 was added to the system.

b. Some O_2 was removed.

c. Some SO_2 is added to the system.

d. The temperature is increased.

e. A catalyst was added.

f. The pressure was decreased by increasing the volume.