Recitation Worksheet 1

Name: Key

MyID:

Textbook:

Chemistry & Chemical Reactivity
by John C. Kotz, Paul M. Treichel, John R. Townsend, David Treichel
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Instructions:

- This recitation worksheet covers CHEM 1211 Review and will be graded.
- Please enter your first and last name as it appears on the eLC roster (do not use a nickname that is not reflected in eLC).
- Your UGA myID is a combination of letters and numbers (example: Dr. Abdelrahman's MyID is ema88805). **Do not use your 81x number**.
- Your completed worksheet has to be submitted to **Gradescope**. You have multiple options for submission:
  - You may use an app to annotate the worksheet by placing your answers in the answer boxes and showing your work when appropriate. Afterward, submit the worksheet to Gradescope. You will not need to upload anything to eLC.
  - You may print out the worksheet, write your answers in the answer boxes, and show your work on it when appropriate. Afterward, convert the worksheet to a PDF and submit to Gradescope. You will not need to upload anything to eLC.
  - If you do not have access to a printer, you may type your answers directly into the worksheet PDF and then submit it to Gradescope. Write your work on separate sheets of paper, convert them to a PDF, and upload to the appropriate dropbox on eLC.
  - There is a Gradescope app available for both iOS and Android devices that allows you to scan and submit your printed work, or you can submit your fillable PDF directly.
- The following criteria **must** be met to be eligible for full credit:
  - You must make sure the pages are in the correct order and have the same layout as the original worksheet when submitting to Gradescope regardless of your submission type.
  - Answers must be written in the corresponding answer boxes.
  - You must show your work when appropriate.
- This worksheet is due no later than **12:00 PM (noon), Monday, August 26th.**
- A periodic table and formula sheet are attached to the end of this worksheet. Please keep these attached to your worksheet in the correct order when submitting to Gradescope.

Part I: CHEM 1211 Review

1. In a user's manual accompanying an American-made car, a typical pressure gauge performance of car tires is 32 lb/in^2. What is the pressure in kg/m^2? (1 lb. = 453.59 g and 1 in. = 2.54 cm).

exact numbers

$\boxed{22{,}000}$ kg/m^2

or

2.2×10^4

Both answers are acceptable

2 sig figs

$$\frac{32\ \cancel{lb}}{\cancel{in^2}} \times \frac{453.59\ \cancel{g}}{1\ \cancel{lb.}} \times \frac{1\ kg}{1000\ \cancel{g}} \times \left(\frac{1\ \cancel{in}}{2.54\ \cancel{cm}}\right)^2 \times \left(\frac{100\ \cancel{cm}}{1\ m}\right)^2$$

$$= 2.2498109 \times 10^4\ kg/m^2$$

this conversion must be squared for the units to cancel out

Note: wait till the end to round to the correct number of sig figs

Answer: 2.2×10^4 or 22,000 kg/m^2

2. Blood alcohol content (BAC) is sometimes reported in weight-volume percent and, when it is, a BAC of 0.10% corresponds to 0.10 g of ethyl alcohol per 100 mL of blood. In many jurisdictions, a person is considered legally intoxicated if his or her BAC is 0.10%. Suppose that a 68 kg person has a total blood volume of 5.4 L and breaks down ethyl alcohol at a rate of 10.0 grams per hour. How many 145 mL glasses of wine, consumed over three hours, will produce a BAC of 0.10% in this 68 kg person? Assume the wine has a density of 1.01 g/mL and 11.5% ethyl alcohol by mass (11.5 g ethyl alcohol/100 g wine). edit this for students

2.10	glasses of wine

① Find the mass of ethyl alcohol that would produce the 0.10% BAC

$$\frac{0.10\text{g ethyl alcohol}}{100\cancel{\text{mL}}\text{ blood}} \times \frac{1000\cancel{\text{mL}}}{\cancel{1L}} \times 5.4\cancel{L}\text{ blood} = 5.4\text{g ethyl alcohol}$$

② Amount of alcohol broken down over three hours

$$\frac{10.0\text{g}}{1\text{ hour}} \times 3\text{hours} = 30.0\text{g ethyl alcohol}$$

if this amount breaks down & 5.4g gives 0.10% BAC

∴ the total amount of alcohol in the blood is 30.0g + 5.4g = 35.4g ethyl alcohol

③ Find the mass of ethyl alcohol in 145mL glass of wine

$$11.5\% \; \left\{ \frac{11.5\text{g ethyl alcohol}}{100.0\cancel{\text{g}}\text{ wire}} \right. \times \underbrace{\frac{1.01\cancel{\text{g}}}{\cancel{\text{mL}}}}_{\text{density}} \times \frac{145\cancel{\text{mL}}}{1\text{glass of wire}} = \frac{16.84175\text{g ethyl alcohol}}{1\text{ glass of wire}}$$

④ Number of glasses of wine that produce 0.10% BAC =

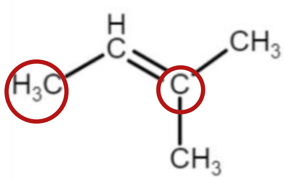
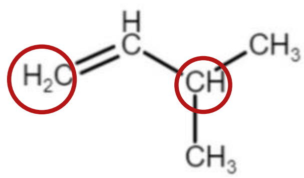
$$\frac{1\text{ glass of wire}}{16.84175\text{g }\cancel{\text{ethyl alcohol}}} \times 35.4\text{g }\cancel{\text{ethyl alcohol}} = 2.101919337$$

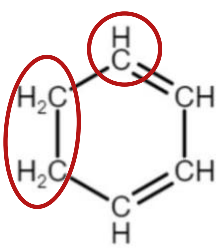
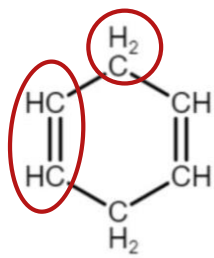
≈ 2.10 glasses of wire

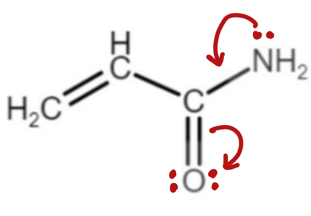
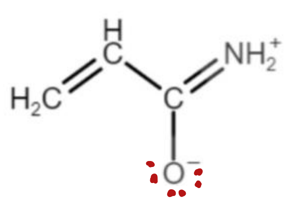
Remember: in resonance only electrons move and atoms stay in the same location

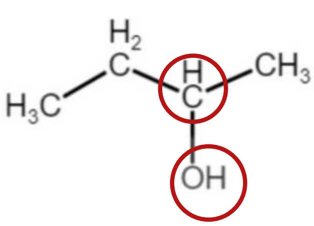
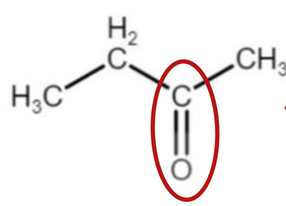
3. Students have proposed resonance structures for different chemical species. Which set(s) represent resonance structures? Select all that apply. Insert letters without spaces in the answer box, example **ABCD**.

CE

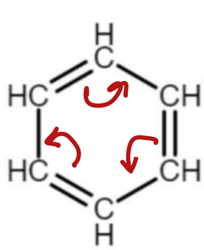
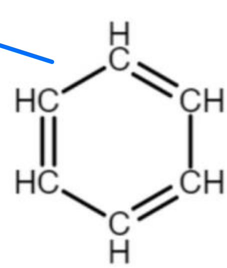
A.  and  → this is not resonance

B.  and  → this is not resonance

C.  and  Resonance

D.  and  → this is not resonance

Note that the location of the atoms stayed the same

E.  and  Resonance

4. Which of these molecules are polar? Select all that apply. Insert letters without spaces in the answer box, example **ABCD**.

BCDE

Remember: A molecule can have polar bonds but the molecular geometry can result in a non-polar compound

(6 molecular geometries that result in a non-polar molecule: linear, octahedral, tetrahedral, trigonal planar, trigonal bipyramidal, & square planar).

A. $AsCl_5$

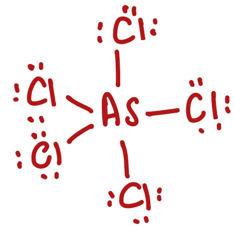
B. OF_2

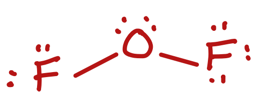
C. $SOCl_2$

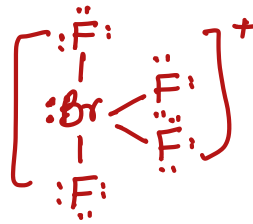
D. BrF_4^+

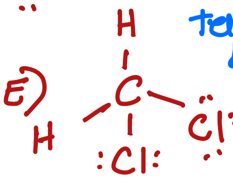
E. CH_2Cl_2

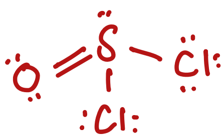
F. IF_4^-

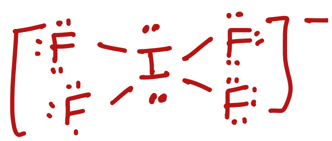
A)

trigonal bipyramidal (non-polar)

B)

Bent (polar)

D)

See saw (polar)

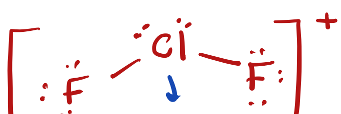
E)

tetrahedral but symmetry is broken by the chlorines (polar)

C)

Trigonal pyramidal (polar)

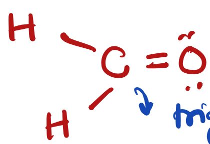
F)

square planar (non-polar)

5. What is the hybridization of the **central atom** in each of the ions or molecules below?

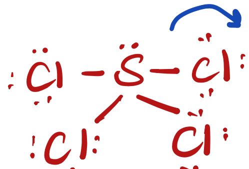
A. ClF^+ $\boxed{sp^3}$


tetrahedral

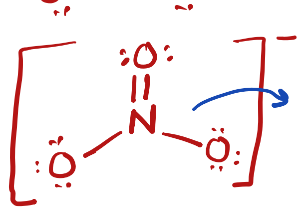
B. H_2CO $\boxed{sp^2}$


trigonal planar

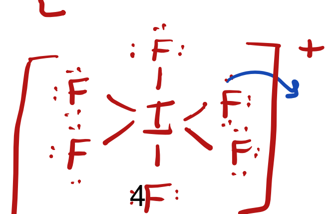
C. SCl_4 $\boxed{sp^3d}$


trigonal bipyramidal

D. NO^- $\boxed{sp^2}$


trigonal planar

E. IF_6^+ $\boxed{sp^3d^2}$


octahedral

6. Dimethylolpropionic acid (shown below) is used in the preparation of water-soluble resins to make high gloss coatings with excellent flexibility and toughness. What is the hybridization of each of the carbon atoms labeled below?

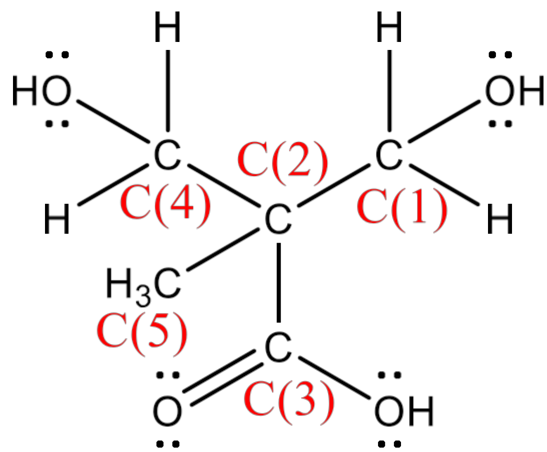
A. C(1) $\boxed{sp^3}$

B. C(2) $\boxed{sp^3}$

C. C(3) $\boxed{sp^2}$

D. C(4) $\boxed{sp^3}$

E. C(5) $\boxed{sp^3}$



7. What is the **total ionic equation** for the reaction between copper(II) nitrate and sodium phosphate?

$\boxed{C}$

1) $3Cu(NO_3)_2(aq) + 2Na_3PO_4(aq) \rightarrow 6NaNO_3(aq) + Cu_3(PO_4)_2(s)$

2) $3Cu^{2+}(aq) + 6NO_3^-(aq) + 6Na^+(aq) + 2PO_4^{3-}(aq) \rightarrow 6Na^+(aq) + 6NO_3^-(aq) + Cu_3(PO_4)_2(s)$ (total ionic)

A. $3\ Cu(NO_3)_2(aq) + 2\ Na_3PO_4(aq) \longrightarrow 6\ NaNO_3(aq) + Cu_3(PO_4)_2(s)$
B. $Cu^{2+}(aq) + NO_3^-(aq) + Na^+(aq) + PO_4^{3-}(aq) \longrightarrow Na^+(aq) + NO_3^-(aq) + PO_4^{3-}$
C. $3\ Cu^{2+}(aq) + 6\ NO_3^-(aq) + 6\ Na^+(aq) + 2\ PO_4^{3-}(aq) \longrightarrow 6\ Na^+(aq) + 6\ NO_3^-(aq) + Cu_3(PO_4)_2(s)$
D. $3\ Cu^{2+}(aq) + 6\ NO_3^-(aq) + 6\ Na^+(aq) + 2\ PO_4^{3-}(aq) \longrightarrow 6\ Na^+(aq) + 6\ NO_3^-(aq) + 3\ Cu^{2+}(aq) + 2\ PO_4^{3-}(aq)$
E. $3\ Cu^{2+}(aq) + 2\ PO_4^{3-}(aq) \longrightarrow Cu_3(PO_4)_2(s)$
F. No reaction occurs

3) $3Cu^{2+}(aq) + 2PO_4^{3-}(aq) \rightarrow Cu_3(PO_4)_2(s)$ (net ionic)

8. What is the **net ionic equation** for the reaction between HNO_3 and $Ba(OH)_2$?

HNO_3 ↓ Acid; $Ba(OH)_2$ ↓ Base

$\boxed{C}$

A. $2\ HNO_3(aq) + Ba(OH)_2(aq) \longrightarrow Ba(NO_3)_2(aq) + 2\ H_2O(l)$
B. $2\ H^+(aq) + 2\ NO_3^-(aq) + Ba^{2+}(aq) + 2\ OH^-(aq) \longrightarrow Ba^{2+}(aq) + 2\ NO_3^-(aq) + 2\ H_2O(l)$
C. $H^+(aq) + OH^-(aq) \longrightarrow H_2O(l)$
D. No reaction occurs

1) $2HNO_3(aq) + Ba(OH)_2(aq) \rightarrow Ba(NO_3)_2(aq) + 2H_2O(l)$

2) $2H^+(aq) + 2\cancel{NO_3^-}(aq) + \cancel{Ba^{2+}}(aq) + 2OH^-(aq) \rightarrow \cancel{Ba^{2+}}(aq) + 2\cancel{NO_3^-}(aq) + 2H_2O(l)$

3) $2H^+(aq) + 2OH^-(aq) \rightarrow 2H_2O(l)$ ∴ $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

9. Which of these compounds are soluble in water? Select all that apply. Insert letters without spaces in the answer box, example **ABCD**.

BCEGH

SOLUBLE COMPOUNDS	EXCEPTIONS
Almost all salts of Na^+, K^+, NH_4^+	
Salts of nitrate, NO_3^- chlorate, ClO_3^- perchlorate, ClO_4^- acetate, $CH_3CO_2^-$	
Almost all salts of Cl^-, Br^-, I^-	Halides of Ag^+, Hg_2^{2+}, Pb^{2+}
Salts containing F^-	Fluorides of Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}
Salts of sulfate, SO_4^{2-}	Sulfates of Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}, Ag^+

INSOLUBLE COMPOUNDS	EXCEPTIONS
Most salts of carbonate, CO_3^{2-} phosphate, PO_4^{3-} oxalate, $C_2O_4^{2-}$ chromate, CrO_4^{2-} sulfide, S^{2-}	Salts of NH_4^+ and the alkali metal cations
Most metal hydroxides and oxides	Alkali metal hydroxides and $Ba(OH)_2$ and $Sr(OH)_2$

A. $BaSO_4$

B. CH_3COONH_4

C. $NaClO_4$

D. $CaCO_3$

E. $FeBr_3$

F. AgI

G. $ZnCl_2$

H. $Pb(NO_3)_2$

10. Classify the compounds below as an acid, base, or salt. Insert acid, base, or salt in the boxes below.

A. $HClO_4$ Acid

B. C_6H_5COOH Acid

C. RbOH Base

D. $CaCl_2$ Salt

E. NaBr Salt

F. $Mg(OH)_2$ Base

G. K_2SO_4 Salt

H. NH_3 Base

11. How many milliliters of 0.650 M K_2CrO_4 are needed to precipitate all the silver in 415 mL of 0.186 M $AgNO_3$ as $Ag_2CrO_4(s)$?

$$2\,AgNO_3(aq) + K_2CrO_4(aq) \longrightarrow Ag_2CrO_4(s) + 2\,KNO_3(aq)$$

$\boxed{59.4}$ mL

$$415\,\cancel{mL} \times \frac{1\,\cancel{L}}{1000\,\cancel{mL}} \times \frac{0.186\,\cancel{mol\,AgNO_3}}{1\,\cancel{L}} \times \frac{1\,mol\,\cancel{K_2CrO_4}}{2\,\cancel{mol\,AgNO_3}} \times \frac{1\,\cancel{L}}{0.650\,\cancel{mol\,K_2CrO_4}} \times \frac{1000\,mL}{1\,\cancel{L}} = 59.37692308\,mL \approx 59.4\,mL$$

12. Phosphorous trichloride, PCl_3, is a commercially important compound used in the manufacturing of pesticides, gasoline additives, and a few other products. Liquid PCl_3 is made by the direct combination of phosphorous and chlorine as shown in the **unbalanced** equation below.

$$P_4(s) + 6Cl_2(g) \rightarrow 4PCl_3(l)$$

A. What is the maximum mass of PCl_3 produced from 125 g of P_4 and 323 g of Cl_2?

$\boxed{417}$ g

Determine the limiting reactant :

From P_4 :

$$125\,g\,P_4 \times \frac{1\,mol\,P_4}{123.89\,g\,P_4} \times \frac{4\,mol\,PCl_3}{1\,mol\,P_4} \times \frac{137.324\,g\,PCl_3}{1\,mol\,PCl_3}$$
$$= 554\,g\,PCl_3$$

From Cl_2 :

$$323\,g\,Cl_2 \times \frac{1\,mol\,Cl_2}{70.90\,g\,Cl_2} \times \frac{4\,mol\,PCl_3}{6\,mol\,Cl_2} \times \frac{137.324\,g\,PCl_3}{1\,mol\,PCl_3}$$
$$= 417.07\,g \sim 417\,g\,PCl_3$$

limiting reactant

B. What is the limiting reactant and what mass of the excess reactant remains?

$\boxed{\text{i}}$

From part A we know that the limiting reactant is Cl_2
∴ excess reactant is P_4

i. Cl_2 is the limiting reactant and 30.9 g of P_4 remain
ii. P_4 is the limiting reactant and 137 g of Cl_2 remain
iii. Cl_2 is the limiting reactant and 93.9 g of P_4 remain
iv. P_4 is the limiting reactant and 198 g of Cl_2 remain
v. P_4 is the limiting reactant and 30.9 g of Cl_2 remain

two methods to find out the amount of excess reactant

Method 1: the amount of P_4 consumed by reacting with Cl_2:

$$323 g\ Cl_2 \times \frac{1\ mol\ Cl_2}{70.90 g\ Cl_2} \times \frac{1\ mol\ P_4}{6\ mol\ Cl_2} \times \frac{123.88 g\ P_4}{1\ mol\ P_4} = 94.06027268 \sim 94.1 g$$

∴ Mass of P_4 remaining $= 125 - 94.1 = 30.9 g \sim 31 g$

13. Using Hess's law, determine $\Delta H°$ for the reaction below:

Method 2: subtract the masses of PCl_3 produced from P_4 & Cl_2: $554 - 417 = 137 g\ PCl_3$

$$C_2H_4(g) + Cl_2(g) \longrightarrow C_2H_4Cl_2(l)$$

Given that, $137 g\ PCl_3 \times \frac{1\ mol\ PCl_3}{137.32 g\ PCl_3} \times \frac{1\ mol\ P_4}{4\ mol\ PCl_3} \times \frac{123.88 g\ P_4}{1\ mol\ P_4} = 30.89782989 \sim 30.9 g\ P_4$ remaining

$4\ HCl(g) + O_2(g) \longrightarrow 2\ Cl_2(g) + 2\ H_2O(l)$ $\Delta H° = -202.4$ kJ/mol Flip & multiply by ½

$2\ HCl(g) + C_2H_4(g) + ½\ O_2(g) \longrightarrow C_2H_4Cl_2(l) + H_2O(l)$ $\Delta H° = -318.7$ kJ/mol Stays the same

$\boxed{-217.5}$ kJ/mol

$Cl_2(g) + \cancel{H_2O(l)} \longrightarrow \cancel{2HCl(g)} + \cancel{\frac{1}{2}O_2(g)}$ $\Delta H° = +101.2$ kJ/mol

$\cancel{2HCl(g)} + C_2H_4(g) + \cancel{\frac{1}{2}O_2(g)} \longrightarrow C_2H_4Cl_2(l) + \cancel{H_2O(l)}$ $\Delta H° = -318.7$ kJ/mol

$C_2H_4(g) + Cl_2(g) \longrightarrow C_2H_4Cl_2(l)$ $\Delta H° = -217.5$ kJ/mol

Part II: CHEM 1212 Syllabus and Assignments

You may find the answers in the instructions of this document and in the course syllabus. Please read both of those before submitting:

1. Where should this recitation worksheet be submitted?

$\boxed{\text{C}}$

A. eLC
B. By email to the instructor
C. The worksheet must go to Gradescope. If the work is not written on the worksheet, then upload the work to eLC.

2. What time are recitation worksheets due?

$\boxed{\text{C}}$

A. At the end of recitation
B. By the next lecture period
C. Saturday at 12:00 pm (noon) of the recitation week

3. What day and time are the exams? Choose the two that correctly pair (example: AB).

$\boxed{\text{DG}}$

A. Monday
B. Tuesday
C. Wednesday
D. Thursday
E. During the lecture period
F. 7:00 pm
G. 5:30 pm

4. What assignments are due every week on WebAssign?

$\boxed{\text{D}}$

A. Exams
B. In-Class Activities
C. Recitations
D. Weekly Quizzes
E. Suggested exercises and practice quizzes

Formula Sheet

Length
1 kilometer = 0.62137 mile
1 inch = 2.54 centimeters (exactly)
1 Ångstrom = 1×10^{-10} meter

Energy
1 joule = 1 $kg \cdot m^2/s^2$
1 calorie = 4.184 joules
1 Calorie = 1 kilocalorie = 1000 calories
1 L·atm = 101.325 joules

Pressure
1 pascal = 1 N/m^3 = 1 $kg/m \cdot s^2$
1 atmosphere = 101.325 kilopascals = 760 mm Hg = 760 torr = 14.70 lb/in^2
1 bar = 1×10^5 Pa (exactly)

Temperature
0 K = −273.15°C
K = °C + 273.15
°C = (5/9)(°F − 32)

Mass
1 kg = 2.205 lbs

Volume
1 mL = 1 cm^3 = 1 cc

Constants
$c = 2.998 \times 10^8$ m/sec
$h = 6.626 \times 10^{-34}$ $J \cdot sec^{-1}$
R = 0.08206 L·atm/mol·K = 8.314 J/mol·K
Specific heat of water = 4.184 J/g·K
Mass of an electron: 9.109×10^{-31} kg
Mass of a proton: 1.673×10^{-27} kg
RH = 2.18×10^{-18} J
Specific heat of water = 4.184 J/g·K
STP = 273.15 K and 1 atm
Avogadro's number: 6.022×10^{23}

Equations
d (density) = m/V
$P_1V_1=P_2V_2$
$V_1/T_1=V_2/T_2$
$P_1V_1/n_1T_1=P_2V_2/n_2T_2$
$PV=nRT$
$(P + a(n^2/V^2))\cdot(V - nb) = nRT$
molar mass (M) = mRT/PV
density (d) = MP/RT
$x_A = n_A/n_{tot} = P_A/P_{tot} = V_A/V_{tot}$
$P_{tot} = P_A + P_B + \ldots$
$n_{tot} = n_A + n_B + \ldots$

$$\mu_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\frac{Rate\ of\ effusion\ A}{Rate\ of\ effusion\ B} = \sqrt{\frac{MW_B}{MW_A}}$$

$Q = C \times \Delta T = c_{specific} \times m \times \Delta T$
$Q = n \times \Delta H$ (kJ/mol) $= m \times \Delta H$ (kJ/g)
$w = -P\Delta V$
$\Delta E = q + w$
$\Delta H° = \Sigma n\Delta Hf°(\text{products}) - \Sigma n\Delta Hf°(\text{reactants})$
$\Delta H° = \Sigma n\Delta H°(\text{bonds broken}) - \Sigma n\Delta H°(\text{bonds formed})$
$E=h\nu$
$c=\lambda\nu$
$\lambda = h/mv$
$\Delta E = -2.18 \times 10^{-18} J(\frac{1}{n_f^2} - \frac{1}{n_i^2})$

$$\ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$C_g = kP_g$
$P_{solution}=P_{solvent}\ X_{solvent}$
$P_{solution}=\sum P_j=\sum P_jX_j$
$\Delta T_b = K_b m i$
$\Delta T_f = K_f m i$
$\pi = MRTi$

Thermodynamic and Electrochemistry

$S = k_b \times \ln(W)$
$k_b = 1.381 \times 10^{-23}$ J/K
$\Delta S = q_{rev}/T$
$\Delta S_{surr} = q_{surr}/T = -q_{rev}/T$
$\Delta S_{univ} = \Delta S_{sys} + \Delta S_{surr}$
$\Delta S°_{rxn} = \Sigma v S°_{products} - \Sigma v S°_{reactants}$
$\Delta H°_{rxn} = \Sigma v H°_{products} - \Sigma v H°_{reactants}$
$\Delta G°_{rxn} = \Sigma v G°_{products} - \Sigma v G°_{reactants}$
$\Delta G = \Delta H - T\Delta S$
$\Delta G = \Delta G° + RT\cdot\ln Q$
R=8.314 J/mol.K
$\Delta G° = -RT\cdot\ln K$
$\Delta G= -nFE_{cell}$
F = 96485 J/(V·mol e^-)
$E°_{cell} = RT/nF \ln K$
$E°_{cell} = (0.0257/n) \ln K = (0.0592/n) \log K$
$E_{cell} = E°_{cell} - (RT/nF) \ln Q$
$E_{cell} =E°_{cell} - (0.0257/n) \ln Q$
Electrolysis: Q (total charge) = I × t = n × F

Integrated Rate Laws & half-life

$$\ln \frac{[A]}{[A]_0} = -kt$$

$$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$$

$$[A] = -kt + [A]_0$$

$$t_{1/2} = \frac{[A]_0}{2k}$$

$$t_{1/2} = \frac{\ln 2}{k} = \frac{0.693}{k}$$

$$t_{1/2} = \frac{1}{k[A]_0}$$

$$ln \frac{k_2}{k_1} = -\frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

Equilibrium and Acid / Base

$K_P = K_c \times (RT)^{\Delta n}$

$pH = -\log[H_3O^+]$

$K_w = 1.0 \times 10^{-14}$ at 25 °C

$K_w = [H_3O^+] \times [OH^-]$

$K_w = K_a \times K_b$

$pK_a = -\log[K_a]$

Buffer: $pH = pK_a + \log \frac{[A^-]}{[HA]}$

$$ln \frac{K_2}{K_1} = \frac{\Delta H^\circ_{rxn}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** 1.01																	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											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** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.87	23 **V** 50.94	24 **Cr** 51.99	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.38	31 **Ga** 69.72	32 **Ge** 72.63	33 **As** 74.92	34 **Se** 78.97	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** 95.95	43 **Tc** 98.91	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** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57-71	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.23	77 **Ir** 192.22	78 **Pt** 195.09	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** [208.98]	85 **At** 209.99	86 **Rn** 222.02
87 **Fr** 223.02	88 **Ra** 226.03	89-103	104 **Rf** [261]	105 **Db** [262]	106 **Sg** [266]	107 **Bh** [264]	108 **Hs** [269]	109 **Mt** [278]	110 **Ds** [281]	111 **Rg** [280]	112 **Cn** [285]	113 **Nh** [286]	114 **Fl** [289]	115 **Mc** [289]	116 **Lv** [293]	117 **Ts** [294]	118 **Og** [294]

57 **La** 138.91	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** 144.91	62 **Sm** 150.36	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.06	71 **Lu** 174.97
89 **Ac** 227.03	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** 237.05	94 **Pu** 244.06	95 **Am** 243.06	96 **Cm** 247.07	97 **Bk** 247.07	98 **Cf** 251.08	99 **Es** [254]	100 **Fm** 257.10	101 **Md** 258.1	102 **No** 259.10	103 **Lr** [262]