Recitation Worksheet Eight

Name: Key

UGA ID:

Textbook:
Chemistry & Chemical Reactivity
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Instructions:

- This recitation worksheet covers Ch. 6.1-6.5.
- 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. Seivert's MyID is mds73312). **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 **9:00 AM on the Saturday of the recitation week.**
- 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.

1. Answer the questions below based on the illustration of the wave provided:

(a) What is the wavelength of the wave (in nm)? Report your answer in **standard notation**.

444	nm

(b) What is the frequency of the wave (in Hertz)? Report your answer in **scientific notation**.

$c = \lambda \nu$

$3e8 \text{ m/s} = \left(444 \text{ nm} \times \frac{10^{-9-0} \text{ m}}{1}\right) \nu$

6.76×10^{14} Hz

$Hz = s^{-1}$

(c) If the wavelength of the wave is halved, what will happen to the speed of light (*c*)?

$\boxed{E}$

A. *c* will be doubled
B. *c* will increase, but not double
C. *c* will be halved
D. *c* will decrease, but not in half
E. *c* will not change

↳ constant

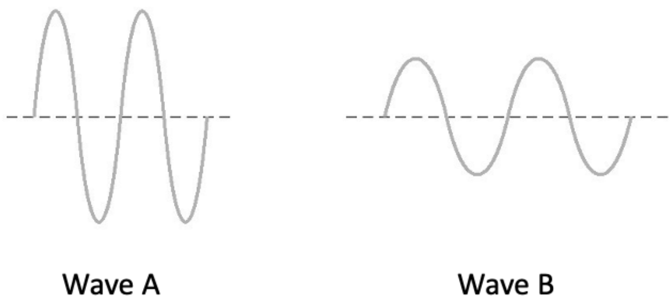
(d) If the wavelength of the wave is halved, what will happen to the frequency (ν)?

$\boxed{A}$

A. ν will be doubled
B. ν will increase, but not double
C. ν will be halved
D. ν will decrease, but not in half
E. ν will not change

$\nu = \frac{c}{\lambda}$

2. Consider the two waves illustrated below (line hashmarks included for scale). Which of the following statements is **false**?



E

A. Wave A has a shorter wavelength than Wave B
B. Wave B has a lower amplitude than Wave A
C. Wave B has a lower energy than Wave A
D. If Wave A corresponds to blue light, then wave B could correspond to infrared radiation
E. None of the above are false

3. Which of the following photons has the *shortest* wavelength?

A

A. Visible - green
B. Microwave
C. Visible - red
D. Infrared
E. Radio

Reference EM spectrum; know order of visible region (ROYGBIV)

4. What is the wavelength (m) of a photon with a frequency of 195 MHz? Report your answer in **standard notation**.

1.54 m

195 MHz → 195×10^6 Hz → 1.95×10^8 Hz
($Hz = s^{-1}$)

$$\lambda = \frac{c}{\nu} = \frac{3 \times 10^8 \text{ m/s}}{1.95 \times 10^8 \text{ s}^{-1}}$$

5. Laser tattoo removal is commonly employed using lasers of various wavelengths. If the wavelength of a particular laser is 532 nm, what is its energy in Joules? What is its frequency in Hertz? Report your answers in **scientific notation**.

$\boxed{3.74} \times 10^{\boxed{-19}}$ J

$\boxed{5.64} \times 10^{\boxed{14}}$ Hz

$$532 \text{ nm} \left(\frac{10^{-9} \text{ m}}{1 \text{ nm}}\right) = 5.32e{-7} \text{ m}$$

$$E = \frac{hc}{\lambda} = \frac{(6.626e{-34} \text{ J}\cdot\text{s})(3e8 \text{ m/s})}{5.32e{-7} \text{ m}}$$

$$c = \lambda \nu$$

$$3e8 \text{ m/s} = (5.32e{-7} \text{ m})\,\nu$$

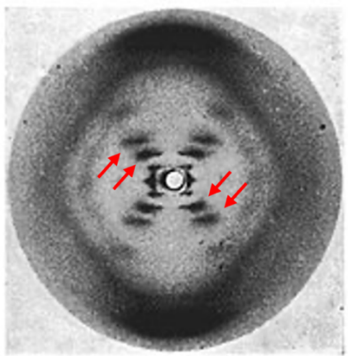
6. Light is shined onto a metal such that the frequency of the light is below the threshold frequency. If the frequency of the light is increased above the threshold frequency, which of the following statements are **true**? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE). (this is photoelectric effect)

$\boxed{AD}$

A. The energy of the light increased. $\uparrow \nu = \uparrow E$
B. The wavelength of the light ~~increased~~. decreased $\uparrow \nu = \downarrow \lambda$
C. ~~Photons~~ are ejected from the metal after the light is changed.
D. Electrons are ejected from the metal after the light is changed.
E. Electrons are ~~absorbed~~ by the metal after the light is changed.

7. Watson and Crick were awarded the Nobel Prize in 1962 for the discovery of DNA, but it was Rosalind Franklin's research group who collected "Photo 51", an x-ray diffraction image that was critical in this discovery. The diffraction image clearly illustrated diffraction spots throughout the pattern (shown below by the red arrows) which was a result of x-rays diffracting off of the DNA structure. Based on this information, which of the following statements is/are true? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

Hint: the diffraction spots were a result of increased amplification.



BDE

A. The spots seen were a result of destructive interference
B. The spots seen were a result of constructive interference
C. The x-rays used in this experiment had a higher wavelength than infrared or microwave radiation
D. The x-rays used in this experiment had a lower wavelength than infrared or microwave radiation
E. The x-rays used in this experiment had higher energy than infrared or microwave radiation
F. The x-rays used in this experiment had lower energy than infrared or microwave radiation

$$\Delta E = -2.178 \times 10^{-18} J \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

8. Consider an electron that transitions from the n = 4 level to a lower energy level...

(a) In which transition would the resulting photon produced be at the shortest wavelength? Answer by using an integer (e.g. 0, 1, etc.).

n = 4 → n = ?

$E = \frac{hc}{\lambda}$

$\uparrow \Delta E = \downarrow \lambda$

n = $\boxed{1}$

$n=4 \rightarrow n=3 \rightarrow \Delta E = -1.059 \times 10^{-19} J$

$n=4 \rightarrow n=2 \rightarrow \Delta E = -4.084 \times 10^{-19} J$

$n=4 \rightarrow n=1 \rightarrow \Delta E = -2.042 \times 10^{-18} J$

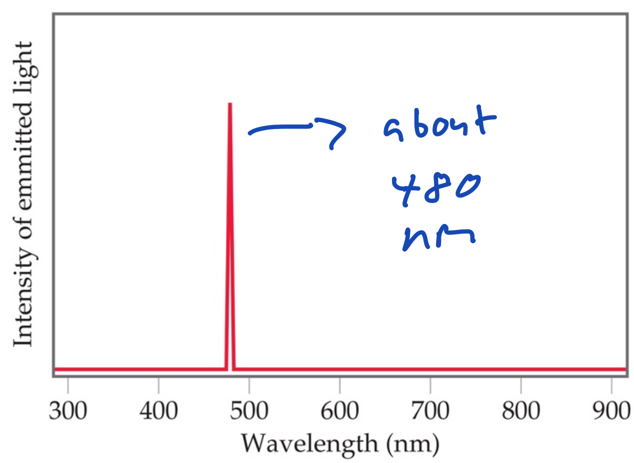
(b) Which transition most likely correlates to the emission of light recorded in the illustration below? Answer by using an integer (e.g. 0, 1, etc.).

n = 4 → n = ?

$$E = \frac{hc}{\lambda} = \frac{(6.626e{-34}\ kg\,m^2 s^{-1})(3e8\ m/s)}{(480 \times 10^{-9}\ m)}$$

$= 4.14 \times 10^{-19} J \rightarrow$ closest to $n=4 \rightarrow n=2$ (above)

n = $\boxed{2}$



9. Which of the following options below will have the smallest de Broglie wavelength when moving at the same velocity?

$\boxed{E}$

$$\lambda = \frac{h}{mv}$$

↑ mass

A. a chemistry book
B. a titanium atom
C. a sheet of paper
D. a drop of water
E. The planet earth (largest mass)
F. There is not enough information to determine this

10. A student walks into their General Chemistry I exam and they realize they have forgotten their nonprogrammable calculator. A prepared friend carefully throws a calculator to them at a velocity of 0.520 m/s. If the calculator has a mass of 113 grams, what is the calculator's wavelength (in m)?

↳ must change to kg

$\boxed{D}$

$$\lambda = \frac{h}{mv}$$

$$= \frac{6.626e\text{-}34 \text{ J}\cdot\text{s}}{(0.113 \text{ kg})(0.520 \text{ m/s})}$$

A. 1.13×10^{-35} m
B. 1.50 m
C. 1.50×10^{-12} m
D. 1.13×10^{-32} m
E. 0.780 m
F. 0.780×10^{-12} m

11. Which statements are **true** based on the Bohr model of the atom? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

$\boxed{AE}$

A. Atomic emission spectra are due to electrons losing energy and changing energy levels
B. The energy of transition for n = 2 to n = 3 would be the same as n = 4 to n = 5
C. The first energy level is set at zero energy
D. Electrons lose energy as they travel around the nucleus
E. Each energy level has a specific energy value

12. Which of the following are **true**? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

CD

A. The Bohr model is the most modern model for electrons in atoms
B. The energy of an electron in an orbit is positive and the energy of an electron after it has left (ionized) from an atom is equal to 0
C. When an electron moves from a high energy level to a low energy level, it is referred to as emission
D. The Heisenberg uncertainty principle states that we cannot exactly know the position and momentum of an electron simultaneously
E. In the Bohr model of the atom, electrons are embedded in the positively charged nucleus

13. Which of the following electronic transitions would result in *emission* of a photon with the *lowest* frequency?

$E = h\nu$

→ smallest energy gap

A

A. n = 4 → n = 3
B. n = 4 → n = 2
C. n = 5 → n = 1
D. n = 2 → n = 1
E. n = 3 → n = 4 (not emission)
F. More than one of the above would have the same frequency

14. The binding energy of a metal is 3.99×10^3 kJ/mol. What is the minimum frequency of light (in Hertz) that is required to remove a singular electron from the metal? Hint: 1 mol = 6.022×10^{23} electrons. Report your answer in **scientific notation**.

$\boxed{1.00} \times 10^{\boxed{16}}$ Hz

$$1 \text{ electron} \times \left(\frac{1 \text{ mol}}{6.022e23 \text{ electrons}}\right) \times \left(\frac{3.99\,e3 \text{ kJ}}{\text{mol}}\right) \times \left(\frac{1000 \text{ J}}{1 \text{ kJ}}\right)$$

$$= 6.625706\,e{-18} \text{ J}$$

$$E = h\nu$$

$$6.625706\,e{-18} \text{ J} = (6.626e{-34} \text{ J}\cdot\text{s})(\nu)$$

15. Consider a sparkle of colored light that contains 285 kJ of energy. How many photons are in the sparkle if the wavelength of the light is 623 nm? Report your answer in **scientific notation**.

$\boxed{8.93} \times 10^{\boxed{23}}$ photons

$$E = \frac{hc}{\lambda} = \frac{(6.626e{-34} \text{ J}\cdot\text{s})(3e8 \text{ m/s})}{(623 \text{ nm})\left(\frac{10^{-9}}{1 \text{ nm}}\right)\text{m}}$$

$$= 3.1906902\,e{-19} \text{ J} \quad \text{(one photon)}$$

$$\frac{285 \text{ kJ} \times \left(\frac{1000 \text{ J}}{1 \text{ kJ}}\right)}{3.1906902\,e{-19} \text{ J}} = 8.93224\,e23 \text{ photons}$$

16. A student is performing a synthesis reaction that requires 514 J of energy. To provide the needed energy, these use a blue laser with a wavelength of 412 nm that produces 2.1×10^{19} photons/sec. How many seconds do they need to run the laser? Report your answer in **standard notation**.

51	seconds

$$E = \frac{hc}{\lambda} = \frac{(6.626e{-}34\ J \cdot s)(3e8\ m/s)}{412e{-}9\ m} = 4.8\underline{\underline{2}}4757e{-}19\ J$$

(one photon)

$$\frac{514\ J}{} \left| \frac{1\ \text{photon}}{4.8\underline{\underline{2}}4757e{-}19\ J} \right| \frac{\text{second}}{2.1\ e19\ \text{photons}} = 5\underline{\underline{0}}.7304\ \text{seconds}$$

17. Which of the following statements are **false**?

B

A. Quantum numbers indicate the orbitals occupied by electrons and their corresponding energy
B. The quantum number ℓ defines the shape and orientation of s, p, d, f, etc. orbitals
C. A 3p orbital and 75p orbital have the same number of possible m_ℓ values
D. There is only one orbital that corresponds to the following quantum numbers: $n = 7$, $\ell = 3$, $m_\ell = -2$
E. More than one of the above are false
F. None of the above are false

18. Which of the following subshell designations are **invalid**? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

BC

A. 1s
B. 1p
C. 1d
D. 2s
E. 3d
F. 4p
G. 8p
H. 20d

Extra Practice Questions: these questions will not be graded.

1. Consider a laser that emits energy at a rate of 212 J/s. If the laser has a wavelength of 635 nm, how many photons are emitted every 2.00 seconds? Report your answer in **scientific notation**.

$\boxed{1.35} \times 10^{\boxed{21}}$ photons

$$2.00 \text{ seconds} \left(\frac{212 \text{ J}}{\text{second}}\right) = 424 \text{ J}$$

$$E = \frac{(6.626e{-34} \text{ J}\cdot\text{s})(3e8 \text{ m/s})}{(635 \times 10^{-9} \text{ m})} = 3.1\underline{3}039 \times 10^{-19} \text{ J/photon}$$

$$\frac{424 \text{ J}}{3.1\underline{3}039 \times 10^{-19} \text{ J/photon}} = 1.35 \times 10^{21} \text{ photons}$$

2. A scientist finds an unknown metal in the lab. They determine it requires approximately 342 kJ/mol of energy to remove electrons from the surface of the metal. As a result, what minimum wavelength of light is required to reproduce the photoelectric effect they observed? Hint: 1 mol = 6.022 × 10^{23} photons. Report your answer in **standard notation**.

$\boxed{350.}$ nm

$$\frac{342 \text{ kJ}}{\text{mol}} \times \left(\frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ photons}}\right)$$

$$= 5.6\underline{7}918 \times 10^{-22} \text{ kJ/photon}$$

$$(5.6\underline{7}918 \times 10^{-22} \text{ kJ})\left(\frac{1000 \text{ J}}{1 \text{ kJ}}\right) = \frac{(6.626e{-34} \text{ kg}\cdot\text{m}^2\text{s}^{-1})(3e8 \text{ m/s})}{\lambda}$$

3. A scientific lab is performing an experiment with photons and electromagnetic radiation. They find stray photon signals that they think are coming from local radio broadcasting stations. Which radio station should they ask to turn down their signal if they are getting individual photons with a wavelength of just 304 cm?

$\boxed{B}$

$c = \lambda \nu$

$3e8\ m/s = (3.04\ m)(\nu)$

$\nu = 9.86 \times 10^7\ s^{-1}$

$= 9.86 \times 10^7\ Hz$

$= 98.6\ MHz$

A. 106.5 MHz
B. 98.6 MHz
C. 96.1 MHz
D. 91.2 MHz

4. What is the minimum energy (in Joules) of a photon that must be absorbed to excite the electron from the ground state in a hydrogen atom to n = 5? Report your answer in **scientific notation** and **three significant figures**.

$\boxed{2.09} \times 10^{\boxed{-18}}$ J

$\Delta E = -2.178 \times 10^{-18} J \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$

$= -2.178 \times 10^{-18} J \left(\frac{1}{1^2} - \frac{1}{5^2} \right)$

5. What is **true** about the Bohr model of the atom?

A

A. Electrons orbit the nucleus in fixed energy levels
B. Electrons absorb energy as photons when they fall from an excited state to a ground state
C. The spacing of energy levels is even; all transitions have the same change in energy
D. Electrons falling from an excited state can emit a range of wavelengths if they fall in-between energy levels
E. Electrons have to continually absorb energy so they do not fall toward the nucleus

6. A certain atom has four bright lines in its atomic emission spectrum in the microwave, infrared, ultraviolet, and x-ray regions corresponding to n = 5 to n = 6, n = 4 to n = 2, n = 3 to n = 1, and n = 2 to n = 1. Which of these transitions corresponds to the emission in the microwave region?

A

A. n = 5 to n = 6 → smallest energy gap
B. n = 4 to n = 2
C. n = 3 to n = 1
D. n = 2 to n = 1

lowest energy ↓

Energy trend:

X-ray > ultraviolet > Infrared > microwave

7. Photosynthesis uses 660. nm light to convert CO_2 and H_2O into glucose and O_2. Calculate the frequency (in Hz) of this light. Report your answer in **scientific notation**.

$\boxed{4.55} \times 10^{\boxed{14}}$ Hz

$c = \lambda \nu$

↓

$\nu = \frac{c}{\lambda}$

$= \frac{3e8 \ m/s}{660. \ nm \times \left(\frac{10^{-9} \ m}{1 \ nm}\right)}$

8. Which of the following transitions in the Bohr hydrogen atom will result in *absorption* of the *highest energy* photon?

C

A. n = 5 → n = 1 (emission)
B. n = 3 → n = 4
C. n = 1 → n = 4 → largest gap = highest E
D. n = 2 → n = 5
E. More than one of the above

9. Which of the following types of electromagnetic radiation would have the *shortest* wavelength?

D

A. Visible light
B. Infrared radiation
C. Microwaves
D. X-rays
E. UV radiation

reference EM spectrum

10. The quantum number that describes the orientation of an orbital is…

C

A. n
B. ℓ
C. m_ℓ
D. None of the above

11. What is the correct orbital designation for the following quantum numbers:

$$n = 9, \ell = 0, m_\ell = -2$$

(s)

9s

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** 32.06	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** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.38	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** [97]	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** 127.60	53 **I** 126.90	54 **Xe** 131.29
37 **Cs** 132.91	56 **Ba** 137.33		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** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** [209]	85 **At** [210]	86 **Rn** [222]
87 **Fr** [223]	88 **Ra** [226]		104 **Rf** [267]	105 **Db** [268]	106 **Sg** [269]	107 **Bh** [270]	108 **Hs** [269]	109 **Mt** [277]	110 **Ds** [281]	111 **Rg** [282]	112 **Cn** [285]	113 **Nh** [286]	114 **Fl** [290]	115 **Mc** [290]	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** [145]	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** 173.05	71 **Lu** 174.97	
		89 **Ac** [227]	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	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** [262]	

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 = 2.998×10^8 m/sec
h = 6.626×10^{-34} J·sec
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
Avogadro's number: 6.022×10^{23}
F = 96485 J/(V·mol e^-)
$K_w = 1.0 \times 10^{-14}$ at 25 °C
$k_b = 1.381 \times 10^{-23}$ J/K

Equations
$(P + a(n^2/V^2))\cdot(V - nb) = nRT$
molar mass (M) = mRT/PV
density (d) = MP/RT

$$KE = \frac{3}{2}RT$$

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

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

$$\Delta E = -2.18 \times 10^{-18} J\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

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

$C_g = kP_g$
$P_{solution} = P_{solvent}\ X_{solvent}$
$P_{solution} = \sum P_j = \sum P_j X_j$
$\pi = MRTi$

Thermodynamic and Electrochemistry

$S = k_b \times \ln(W)$
$\Delta S = q_{rev}/T$
$\Delta G = \Delta G° + RT \cdot \ln Q$
R=8.314 J/mol.K
$\Delta G° = -RT \cdot \ln K$
$\Delta G = -nFE_{cell}$
$E°_{cell} = RT/nF \ln K$
$E°_{cell} = (0.0257/n) \ln K = (0.0592/n) \log K$
$E_{cell} = E°_{cell} - (RT/nF) \ln Q$
$E_{cell} = E°_{cell} - (0.0257/n) \ln Q$
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

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

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