VC210 Recitation Class 1

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Contents

Comments Before Class

1. Take notes to prepare cheating paper
2. Ask questions & **ask good questions**!

What is a good question?

specific enough
background info attached

Unit

- common unit: inch, minute, etc.
- **SI unit**: K, kg etc.

Mega	M $= 10^{6}$
kilo	k $= 10^{3}$
deci	d $= 10^{-1}$
centi	c $= 10^{-2}$
milli	m $= 10^{-3}$
micro	$\mu = 10^{-6}$
nano	n $= 10^{-9}$
pico	p $= 10^{-12}$

count SF

Practice by yourself!

1.234	4
1.02	3
0.012	2
0.100	3
5000	1
5000.	4
5×10^3	1
5.00×10^3	3
Planck Constant $h = 6.626 \times 10^{-34} J/s$	∞

Calculation

- addition & subtraction
  Round off the result to the leftmost **decimal place**.
- multiplication & division
  Round off the result to the smallest number of **significant figures**.
- logarithm
  Remain the same SF number in the **mantissa**.
- exponent
  Result's SF number is same as the given number's mantissa.

Round off

- Up if last digit is larger than 5, down if last digit is smaller than 5.
- For number sending in 5, always round to the nearest even number (4 or 6).

example

3.75→3.8
3.65→3.6

Exercise 1

- 40.123+20.34
- 1.23×2.0
- $\log 12.8$
- $10^{1.23}$

Exercise 1

$40.123 + 20.34 = 60.46$
$1.23 \times 2.0 = 2.5$
$\log 12.8 = 1.107$
$10^{1.23} = 17$ or 1.7×10^{1}

Matter

- element
- atoms: count protons, neutrons, atomic number
- molecule & ion (cation[+] & anion[-])
  Requirements: able to recognize the name.
- compound & mixture (**heterogeneous** or **homogeneous**).
- state of matter: gas (g), liquid (l), solid (s).

Moles and Molar Masses

- molar mass: g/mol
- formula weight
- two kinds of formulas
    - **Empirical formulas: only show ratio of atoms**
    - **Molecular formulas: actual number of atoms**
    - e.g. organic matter

Vacabulary

- empirical formula: 实验式/最简式
- molecular formula: 分子式
- solute: 溶质
- solvent: 溶剂
- solution: 溶液
- heterogeneous: 非均相
- homogeneous: 均相 (single phase; cannot distinguish particles)
- electrolyte: 电解质
- neutralization reactions: 中和反应
- redox reactions: 氧化还原反应

Vacabulary

- Separation Techniques
  - Chromatography: absorption ability 层析
  - Distillation: boiling point 蒸馏
  - Decanting: density 倾析
  - Filtration: particle size and solubility 过滤

reaction stoichiometry

$1N_2 + 3H_2 \rightarrow 2NH_3$

- stoichiometric coefficient (化学计量系数): 1, 3, 2
- stoichiometric relation:

  1 mol N_2 ≙ 2 mol NH_3
  3 mol H_2 ≙ 2 mol NH_3

Periodic Table

Periodic Table

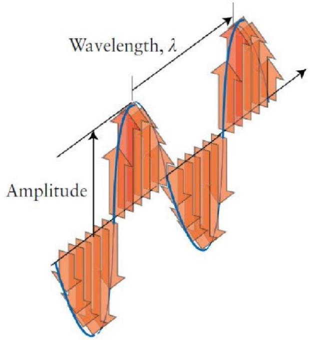
1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 -71	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 -103	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
		57 La	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	
		89 Ac	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	

Electromagnetic Radiation

- $c = 2.998 \times 10^8 \mathrm{m/s}$

$$\overbrace{\lambda}^{\text{wavelength}} \times \overbrace{\nu}^{\text{frequency}} = \overbrace{c}^{\text{speed of light}}$$

The intensity is determined by the square of amplitude.



Different Radiation

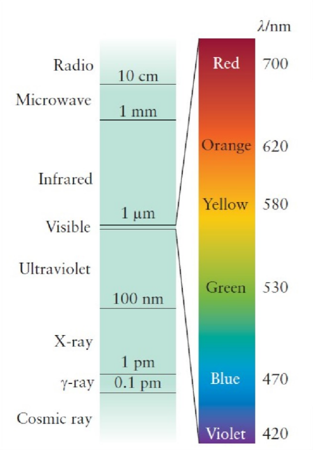


TABLE 1.1 Color, Frequency, and Wavelength of Electromagnetic Radiation

Radiation type	Frequency (10^{14} Hz)	Wavelength (nm, 2 sf)*	Energy per photon (10^{-19} J)
x-rays and γ-rays	$\geq 10^3$	≤ 3	$\geq 10^3$
ultraviolet	8.6	350	5.7
visible light			
violet	7.1	420	4.7
blue	6.4	470	4.2
green	5.7	530	3.8
yellow	5.2	580	3.4
orange	4.8	620	3.2
microwaves and radio waves	$\leq 10^{-3}$	$\geq 3 \times 10^6$	$\leq 10^{-3}$

1 Hz = $1 s^{-1}$

Draw it on your cheating paper!

The Nuclear Model of the Atom

e$=1.602 \times 10^{-9}$C
$m_e = 9.109 \times 10^{-31}$kg

	Experiment	Model	Other Achievement
J.J. Thomson	Cathode Ray Experiment	“Plum-pudding Model”	e/me
Millikan	Oil Drop Experiment	/	e=1.602*10^-9C
Rutherford	α Scattering Experiment	“Nuclear Model”	/

Black Body

- Wien' s Law:
  - There's a maximal wavelength at which the intensity is the highest.
  - $\lambda_{max} \times T = b$ (b$=2.897 \times 10^{-3} m \cdot K$)
- Stefan Boltzmann Law:
  - The total indensity of radiation=constant $\times T^4$ (constant$=5.67 \times 10^{-8} W \cdot m^{-2} \cdot K^{-4}$)

Hydrogen Spectrum

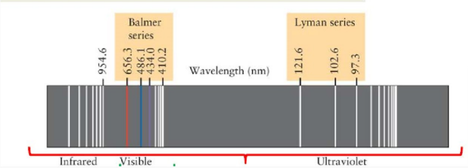
Bohr's Model:

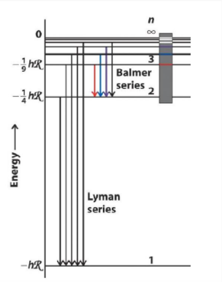
- Electrons orbit the nucleus in orbits which have set size & energy.
- Energy of orbit relates to its size (like planet model).
- When electrons move from one orbit to another, energy is emmited or absorbed in the form of radiation.

Calculation in Hydrogen Spectrum

Calculate the wavelength & frequency of radiation.

- $\nu = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$
- Rydberg constant: $R = 3.29 \times 10^{15} Hz$
- $\frac{1}{\lambda} = R_\lambda \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$
- Rydberg constant: $R_\lambda = 1.097 \times 10^7 m^{-1}$





ATTENTION: the constants are different!

Add wavelength of Balmer series & Lyman series to cheating paper!

Photoelectric Effect

A "strong" photon could eject one electron from an atom.

$$\boxed{h\nu = \phi + \frac{1}{2}mv^2 = h\nu_0 + \frac{1}{2}mv^2}$$

ϕ: Minimal work needed for the effect to happen Also called: *work function*

ν_0: Threshold frequency – the minimal frequency required for the light

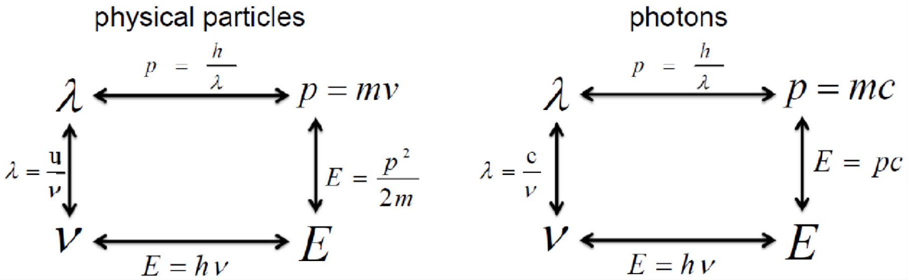
m: Mass of ejected electrons

v: The speed of the ejected electrons

Wave-Particle Duality of Matter

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

Note: the unit of mass is kg!!!

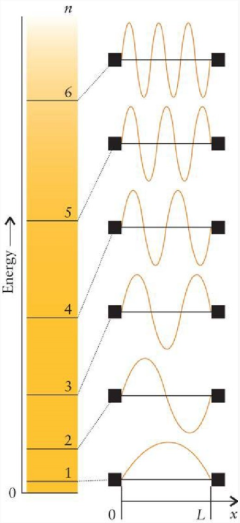


Schrödinger Equation in 1-D Box

n: quantum number

- Wave function: $\psi_n(x) = \sqrt{\frac{2}{L}}\sin(\frac{n\pi x}{L})$
- Probability density function: $p_n(x) = {\psi_n}^2(x)$
- Energy function: $E_n = \frac{n^2h^2}{8mL^2}$

  Note: the unit of mass is kg!!!
- Special: number of nodes = n - 1



Further Explanation

$$E_n = \frac{n^2h^2}{8mL^2}$$

n = 1, 2, ... L is the length of the box; m is mass; h is a constant.

As *L* increases or mass increase:

- energies of levels decrease
- separations between levels decrease
- The quantum effect decreases.

This is why we cannot see the quantum effect on the macro-scale

- $\Psi(x)$
  - $\Psi(x)$: describe a wave.
  - $\Psi^2(x)$: describe the probobility of finding the particle (probability density).
- node
  - where probability=0
  - ATTENTION when counting node: probability =0 when L=0 & L=L!

Schrödinger Equation in n-D Box

2-dimensional box
(*L* may also differ)

$$E_{n_x n_y} = \frac{h^2}{8m}\left(\frac{n_x^2}{L_x^2} + \frac{n_y^2}{L_y^2}\right)$$

3-dimensional box

$$E_{n_x n_y n_z} = \frac{h^2}{8m}\left(\frac{n_x^2}{L_x^2} + \frac{n_y^2}{L_y^2} + \frac{n_z^2}{L_z^2}\right)$$

The Heisenberg's Uncertainty Principle

- Formulas
  - $\Delta x \Delta p \geq \frac{h}{4\pi}$
  - $\Delta x \geq \frac{h}{4\pi m \Delta v}$ (in both formulas, h is the Planck constant)
- Explanation
  - Limitation of the precision of a particle's positon & momentum
  - The more precisely the position of some particle is determined, the less precisely its momentum can be predicted from initial conditions, and vice versa.

The End

Thank you for your attendance.
Q & A
Office Hour at 326I, Longbin Building