① Scientific notation:

.000436 → 4.36×10^{-4}

150,000 → 1.5×10^{5}

② Converting units

given → goal

$650{,}000\ cm \left(\frac{1\ m\ goal}{100\ cm\ given}\right)$

$\frac{650{,}000}{100} = 6{,}500\ m$

③ Significant figures

1-9 = always sig

0^5 = * in b/w 2 sig fig ex → 2003 = 4 s.f.

* following decimal and a # ex 0.0023400 = 4 s.f.

ⓐ adding + subtracting

* answer must be rounded to the least # of decimal places

3.462 + .03502 =

```
  3.462
+
  .03502
-------
  3.49702
```

3.497

ⓑ multiplication + division

(density question) tables $D = \frac{m}{V}$ g/cm³ or ml

* answer must be to the smallest # of s.f.

$5.25 \times 0.00003 = 1.57 \times 10^{-4} = 2 \times 10^{-4}$

(4) % error - table T

$$\left| \frac{\text{(determined) measured value} - \text{accepted value}}{\text{fact} \leftarrow \text{accepted value (true)}} \right| \times 100$$

A student conducted a lab investigation in which they determined the density of a metal to be $5.2\ g/cm^3$ true value is $5.6\ g/cm^3$

$$\frac{5.2 - 5.6}{5.6} \times 100 = -7.142857\ \%$$

Atomic structure

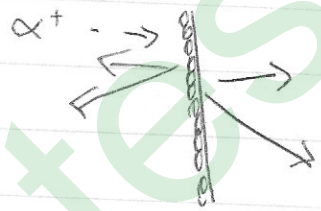
history:

Dalton indivisible → thompson plum-pudding model - cathode ray tube → *Rutherford gold foil experiment → Bohr ~~Bohr~~ planetary model → Modern atomic theory wave mechanical e- cloud model

model electrons act as both *particles + waves

x electrons found in orbitals = probable locations

*Rutherford



* most of atom is empty space

* dense positevly charged core = nucleus

subatomic particle

1. Nucleons - particles found in nucleus:

protons: +1 - 1 amu (u)

neutrons - 0 - 1 amu

electron -1 ~0amu

# of protons plus # of neutrons (3)

atomic mass → 22.98977

Na

11
2-8-1
atomic #

of p^+ = # of e^-

11 p^+
11 p^+
12 n°

Atomic mass = weighted avg. of all the naturally occuring isotopes.

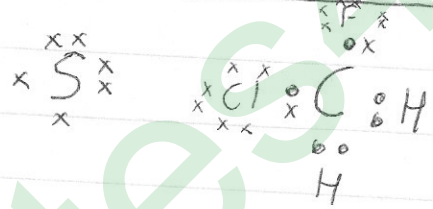
Mass # = 23 (# of p^+ + # of n°)

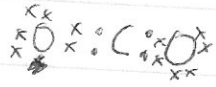
1st packet # 65

$(.9493 \times 31.97) + (.0076 \times 32.97) + (.0429 \times 33.97) + (.0002 \times 35.97)$

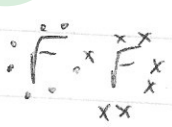
Isotopes - same # protons, dif # of neutrons
same atomic #, dif atomic mass

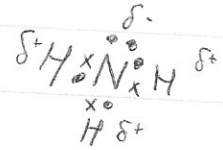
Lewis dot diagram

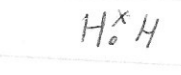




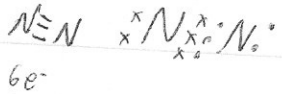
O=C=O



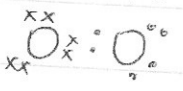




multiple covalent O and N



6e⁻
3 pairs



O=O

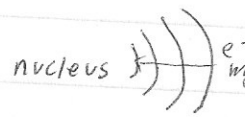
The Bohr Atom

Ground vs excited

absorbs heat energy → excited → ground → release light energy = Bright line spectrum

nuclear charge - always positive and = to # of protons

ex. $^{12}_{6}C$ +6



the further away from nucleus the more energy the e⁻ has

Periodic table

- modern PT goes in order of increasing atomic #
- organized based on elements periodic functions every 8 or 18 elements
- elements found in the same group have similar properties

Trends

En ↑ →

I.E. ↓ ←

atomic radius - as you go down a group it increases

as you go ~~acct~~ across a period the atomic radius decreases due to an increase in nuclear charge (more p)

Metals

atom	Ion (cation)
Na	Na^+
2-8-1	2-8

* atomic radius is larger than ionic radius

Non-Metals

Atom	Ion (anion)
$_{17}Cl$	Cl^-
2-8-7	17 2-8-8

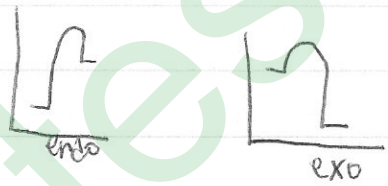
* The atomic radius is smaller than the ionic radius

Bonding

Bond - a force/attraction/interacting b/w atoms of 1 element + atoms of another element

make - release Energy = exo

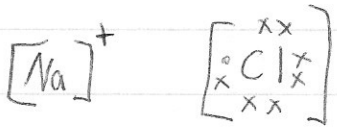
break - absorb energy = endo



Ionic = M + NM

Metal transfers e⁻s to NM

↓ + ion ↓ - ion



properties:

high m.p. + b.p.

good conductors = only as liquid or aq.

hard solids

form ions

molecular / covalent NM + NM

* shared

properties

low m.p. + b.p.

don't conduct

soft

Polar - unequal sharing -

$\delta^+ H-Cl^{\delta-}$

ex H_2O, NH_3

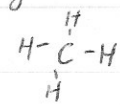
polar - only polar will dissolve in H_2O "like dissolves like"

alcohols = polar

Non-polar - no pull - equal sharing of e⁻s.

diatomics -

symetrical - AB_4 or AB_2



- polar bonds but non-polar molecule

Network - a large # of bonded atoms or molecules → results in hard substances with high mp + bp (still don't conduct)

ex carbon - diamond

SiO_2

SiC

Coordinate Covalent

$H_2O + H^+ \rightarrow H_3O^+$

$NH_3 + H^+ \rightarrow NH_4^+$

Metallic - a large # of metal atoms

positive ions in a sea of mobile e⁻s " (conduct even as solids)

ex Al(s)

Cu(s)

- hard solids
- high mp + b.p.

Intermolecular Forces

1) Weak intermolecular

VDW - London Dispersion

2 non-polar molecules

- found in b/w 2 diatomics or symmetrical
- more electrons → stronger forces of attraction → higher b.p. mp.
- higher b.p. ⇒ stronger IMF

(table H)

Dipole-Dipole

$\overset{\delta+}{H}-F^{\delta-} \cdots\cdots \overset{\delta+}{H}-F^{\delta-}$

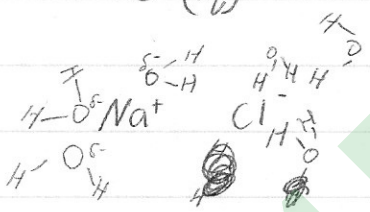
- 2 polar molecules.
- Hydrogen bonding

  HF, H_2O, NH_3 * unusually high b.p

- small radius
- high electronegativity

Molecule Ion

$NaCl(aq)$



Writing Formulas + Naming Compounds

criss-cross

ex magnesium fluoride

$Mg^{+2} F^{-1} \rightarrow MgF_2$

ex dinitrogen pentoxide -

N_2O_5

Ionic
Covalent } Binary - (2 elements) element + ide ending

Ionic - m + Nmide

Cu^{+1} → copper(I)chloride

Cu^{+2} → copper(II)chloride

$Cu^{+1} Cl^{-1} \rightarrow CuCl$

$Cu^{+2} Cl^{-} \rightarrow CuCl_2$

Covalent prefix - every element gets prefix - 1st element no mono

P_2O_3 = diphosphorous trioxide

Table E Polyatomic ions

$MgSO_4$ = magnesium sulfate

* any compound that isn't binary involves a polyatomic ion

ex $NaHCO_3$ = sodium hydrogen carbonate

Mg (ionic) SO_4 (covalent) 1 mg ions, 1 sulfate ion

*NH_4NO_3 = ionic and covalent bonds

m 2 ions

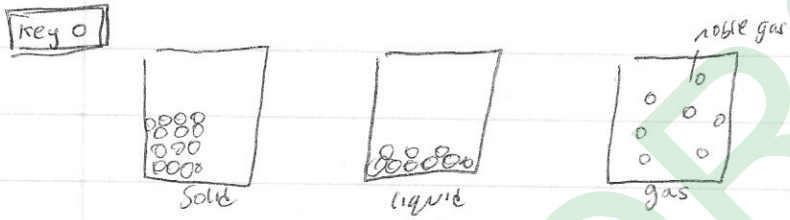
Matter + Energy

- 3 phases - (Physical Change)

solid - organized - low entropy
close together - organized

liquid - moving - medium entropy
close together

gas random - high entropy
far apart



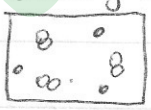
substance - "pure" - element
compound

= H_2O molecule

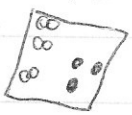
= diatomics

Mixture - 2 substances

Homogeneous = solution
evenly mixed (aq)



Heterogeneous
not evenly mixed



Seperation of mixtures

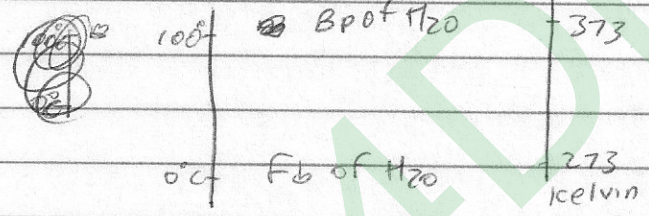
1. Filtration - 2 substances are not soluble in each other

2. Chromatography - pigments
"attraction to the transporting medium"

3. Distilation - 2 dif b.p.
   - liquid → gas
   - gas → liquid

Energy

Temp - av KE



c° + 273 = kelvin

$q = mc\Delta T$ table T + B

$q = mH_f$

$q = mH_v$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

T_1 → kelvin

at STP =

at STP =

273k 101.3 kpa
1atm

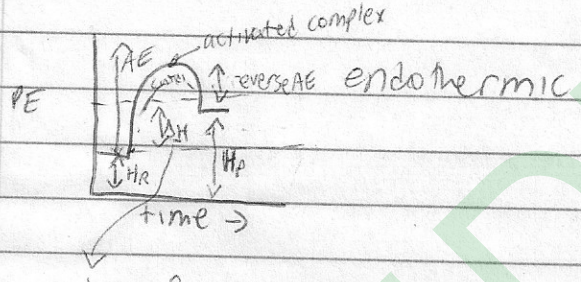
Kinetic Molecular Theory

1) no attractive forces b/w gas particles
2) negligible volume due to great distances
3) collisions are elastic - no loss or gain of energy
4) particles move in random straight line motion

Ideal gases = high temp + low pressure

Kinetics + Equilibrium

def - study of rates of chemical reactions



endothermic

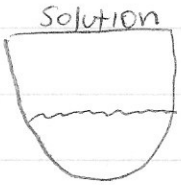
heat of reactions

* A catalyst speeds up both the foward + reverse reactions equally by providing an alternate pathway which lowers the activation energy.

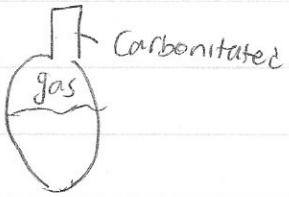
* Collision Theory - The proper orientation + proper energy are required for a reaction to take place
Factors that affect rate of reaction: temp, concentration, surface area: a powder will react fastest
catalyst
nature of reactants

Equilibrium - rate of foward rx = rate of reverse reaction.

- concentration of reactants + products is constant



rate of dissolving is = to rate of recrystilization

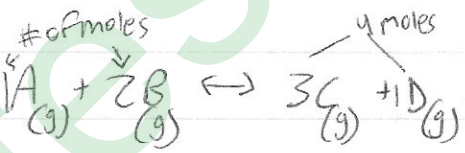


phase eq. during a phase change

$L \longrightarrow g$

Changes in pressure, temp + concentration will affect eq.

* any of these stresses put on system cause the eq to shift to undo the stress.



increase in temp causes eq to shift to the left

increase Conc. B eq shifts right

increas pressure eq shifs to the left to where there are less moles

Common Ion effect - adding an ionic compound that has an ion in common with 1 in the reaction its as if you added the ion itself. →→

Acids + Bases

Arrhenius -

acid - gives off H^+ as the only positive ion in solution

NaOH $Ca(OH)_2$ Base - gives off OH^- as the only negative ion in solution.

Table K - common acids Table L common bases

Alternate Theory

Acid - proton donor

Base - proton acceptor

* electrolytes - conduct electricity

table M = indicators

pH - measure of acidity or alkalinity of a substance.

* cleaners are basic

4 5 6 7 8 9

going from a ph of 7 to a ph of 4 is 1000 times more H^+ or 1000 times more acidic

$H^+ = H_3O^+$

16

Neutralization - (ionic)

Acid + Base → Salt + H_2O

$\underset{NM}{HCl} + \underset{M}{KOH} \rightarrow \underset{M\ NM}{KCl} + \underline{\quad H_2O \quad}$

Titration - lab

$M_A V_A = M_B V_B$

15.0ml of 1.5M HCl

+ 10.0ml of KOH

What is the molarity/concentration of base?

$1.5M \times 15.0ml = X \times 10.0ml$

Redox + Electrochemistry

oxidation - losing electrons LEO ↑ charge
reduction - gaining GER ↓ charge

* Follow path of electrons
* assign oxidation #s
  - Na^0 = element alone = 0
  - Mg^{+2} = ion Ox # = Charge (+2)
  - sum of oxidation #s in a compound = 0
  - group 1 = +1
  - group 2 = +2
  - halogens -1 in binary compounds
  - hydrogen = +1
  - oxygen is = (-2)

$$Fe^{+3} + Na^0 \rightarrow Na^{+1} + Fe^{+2}$$

ox - $Na^0 \rightarrow Na^+ + 1e^-$
red - $Fe^{+3} + 1e^- \rightarrow Fe^{+2}$

electrons go on more positive side

(+6) (+6)

$$3Mg^0 + 2Fe^{+3} \rightarrow 3Mg^{+2} + 2Fe^0$$

ox - $3(Mg^0 \rightarrow Mg^{+2} + 2e^-)$
red - $2(Fe^{+3} + 3e^- \rightarrow Fe^0)$

* all redox reactions there is a conservation of matter, energy and charge

Electrochemical Cells

Oxidation occurs at anode

Reduction occurs at cathode

ANOX | RED CAT

2 types:

* Voltaic cells

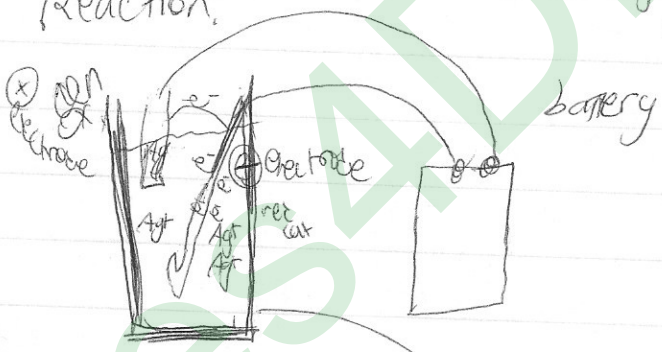
Spontaneous.

"Chemical reaction produces electrical energy"

* Electrolytic cells - non spontaneous

using electrical energy to force a chemical reaction.

electroplating



$Ag \rightarrow Ag^+ + 1e^-$

(20)

organic ~~Inorg~~

Contain C (H)

properties:

non-polar covalent except for alcohols

Slow reactions

not electrolytes except organic acids

alkanes "double +2"

C_2H_6

all single bonds

saturated

alkenes -double

Cyclo

double bond

unsaturated

alkynes "double -2"

C_3H_4 triple bond

unsaturated

one member to next ∨ are adding CH_2

21

Isomer

2 compounds have the same molecular formula but diff. structures

ex ethers + alcohols

CH_3-O-CH_3 | $-\overset{|}{C}-\overset{|}{C}-OH$

C_2H_6O

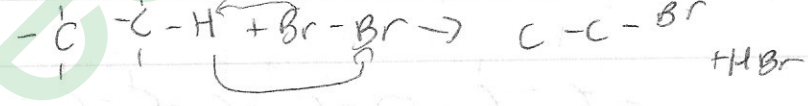
addition

alkene or alkyne → alkane

2R → 1P

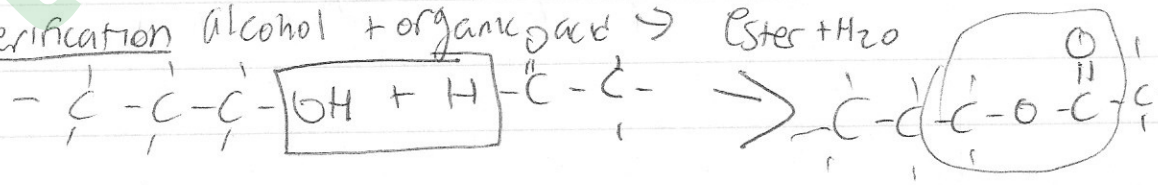
Substitution

alkane + halogen →



pleasant odor

Esterification alcohol + organic acid → Ester + H_2O



C = 4 bonds

O = 2 bonds

H = 1 bond

halogens - 1 bond

propyl alcohol

ethanoate acid

Nuclear Chemistry (23)

Table O - decay modes

due to instability of nuclei - not a 1:1 ratio OF p^+ : n^0

* elements (83) + above = unstable

mass

ex ^4_2H = α + ~~β~~ Alpha particle

Charge

$^0_{-1}B$ = beta

$^0_0\gamma$ = gamma

Penetrating

weakest

Strongest

$^{85}_{36}Kr \rightarrow {}^0_{-1}e + {}^{85}_{37}Rb$

29

Fission

$^{235}_{92}U + {}^{1}_{0}n \rightarrow Kr + Ba + 3{}^{1}_{0}n$

heavy nucleus splits into 2 lighter ones

Fusion -

$^{1}_{1}H + {}^{1}_{1}H \rightarrow {}^{4}_{2}He$

2 light nuclei forming a heavier one

transmutations -

natural - 1 reactant

artificial - 2 reactants

Half life

Time	Mass
0	100g
4	50g
8	25g
12	12.5g

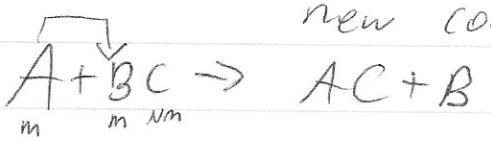
half life is 4 days

Reaction

Synthesis = 2R → 1P

Decomposition = 1R → 2P

Single replacement - element + compound → new element + new compound



Double replacement -

~~AB → CB~~ AB + CD → AC + BD

Combustion -

Organic + O_2 → CO_2 + H_2O + E

Neutralization -

(DD) acid + base → Salt + H_2O

Redox Reaction:

*Changes in charge

Addition (synthesis)

Substitution

Esterification

Saponification

polymerization

Fermentation

Fission

Fusion

natural transmutation

artificial transmutation