

# Comprehensive and detailed chemistry notes essay sample

[Science](#), [Chemistry](#)



**ASSIGN  
BUSTER**

## 1. MUCH OF THE WORK OF CHEMISTS INVOLVES MONITORING THE REACTANTS AND PRODUCTS OF REACTIONS AND MANAGING REACTION CONDITIONS

\* outline the role of a chemist employed in a named industry or enterprise, identifying the branch of chemistry undertaken by the chemist and explaining a chemical principle that the chemist uses

\* identify the need for collaboration between chemists as they collect and analyse data

Chemists usually work in teams. The needs for collaboration are:

- The sharing of expertise. Not all chemists work in the same field.
- There is a wider knowledge available
- Increases validity and accuracy of data and results
- Time is saved since data is gathered and analysed in teamwork

\* describe an example of a chemical reaction such as combustion, where reactants form different products under different conditions and thus would need monitoring

Once a reaction takes place, it is important to monitor the reaction. This is because if conditions in the reaction chamber are altered, harmful products may be produced and reaction wouldn't go to completion.

Eg: Incomplete combustion

- Incomplete combustion of octane:  $C_8H_{18}(l) + 9O_2(g) \rightarrow \frac{1}{2} 3CO_2(g) + 3CO(g) + 2C(s) + 9H_2O(g)$

- CO is a poisonous gas which combines strongly with haemoglobin preventing transport of oxygen

- Carbon is a pollutant and forms soot

- Incomplete combustion occurs in poorly started engines.

Eg: Complete combustion

- Complete combustion of octane:  $C_8H_{18}(l) + 12.5O_2(g) \rightarrow 8CO_2(g) + 9H_2O(g)$

- In order for complete combustion to occur there must be sufficient oxygen available for the octane to burn completely.

- The products of complete combustion are  $CO_2$  and  $H_2O$ .

## 2. CHEMICAL PROCESSES IN INDUSTRY REQUIRE MONITORING AND MANAGEMENT TO MAXIMISE PRODUCTION

\* identify and describe the industrial uses of ammonia

Ammonia is the feedstock for a variety of industrial chemicals. The making of fertilisers accounts for 80% of the world wide use of ammonia. Other uses of ammonia are:

- production of explosives ( TNT ).

- acrylic and nylon plastics

- dyes

- antibiotic drugs

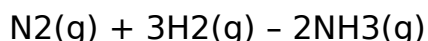
- cationic detergents

\* identify that ammonia can be synthesised from its component gases, nitrogen and hydrogen

Ammonia can be synthesised using the two component gases. These are Nitrogen( N<sub>2</sub> ) and Hydrogen( H<sub>2</sub> ). The complete reaction is: N<sub>2</sub> (g) + 3H<sub>2</sub> (g) - 2NH<sub>3</sub> (g)

- Under pressure and heat, 3 moles Hydrogen and 1 mole Nitrogen react to produce 2 moles of ammonia.

\* describe that synthesis of ammonia occurs as a reversible reaction that will reach equilibrium



- This is a reversible reaction which reaches equilibrium.

- Nitrogen and Hydrogen react to form ammonia ( forward reaction ).

- Nitrogen and Hydrogen are formed from ammonia ( reverse reaction ).

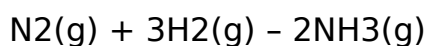
- At the start rate of reaction is slow

- Equilibrium is reached when forward reaction rate is equal to the reverse reaction rate

- Conditions must be established to shift equilibrium to the right yielding more ammonia.

\* identify the reaction of hydrogen with nitrogen as exothermic

- The forward reaction to produce ammonia is exothermic, ( 92 KJ ) of heat are released.



$$\Delta H = -92 \text{ KJ}$$

\* explain why the rate of reaction is increased by higher temperatures

The rate of reaction is increased with an increase in temperature.

- Increasing the temperature gives molecules higher kinetic energy to a stage where the activation energy barrier is overcome.

- These molecules then collide strongly and more frequently, increasing reaction rate.

- Le Chatelier's principle states that since production of ammonia is exothermic, the equilibrium will shift to the left, using up the newly acquired heat.

\* explain why the yield of product in the Haber process is reduced at higher temperatures using Le Chatelier's principle

- The ammonia equilibrium is exothermic

- therefore an increase in temperature will shift equilibrium to the left to use up the added heat.

- Thus a high temperature causes a decrease in the yield of ammonia

- Le Chatelier's principle states a low temperature favours a higher yield of ammonia.

\* explain why the Haber process is based on a delicate balancing act involving reaction energy, reaction rate and equilibrium

\* explain that the use of a catalyst will lower the reaction temperature required and identify the catalyst(s) used in the Haber process

- Catalysts increase the rate of reaction

- Catalysts are not used up in the reaction

- Catalysts do not have an effect on the equilibrium

- The catalyst for the Haber process is magnetite ( $\text{Fe}_3\text{O}_4$ ) fused with  $\text{K}_2\text{O}$ ,  $\text{Al}_2\text{O}_3$  and  $\text{CaO}$ .

- Magnetite is ground to fine powder with large surface area

- Gaseous Nitrogen and Hydrogen are adsorbed onto the solid surface

- They then re-arrange, to form ammonia
  - The catalysts lowers activation energy
  - This allows for a more rapid reaction at low temperatures
- \* analyse the impact of increased pressure on the system involved in the Haber process

Le Chatelier's principle states that:

- increase in pressure ( by reducing volume ) causes equilibrium to the side of equation with least gaseous molecules
  - Therefore, increasing pressure in the Haber process, will favour the forward reaction and yield more ammonia.
  - High pressure also increases reaction rate because gas molecules are closer together and in high concentrations
  - To maximise yields of ammonia, chemists use the process of liquefaction to remove ammonia as soon as it is formed
  - Equilibrium shifts to the right to restore balance, resulting in higher yield of ammonia.
- \* explain why monitoring of the reaction vessel used in the Haber process is crucial and discuss the monitoring required

Industrial chemists and chemical engineers employed in the ammonia production industry, monitor reaction vessel to ensure quality control. Tasks include:

- High pressure monitoring: This ensures safe conditions are met. Sensors transmit pressure data for monitoring.
- Temperature monitoring: Temperature must remain in optimum range. Sensors transmit temperature data for monitoring.
- Catalyst activity monitoring: Particle size of catalyst must be monitored to ensure high surface area.
- Product monitoring: The ammonia must be monitored after the reaction to ensure that it meets standards and must not contain impurities.
- Liquefaction process monitoring: Liquefaction process must be monitored to ensure optimal yield of ammonia.

### 3. MANUFACTURED PRODUCTS INCLUDING FOOD, DRUGS AND HOUSEHOLD CHEMICALS ARE ANALYSED TO DETERMINE OR ENSURE THEIR CHEMICAL COMPOSITION

- \* deduce the ions present in a sample from the results of tests
- \* describe the use of atomic absorption spectroscopy (AAS), in detecting concentrations of metal ions in solutions and assess its impact on scientific understanding of the effects of trace elements



AAS is a method used used to detect concentrations of metal ions in solution.

The procedure is as follows:

1. A sample of the solution to be analysed is heated at high temperatures to vapourise the atoms.

2. A hollow cathode lamp of the of the element being determined, is used to emit wavelengths of light characteristic of the element being analysed.

3. — As the light passes through vapurised sample, some of the light is absorbed by hot atoms.

— A second beam passes the samples

4. — Emerging light passes through a monochromator

— The light then passes through a slit to select one wavelength band to be measured

5. The intensity of the selected beam is measured

6. Photomultiplier tubes then convert this this measurement into eectrical signals

— The grater the concentration, the greater the amount of light absorbed

— AAS is a very sensitive process whereby concentrations of elemnts in ppm can be detected and sometimes in ppb.

TRACE ELEMENTS

Trace elements: Elements required by living organisms in barely detectable amounts.

— Before AAS, detecting concentrations depended on wet processes such as titration.

— These wet processes were not accurate enough to make a final judgement.

— AAS has an increased accuracy of measurements

— AAS is used all over the world nowadays in the fields of agriculture, environmental pollution, food and water etc.

Eg: Soils are analysed for a lack of trace elements which might reduce agricultural output. Using AAS problems are identified and then solved. This results in much more efficient farming and output.

4. HUMAN ACTIVITY HAS CAUSED CHANGES IN THE COMPOSITION AND STRUCTURE OF THE ATMOSPHERE. CHEMISTS MONITOR THESE CHANGES SO THAT FURTHER DAMAGE IS LIMITED

\* Describe the composition and layered structure of the atmosphere

NAME OF LAYER

MINIMUM AND MAXIMUM DISTANCE FROM EARTH

COMPOSITION

## TEMPERATURE

### Troposphere

0-15 km

78% N<sub>2</sub>, 21% O<sub>2</sub>, 0.9% Ar and small amounts of other gases such as CO<sub>2</sub>

Variable. Weather is determined in this layer

### Stratosphere

15-50 km

Ozone (O<sub>3</sub>) and other gases

-50 to 30 at top

### Mesosphere

50-85 km

Ions and atomic particles

Approximately -90

### Thermosphere

85-600 km

Ions and atomic particles

Can reach over 1700

\* Identify the main pollutants found in the lower atmosphere and their sources

POLLUTANT

SOURCE

EFFECT

Carbon monoxide

Incomplete combustion

Eg: cars

Toxic. Binds with haemoglobin preventing oxygen uptake

Carbon dioxide

Burning of fossil fuels

Adds to global warming effect

Nitrogen oxides

Internal combustion

Reacts to form nitric acid which contributes to acid rain

Ozone

Decomposition of NO<sub>2</sub> in UV light

Causes respiratory problems

Sulfur dioxide

Combustion of coal and oil

Irritating, poisonous gas

\* Describe the formation of a coordinate covalent bond

A coordinate covalent bond is formed when one atom provides both electrons to form the shared bonding pair.

\* Demonstrate the formation of coordinate covalent bonds using Lewis electron dot structures

\* describe ozone as a molecule able to act both as an upper atmosphere UV radiation shield

— Ozone is a toxic gas in the troposphere

— In the stratosphere it is vital for life

— In the stratosphere, ozone molecules absorb UV radiation

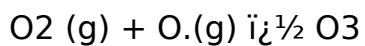
— UV radiation is harmful to living cells

— UV-B and UV-C radiation is absorbed

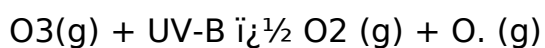
— UV-A is allowed to reach the Earth

— UV-A promotes production of vitamin-D in our skin

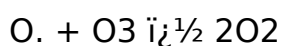
— Ozone is naturally formed in stratosphere:



— Ozone naturally decomposes when it absorbs UV-B and UV-C radiation:



— The radical formed can react with ozone to form oxygen molecules:



\* compare the properties of the oxygen allotropes O<sub>2</sub> and O<sub>3</sub> and account for them on the basis of molecular structure and bonding

Properties

gaseous oxygen

gaseous ozone

Explanation

colour

colourless

blue

-

boiling point

-183½C

-111½C

The boiling point of diatomic oxygen is lower than that of the ozone as diatomic oxygen has a lower molecular mass requiring less energy in the boiling process.

solubility in water

sparingly soluble

more soluble than oxygen

Non-polar O<sub>2</sub> does not form strong intermolecular forces in the polar water. Ozone has a bent structure, which provides for some polarity of the molecule in its interaction with water.

chemical stability

far more stable than the ozone molecule

far less stable than the oxygen molecule

Ozone is easily decomposed into oxygen molecules:

#More detailed information below.

oxidation ability

less powerful oxidant

more powerful oxidant

e. g. reaction with metals: oxygen forms the oxide as the only product whereas ozone reacts more readily producing the metallic oxide and an oxygen molecule.

\* compare the properties of the gaseous forms of oxygen and the oxygen free radical.

— In its lowest energy state,  $O_2$  has a valence shell with 3 pairs of electrons

— When combines, each oxygen atom shares a pair of electrons to form double covalent bond

— When oxygen atoms split into separate oxygen atoms, the atoms are called oxygen free radicals.

— These have 2 paired electrons and 2 unpaired

— This makes radicals very reactive

— Oxygen free radicals are more reactive than ozone

\* identify the origins of chlorofluorocarbons (CFCs) and halons in the atmosphere

— CFC's are haloalkanes where all hydrogen atoms are replaced by fluoro- and chloro- functional groups



- CFC's were developed in the 1930's replacing ammonia as refrigerants in refrigerators and air conditioners.
- CFC's were also used as propellants in spray cans, solvents for cleaning electrical circuits and blowing agents for packaging
- Gases from CFC products were released into the atmosphere
- Halons are haloalkanes in which all the hydrogen atoms have been replaced by bromine, fluorine and/or chlorine atoms
- Halons were developed for use in extinguishing fires, particularly in large computer systems and aeroplanes.
- Halon use has extremely been reduced due to high ozone depletion potential of bromine

##### 5. HUMAN ACTIVITY AFFECTS WATERWAYS. CHEMICAL MONITORING AND MANAGEMENT ASSISTS IN PROVIDING SAFE WATER FOR HUMAN USE AND PROTECTING THE HABITATS OF OTHER ORGANISMS.

\* identify that water quality can be determined by considering:

- > concentrations of common ions
- > total of dissolved solids
- > hardness
- > turbidity

> acidity

> dissolved oxygen and biochemical oxygen demand

\* construct word and balanced formulae equations of chemical reactions as they are encountered

There are three important steps involved:

1- Show all reactants and all products in the word equation.

2- Write the correct formula for each reactant and each product.

3- Balance the formula equation by placing coefficients (numbers) in front of formulas so that you have the same total number of each kind of atom on both the reactant side and the product side. Remember that in chemical reactions atoms are just rearranged, not created or destroyed.

\* identify the industrial source of ethylene from the cracking of some of the fractions from the refining of petroleum

Ethylene is one of the top five products produced by chemical industry.

— Ethylene is usually produced in two ways:

CATALYTIC CRACKING:

— Heavy crude oil is combined with a hot catalyst composed of powdered zeolite

— Zeolite is an Aluminium silicate

— It has a large surface area due to cavities and tunnels

— After the reaction, the catalyst is steam cleaned and recycled

—  $C_{18}H_{38} \longrightarrow 4CH_2=CH_2 + C_{10}H_{22}$

— This can yield small molecules such as ethylene and propylene

\* identify that ethylene, because of the high reactivity of its double bond, is readily transformed into many useful products

Ethylene is more reactive than ethane or other alkanes.

— The high electron density of the double bond makes it very reactive

— This double bond allows it to be chemically transformed into variety of petrochemicals

-Petrochemicals that can be produced by addition across double bond include:

Product

Use

Polyvinyl chloride (PVC)

Plastic pipes, guttering

Ethanol

Solvent, fuel, drinks

Polystyrene

Plastic packaging, insulation

Chloroethane

Solvent, refrigerant

HYDRATION:

Water adds across the double bond to form ethanol ( $C_2H_4 + H_2O \rightarrow C_2H_5OH$ )

HYDROHALOGENATION:

Hydrogen chloride reacts with ethylene to form chloroethane ( $C_2H_4 + HCl \rightarrow C_2H_5Cl$ )

\* identify that ethylene serves as a monomer from which polymers are made

- Ethylene is an important monomer.
- Ethylene undergoes addition polymerisation to form polyethylene.
- In this process the double bond breaks

LDPE:

- It is made under high pressures and temperatures
- An initiator such as benzoyl peroxide is used

Steps in the process are:

- Heated benzoyl peroxide splits to form free-radicals
- These react with ethylene double bond as initiators. Activated monomer radical forms.
- The monomer radicals combine with new ethylene monomers building up the chain
- Chain growth terminates when free-radicals combine forming non-activated species

HDPE:

- HDPE is manufactured under low pressures and temperatures
- A ziegler-Natta catalyst is used to polymerise ethylene into polyethylene
- The catalyst is titanium chloride and triethyl aluminium chloride
- HDPE is produced as a linear polymer with little branching
- This makes it rigid and crystalline
- Is used to make crates, petrol tanks and rubbish bins

identify polyethylene as an addition polymer and explain the meaning of this term

- Addition polymerisation is a process in which unsaturated monomers combine by the process of addition
- In ethene, the reactive group is the Carbon-Carbon double bond
- This reacts giving a free-radical which rapidly adds another monomer molecule
- This is a chain reaction and goes on and on
- Polyethylene is an addition polymer, as the ethene keeps adding on

The key features of addition polymerisation are:

- \* molecular species can react only with active centres
- \* chains are long at all times
- \* some monomer remains until end of reaction
- \* reactions relatively fast, generate lots of heat
- \* identify the following as commercially significant monomers:
  - > vinyl chloride
  - > styrene
  - > by both their systematic and common names
- \* describe the uses of the polymers made from the above monomers in terms of their properties

## MONOMERS

## POLYMERS

Common name

Systematic name

Name

Properties

Used for

ethylene

ethene

LD polyethylene

low density, soft

flexible food bags

HD polyethylene

high density, hard

crinkly garbage bags

vinyl chloride

chloroethene

polyvinylchloride

made rigid and flame resistant with additives, water resistant

rigid pipes and gutters,

flexible raincoats and shower curtains

styrene

ethenylbenzene

polystyrene

transparent, due to few crystals,

when gas added forms foam

compact disc cases,

heat insulation, floats

## 2. SOME SCIENTISTS RESEARCH THE EXTRACTION OF MATERIALS FROM BIOMASS TO REDUCE OUR DEPENDENCE ON FOSSIL FUELS

\* discuss the need for alternative sources of the compounds presently obtained from the petrochemical industry

— Crude oil is the current source of petrochemicals

— Natural gas, coal and petroleum are non-renewable

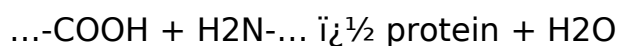


- Consumption of these fossil fuels is accelerating
  
  - These fossil fuels will eventually run out
  
  - Alternative sources of carbon compounds must be developed to allow economies to grow
  
  - Biomass is a very important candidate in being used in developing alternatives
  
  - Cellulose is a major component of biomass
  
  - Biomass is a very large energy resource
  
  - Biomass is renewable
  
  - Cellulose can be fermented to produce ethanol; can be used as fuel
  
  - The burning of fossils is releasing CO<sub>2</sub> which affects composition of the atmosphere
  
  - This can lead to drastic changes in climate, agriculture and survival of many species
- \* explain what is meant by a condensation polymer
- In condensation polymerisation, reactive groups on both ends of each monomer react with one another
  
  - It is called step-growth polymerisation

- Monomers combine via a chemical process
- Two monomers combine with elimination of a smaller molecule (e. g. water)

\* describe the reaction involved when a condensation polymer is formed

Condensation polymers are those formed from monomers with the removal of water. The formation of proteins from amino acid monomers is a condensation polymer reaction.



Another example is when two glucose monomer molecules react through two hydroxy groups -OH, an H-OH molecule is condensed out, leaving an -O- linking the two monomer molecules. The first two glucose molecules to join condense out an H-OH, and every glucose molecule added to the growing chain then condenses out another H-OH.

\* describe the structure of cellulose and identify it as an example of a condensation polymer found as a major component of biomass

- Cellulose is a condensation polymer which is formed when glucose monomers condense together
- The reaction is between the -OH groups at C1 and C4 carbons of adjacent glucose molecules
- a water molecule is eliminated during this reaction

— More glucose monomers condense together and are linked in long unbranched strands

— Strong hydrogen bonding occurs between -OH groups of neighbouring strands

— Cellulose is water insoluble and is strong and rigid

\* identify that cellulose contains the basic carbon-chain structures needed to build petrochemicals and discuss its potential as a raw material

— Cellulose can be broken down using acid hydrolysis

— Glucose is fermented by yeast to form ethanol

— Ethanol is dehydrated to form ethylene

— Many petrochemicals are manufactured from ethylene

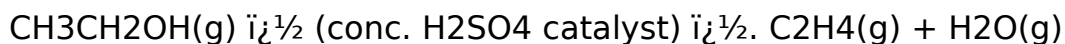
— This method is very expensive in comparison to current ethylene production methods

3. Other resources, such as ethanol, are readily available from renewable resources such as plants

\* describe the dehydration of ethanol to ethylene and identify the need for a catalyst in this process and the catalyst used

— Ethylene can be prepared from ethanol by a process called dehydration

— Concentrated sulfuric acid is used to remove water molecule from ethanol



- Concentrated sulfuric acid acts as a catalyst and dehydrating agent
- The best yield is achieved using 1: 4 ratio of ethanol and sulfuric acid
- The catalyst absorbs the water produced to prevent the reverse reaction
- The greater proportion of sulfuric acid drives reaction towards product side

\* describe the addition of water to ethylene resulting in the production of ethanol and identify the need for a catalyst in this process and the catalyst used

#### INDIRECT HYDRATION:

- Ethylene is reacted with 98% sulfuric acid
- The reaction mixture is mixed with water until sulfuric acid concentration is about 50%
- This is then heated
- Ethanol formed is distilled

The reaction occurs in 2 steps:

1. Sulfuric acid adds across the double bond to produce ethyl hydrogen sulfate

2.

The ethyl hydrogen sulfate reacts with water, generating ethanol; sulfuric acid reforms

CATALYTIC HYDRATION:

— Ethanol can be prepared by catalytic hydration of ethylene

— Ethylene and steam are passed over a zeolite surface impregnated with phosphoric acid

— Phosphoric acid is the catalyst

— The temperature of 300 degrees is a compromise

— At this temperature molecules have sufficient kinetic energy and temperature is not too high affecting yield of ethanol

\* describe and account for the many uses of ethanol as a solvent for polar and non-polar substances

— Ethanol is a polar molecule and a polar solvent

— Ethanol acts as a solvent for both polar and non polar substances

— It is soluble in water in all proportions due to strong hydrogen bonding between the two liquids

- One end of ethanol consists of a hydroxy group -OH. This is hydrophilic and is the polar end of ethanol. Many solutes with polar functional groups interact with the -OH
- Ethanol also has a non polar hydrocarbon end CH<sub>2</sub>CH<sub>3</sub>
- This assists the dissolving of some non polar solutes in ethanol
- This is important because insoluble organic substances in water can dissolve in ethanol
- Ethanol has low toxicity, making it suitable for pharmaceuticals and deodorants
- Ethanol is flammable and can be used as a fuel

\* describe conditions under which fermentation of sugars is promoted

Materials and conditions required for fermentation of sugars are:

- Alcohol tolerant yeast
- Aqueous solution of simple sugars
- pH of 3.7 - 4.6. This low pH prevents growing of pathogens
- Diammonium phosphate is needed to aid the growth of yeast
- Temperature of ~37 degrees
- 3-5 days are needed for ethanol production from fermentation

- Anaerobic conditions are needed (closed vessels, absence of air)
  - A micro-organism such as yeast which contains enzymes to catalyse the reaction
- \* summarise the chemistry of the fermentation process
- Simple sugars derived from plant material are mixed with yeasts
  - Yeasts produce the enzymes; zymase, maltase and invertase
  - These enzymes catalyse a complex biochemical reaction series in which sugars are converted to glucose
  - The glucose then undergoes a process of fermentation in which ethanol and carbon dioxide are produced
  - Molasses syrup is a by-product of the sugar industry
  - It contains a high percentage of sucrose

Hydrolysis of sucrose:  $C_{12}H_{22}O_{11} + H_2O \rightarrow 2C_6H_{12}O_6$

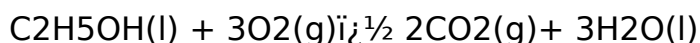
Fermentation of glucose:  $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

Net:  $C_{12}H_{22}O_{11} + H_2O \rightarrow 4C_2H_5OH + 4CO_2$

- \* define the molar heat of combustion of a compound and calculate the value for ethanol from first-hand data

- The molar heat of combustion is the amount of heat released by the complete combustion of one mole of a substance
- The molar heat of combustion is expressed in KJ/mol
- In a plentiful supply of oxygen, alkanols burn completely to produce carbon dioxide and water

The complete combustion of ethanol is shown below:



\* assess the potential of ethanol as an alternative fuel and discuss the advantages and disadvantages of its use

#### ADVANTAGES AND DISADVANTAGES:

- Ethanol does not release as much energy on combustion as petrol. This means it burns more completely because it is a small molecule. Longer chain alkanols produce soot and carbon dioxide upon combustion.  $\text{C}_2\text{H}_5\text{OH}(\text{l}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l})$
- The main sources of ethanol are starch and sugar.  $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2$
- Ethanol is a renewable fuel, unlike fossil fuels which are non renewable
- Large area of arable land are needed to grow the crops needed for production of ethanol which will result in loss of native forests. Australia lacks this arable land.



— Ethanol can only be used as a 10-15% blend with petrol. Any higher proportion of ethanol would require engine modifications which are very expensive.

— Ethanol vapour mixtures have a greater flammability range than petrol vapour mixtures. Therefore ethanol-air mixtures will ignite and combust rapidly

\* identify the IUPAC nomenclature for straight-chained alkanols from C1 to C8

To name the alkanol, the following steps must be followed:

1. Count the number of carbons in the straight chain. Select correct stem to name parent alkane. Remove the ' e' and replace with suffix '-ol'.

2. For chains with 3 or more carbon atoms, number the carbon atoms from end where the alcohol group will have lowest number possible

3. Insert locant of the -OH group in front of the ' ol' suffix

4. OXIDATION-REDUCTION REACTIONS ARE INCREASINGLY IMPORTANT AS A SOURCE OF ENERGY

\* explain the displacement of metals from solution in terms of transfer of electrons

— OILRIG: Oxidation is loss; reduction is gain

— Chemical species that cause reduction are called reductants

- Chemical species that cause oxidation are called oxidants
  - Displacement reactions are oxidation-reduction( redox) reactions
  - More reactive metals displace less reactive metals from solution of their ions
  - More reactive metal loses electrons and becomes an ion, whereas ions of the less reactive metal gain electrons and form the metal
- \* identify the relationship between displacement of metal ions in solution by other metals to the relative activity of metals
- Displacement reactions are used to create an activity series for metals related to their strength as reductants.
  - A displacement reaction will occur only if the metal and the metal ion can successfully donate and accept electrons
  - Active metals readily donate their valence electrons to oxidants

#### ACTIVITY SERIES:

$K > Na > Mg > Al > Mn > Zn > Fe > Ni > Sn > Pb > H_2 > Cu > Ag > Au$

#### RULE:

- Active metals are strong reductants while inactive metals are weak reductants

— Cations of inactive metals are strong oxidants while cations of active metals are weak oxidants

\* account for changes in the oxidation state of species in terms of their loss or gain of electrons

— The oxidation state of an element is a measure of its degree of oxidation

> Uncombined elements have a zero oxidation state

> Simple ions have an oxidation state equal to the charge

> The sum of the oxidation states for elements in a molecule is zero

> The sum of oxidation states of polyatomic ions is equal to the charge of the ion

> In most compounds, hydrogen has oxidation of +I and oxygen has -II oxidation state

— Oxidation involves increase in oxidation state; reduction involves decrease

\* describe and explain galvanic cells in terms of oxidation/reduction reactions

— A galvanic cell is a device which makes a chemical reaction occur in such a way that it produces electricity.

— The reductant and oxidant are physically separated

— The reductant and oxidant are connected by external circuit made of a conductor to carry electrons. They are also connected by a salt bridge to carry charged ions in solution

— Therefore a galvanic cell consists of 2 half cells, a reductant and an oxidant

— The half cells contain a suitable electrolyte

\* outline the construction of galvanic cells and trace the direction of electron flow

— In a galvanic cell there are 2 conducting terminals called electrodes. One is called anode and the other cathode

— Electrons leave the anode (-) of oxidation half cell and travel to the cathode (+) of the reduction half cell through a conducting wire

— A voltmeter is not required. Only used to measure electric potential between the 2 cells

— An electrolyte is required for ions to move through internal circuit

— Cations move towards reduction half cell and anions move towards oxidation half cell

\* define the terms anode, cathode, electrode and electrolyte to describe galvanic cells

Electrodes are the 2 metallic conducting terminals of a galvanic cell

Anode is the electrode at which oxidation takes place. It is negative.

Cathode is the electrode at which reduction takes place. It is positive.

Electrolyte is a substance that releases ions in solution and carries an electric current

## 5. NUCLEAR CHEMISTRY PROVIDES A RANGE OF MATERIALS

\* distinguish between stable and radioactive isotopes and describe the conditions under which a nucleus is unstable

— Isotopes exist when there is a different number of neutrons than protons

— Radioisotopes are unstable isotopes that emit radiation

— In stable light elements, the number of neutrons is generally the same as number of protons

— In heavier elements, more neutrons are required to keep nucleus stable

— Unstable nuclei decay to achieve stability.

— This process releases small particles/rays called radiation

There are three types of radiation:

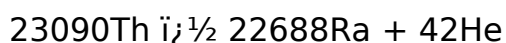
### ALPHA EMISSION:

o Alpha particles are helium nuclei (  $4\text{He}^2$  ).

o Alpha emission tends to occur in nuclei with atomic number greater than 83

o They are ejected from heavy nuclei to remove surplus of protons and neutrons

E. g:



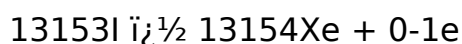
o Alpha particles are fast but do not travel far in air

**BETA EMISSION:**

o Beta particles are electrons ( $0e^{-1}$ ) that are released from nucleus when a neutron decays into a proton and electron

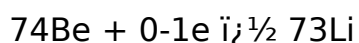
o Beta decay occurs when n : p ratio is too high due to surplus of neutrons

E. g:



o Some unstable nuclei have a surplus of protons (n : p ratio is too low) and to achieve stability they can capture an electron and convert a proton into a neutron

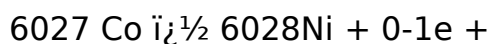
E. g:



**GAMMA EMISSION:**

- o Gamma emissions ( $\gamma$ ) accompany many nuclear decay reactions
- o Gamma rays are high energy electromagnetic rays
- o Gamma rays shed energy as nuclear particles rearrange
- o It does not change atomic number or atomic mass

E. g:



\* describe how transuranic elements are produced

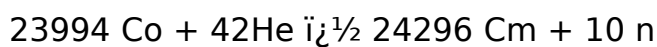
- Elements with atomic number greater than 92 are known as transuranic elements
- Transuranic elements have been artificially synthesised in nuclear reactors or high-energy particle accelerators

**NEUTRON BOMBARDMENT:**

- Neptunium and plutonium can be made in reactors by neutron bombardment of uranium - 238. The unstable U - 239 formed decays by beta emission to form neptunium- 239 and plutonium - 239

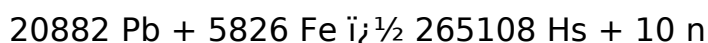
**ALPHA BOMBARDMENT:**

Alpha particles can be used to produce transuranic elements. Plutonium - 239 is bombarded with alpha particles to produce an isotope of curium



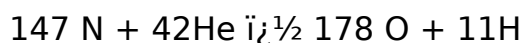
#### NUCLEI BOMBARDMENT:

Transuranic elements can also be produced by bombarding target nuclei with nuclei of other elements using particle accelerators. New elements form when nuclei fuse together. These are highly unstable



\* describe how commercial radioisotopes are produced

— In 1919 Ernest Rutherford conducted an experiment where nitrogen-14 was converted into oxygen-17 by alpha particle collision.



— This process is called nuclear transmutation

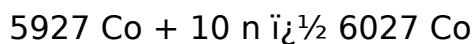
— High energy beams of light ions are used to generate radioisotopes. These include:

Protons, deuterons ( $\text{H-2}$ ), ( $\text{H-3}$ ), and alpha particles

#### NEUTRON BOMBARDMENT:

When Co-59 pellets are placed inside a nuclear reactor and bombarded with neutrons, the neutron is absorbed. An unstable Co-60 nucleus forms





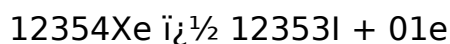
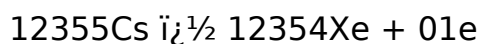
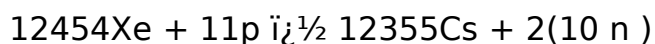
### PROTON BOMBARDMENT:

I-123 can be produced in particle accelerators.

— Protons are fired at xenon-124 target. Caesium-123 and 2 neutrons are formed

— The Caesium-123 decays through xenon-123 to form iodine-123 via positron emission

NOTE: Positrons have same mass as an electron but possess a positive charge



\* identify instruments and processes that can be used to detect radiation

### GEIGER-MULLER PROBE AND COUNTER

— The GM probe and counter detects ionising radiation

— Ionising radiation passes into the detection tube

— Argon gas in the tube is ionised and emitted electrons are accelerated towards the anode (+).

- As the electrons accelerate due to high voltage, they cause more ionisations of gaseous argon leading to a cascade (large amount) of electrons arriving at the anode (+).
- An amplified electrical pulse is created at the anode and is detected by digital counter

#### CLOUD CHAMBER:

- Cloud chamber sare used to investigate radiation produced by nuclear reactions
- The radiation interacts with a cold supersaturated alcohol vapour
- The vapour condenses around ions that are formed during ionisation of the air
- The path of the radiation is made obvious by cloud like trails

\* identify one use of a named radioisotope:

o in industry

o in medicine

Cobalt-60 is a beta and gamma emitter . It is used to sterilise medical instruments and bandages and to irradiate food and fibres to increase storage life. It can also be used to detect flaws, metal fatigue and poor welds.

Technetium-99m is used in medicine to detect abnormalities in many organs of the body.

\* describe the way in which the above named radioisotopes are used and explain their use in terms of their chemical properties

— Co-60 is used to detect flaws in metal parts and poor welds

— Radiation is directed at the object to be checked from sealed source of Co-60

— Radiographic film on the opposite side is exposed when hit by radiation. If there are cracks more radiation will pass through the object.

— Flaws are recorded on film

Co-60 is used because:

\* Gamma rays penetrate metal parts

\* Has a half life of 5.3 years

— Tc-99m is used in medicine to detect abnormalities in many of the body's organs

— It is injected into blood where it attaches to RBC's

— A gamma ray imaging camera monitors path of radioactively labelled cells

Tc-99m is used because:

\* It has short half life of 6 hours

\* Quickly eliminated from the body

1. INDICATORS WERE IDENTIFIED BY OBSERVING THAT THE COLOUR OF SOME FLOWERS DEPENDS ON SOIL COMPOSITION

classify common substances as acidic, basic or neutral

ACIDIC

NEUTRAL

BASIC

White vinegar

Soda water

Lemon juice

Fizzydrink

Car battery acid

Water

Salts(some)

Milk

Oils

Glucose solution

Household cleaners

Household cleaners

Disinfectants

Lime water

Oven cleaners

identify that indicators such as litmus, phenolphthalein, methyl orange and bromothymol blue can be used to determine the acidic or basic nature of a material over a range, and that the range is identified by change in indicator colour

— Chemists have developed a wide range of synthetic acid-base indicators allowing for the determination of acidity and basicity within a narrow range

— These common indicators change colour characteristic to the acid or base concentrations of solution

— Each indicators has its own pH range where it changes colour

identify and describe some everyday uses of indicators including the testing of soil acidity/basicity

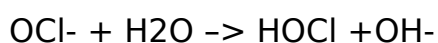
TESTING SOIL ACIDITY/BASICITY:

- Some plants grow best in acidic soils while others prefer alkaline conditions
- Soils which are too acidic may be neutralized by adding bases (Eg: Crushed calcium carbonate).
- Soils which are too basic may be neutralized with addition of fertilizers (Eg: ammonia sulfate) or compost.

A soil sample is saturated in a dish with distilled water. Barium sulfate powder is added to the surface, and soil water soaks into the barium sulfate. Drops of indicator are added to wet barium sulphate, and the colour change is observed.

#### TESTING WATER IN SWIMMING POOLS:

- When sodium hypochlorite is added to swimming pools to kill microbes, The hypochlorite ion reacts with water, producing unstable hypochlorous acid (HOCl) and hydroxide ions.
- HOCl is relatively unstable.



- The hydroxide ions present raise the basicity of the water
- HCl is used to return neutrality
- This is important for protection of eyes and throat of swimmers

— Phenol Red is a very common indicator in pool testing.

2. WHILE WE USUALLY THINK OF THE AIR AROUND US AS NEUTRAL, THE ATMOSPHERE NATURALLY CONTAINS ACIDIC OXIDES OF CARBON, NITROGEN AND SULFUR. THE CONCENTRATION OF THESE ACIDIC OXIDES HAVE BEEN INCREASING SINCE THE INDUSTRIAL REVOLUTION

identify oxides of non-metals which act as acids and describe the conditions under which they act as acids

— Oxides contain oxygen

ACIDIC OXIDES:

— Dissolves in water to form acidic solution

— React with a base to form salt and water

Eg:  $\text{SO}_2 (\text{g}) + \text{H}_2\text{O} (\text{l}) \rightarrow \text{H}_2\text{SO}_3 (\text{aq})$  (sulfurous acid)

$\text{SO}_3 + \text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O}$

BASIC OXIDES:

$\text{Na}_2\text{O} (\text{s}) + \text{H}_2\text{O} (\text{l}) \rightarrow 2\text{NaOH} (\text{aq})$  (sodium hydroxide)

— A solution is basic if when reacts with acid, it gives salt and water

AMPHOTERIC OXIDES:

analyse the position of these non-metals in the Periodic Table and outline the relationship between position of elements in the Periodic Table and acidity/basicity of oxides

— Metals of Groups I and II all form basic oxides. The basicity increases down each group

— Most non-metals form acidic oxides. The acidity of the oxides decrease down each group.

— As we move from left to right of a period, the basicity decreases until an amphoteric oxide is reached. Then the oxide show increasing acidity along the period to group VII.

— Differences in bonding affect the behaviour of each oxide with water

define Le Chatelier's principle

identify factors which can affect the equilibrium in a reversible reaction

TEMPERATURE:

— In endothermic equilibria, an increase in temperature will trigger equilibrium to shift to the right to favor the products

— In exothermic equilibria, an increase in temperature triggers equilibrium to shift to the left to favor the reactants.

CONCENTRATION:



— Increasing the concentration of reactants or decreasing concentration of products shifts equilibrium in favour of the products

— Decreasing concentration of reactants or increasing concentration of products shifts equilibrium to favour the reactants

#### GAS PRESSURE:

— If total pressure of the system is increased, the equilibrium shifts to the side which reduces pressure, thus with less moles

— If total pressure of the system is decreased, the equilibrium shifts to the side which increases pressure, thus with more moles

describe the solubility of carbon dioxide in water under various conditions as an equilibrium process and explain in terms of Le Chatelier's principle

Temperature has quite a large effect on the solubility of Carbon dioxide. Le Chatelier's principle generally states that any if any change occurs in the system, the system will shift the equilibrium in the direction where the change will be counteracted. Using reliable sources, the lower the temperature, the higher the solubility of Carbon Dioxide.

+ heat

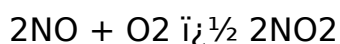
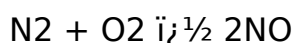
According to Le Chatelier's principle, the heat applied causes the system to absorb some of this applied heat. The equilibrium will shift to the left and more Carbon Dioxide will be released. This means that a lesser amount of

Carbon Dioxide will be dissolved. This accounts for the above bold statement. At low temperatures the rate of reaction is very slow.

identify natural and industrial sources of sulfur dioxide and oxides of nitrogen

Sulfur dioxide is a byproduct of industrial processes and the burning of fossil fuels. Statistics from Canada show that 68% of Sulfur Dioxide emissions are from industrial sources such as power and electricity generating plants.

The principal sources of nitrogen oxides is emissions from vehicles. In the combustion chamber, nitrogen and oxygen combine to form nitric oxide.



describe, using equations, examples of chemical reactions which release sulfur dioxide and chemical reactions which release oxides of nitrogen

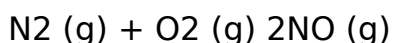
SULFUR DIOXIDE:

- Sulfur dioxide is produced by combustion of fuels such as coal
- Fossil fuels contain small quantities of sulfur minerals (Eg: FeS<sub>2</sub>).
- These sulfur minerals are oxidised during combustion and sulfur dioxide is released



**NITROGEN OXIDES:**

- Most NO<sub>x</sub> comes from engines of motor vehicles
- Nitric oxide is formed when nitrogen and oxygen react at high temperatures.



assess the evidence which indicates increases in atmospheric concentration of oxides of sulfur and nitrogen

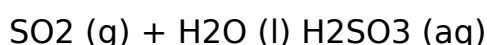
- During the industrial revolution, large amounts of coal were burnt and sulfur dioxide poured into the air
- As iron smelters produced the large amounts of steel required for industry, large volume of sulfur dioxide poured into the air
- The boom in transport and motor vehicles led to increased formation of nitrogen oxides in motor vehicles
- Increased formation of photochemical smog indicates high concentrations of nitrogen oxides
- The increasing incidence of acid rain indicates NO<sub>x</sub> and sulfur dioxides are present in large amounts in the atmosphere
- Due to many health related problems, many departments have raised awareness of these problems and the need to stop them

— Recently, chemical instruments indicate that atmospheric concentrations of these oxides are decreasing at a steady rate

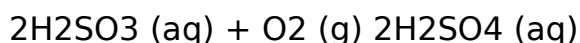
explain the formation and effects of acid rain

Sulfur and nitrogen compounds pollute the atmosphere. Rain water reacts with these acidic oxides and becomes quite acidic due to the high solubility of these gases in water. When this occurs, the pH of rainwater becomes quite low, as low as 3.5-4.0. The following are reactions that occur which cause rain to be acidic.

Sulfur dioxide reacts with rain in the atmosphere forming sulfurous acid:



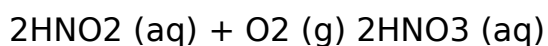
Sulfurous acid then reacts with oxygen; this is catalysed by air particles:



Nitrogen dioxide also reacts with rain, making nitric and nitrous acids:



Nitrous acid then reacts with oxygen, again catalysed by air particles:



**EFFECT OF ACID RAIN ON NATURAL SUBSTANCES:**

Acidic particle deposition and acid rain trigger the corrosion of metals and also the deterioration of paint, marble and limestone. This deterioration and

corrosion reduces societal, economic and cultural values of buildings, bridges and heritage sites.

### 3. ACIDS OCCUR IN FOODS, DRINKS AND EVEN WITHIN OUR STOMACHS

define acids as proton donors and describe the ionisation of acids in water

— An acid is known as a proton( $H^+$ ) donor.

— When acids react with water they ionise and release  $H^+$  ions. Each  $H^+$  consists of one proton

Eg:  $HCl(g) \rightarrow H^+(aq) + Cl^-(aq)$

#### HYDRONIUM IONS:

— The hydrogen ions released by an acid ionising do not exist alone usually.

— They attach themselves to a water molecule, forming hydronium ion( $H_3O^+$ ).

Ionisation reaction of acids is:

$HCl(g) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$

#### MONOPROTIC ACIDS:

— Can release one hydrogen ion per molecule when they react with a strong base

#### DIPROTIC ACIDS:

— Can release two hydrogen ions per molecule when they react with a strong base

#### TRIPROTIC ACIDS:

— Can release three hydrogen ions per molecule when they react with a strong base

identify acids such as acetic (ethanoic acid), citric (2-hydroxypropane-1, 2, 3-tricarboxylic acid), hydrochloric and sulfuric acid

#### ACETIC ACID:

— Acetic acid is a weak acid

— It forms when wine naturally ferments due to microbial oxidation

— It is mainly found in vinega

— Acetic acid is monoprotic

— Molecular formula:  $\text{CH}_3\text{COOH}$

#### CITRIC ACID:

— Citric acid is a weak acid

— It is found in all citrus fruits

— It is a triprotic acid

— Molecular formula:  $\text{C}_6\text{H}_8\text{O}_7$

**HYDROCHLORIC ACID:**

- Hydrochloric acid is the strongest of all acids
- It is monoprotic
- It produced in the stomach to assist digestion
- Molecular formula: HCl

**SULFURIC ACID:**

- It is a diprotic acid
- It is a strong acid
- It is most widely used of all acids in fertilisers and petroleum refining
- Molecular formula: H<sub>2</sub>SO<sub>4</sub>

describe the use of the pH scale in comparing acids and bases

- The pH scale can be used to compare acids and bases
- It is a logarithmic scale that indicates concentration of hydrogen ions in a solution
- Water does contain some ions due to self ionisation producing Hydronium and hydroxide ions
- Adding acids or bases to water will upset equilibrium

— According to Le Chatelier's principle, adding an acid causes equilibrium to shift to the left to use up the hydronium ions produced

— The pH function is defined as:  $\text{pH} = -\log_{10}[\text{H}^+]$

—  $[\text{H}^+]$  means concentration of  $\text{H}^+$

— When bases are added to water, the hydronium ion and hydroxide ion concentrations multiply to give a constant  $1.0 \times 10^{-14}$

— This is known as the water constant ( $K_w$ ) =  $[\text{H}^+][\text{OH}^-]$

— If pH changes by 1, Then  $[\text{H}^+]$  changes by 10

—  $\text{pH} + \text{pOH} = 14$

describe acids and their solutions with the appropriate use of the terms strong, weak, concentrated and dilute

— A strong acid is one that ionises completely and donates protons freely. Examples are HCl, HBr, HI.

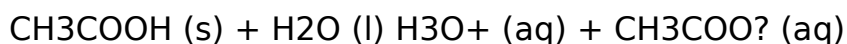
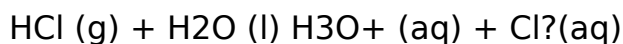
— The ionisation of a strong acid goes to completion

— A weak acid is one that does not ionise completely and therefore is not a good proton donor. Examples are  $\text{CH}_3\text{COOH}$

— The ionisation of a weak acid is reversible and reaches equilibrium

— The difference between a strong and a weak acid can be described in terms of equilibrium between its molecules and its ions





— The molarity of a solution indicates whether an acid is dilute or concentrated

— A dilute acid is an acid that has a low concentration of acid particles

— A concentrated acid is an acid that has a high concentration of acid particles

compare the relative strengths of equal concentrations of citric, acetic and hydrochloric acids and explain in terms of the degree of ionisation of their molecules

— When in solution, HCl has a degree of ionisation of 100 %. Citric acid has a degree of ionisation of approx. 27.5 %. Acetic acid has a degree of ionisation of approx. 4.2%.

— Looking at these results, HCl is the strongest of the acids while acetic acid is the weakest

— The pH of these 3 acids were measured in solution.

— Using the formula,  $[\text{H}^+] = 10^{-\text{pH}}$  (derived from the pH formula), we can find out the concentrations of hydrogen ions released by each acid:

\* HCl:  $[\text{H}^+] = 10^{-1} = 0.1 \text{ mol/L}$

\* CH<sub>3</sub>COOH: [H<sup>+</sup>] = 10<sup>-2.9</sup> = 0.00126 mol/L

\* C<sub>6</sub>H<sub>8</sub>O<sub>7</sub>: [H<sup>+</sup>] = 10<sup>-2.1</sup> = 0.0079

describe the difference between a strong and a weak acid in terms of an equilibrium between the intact molecule and its ions

— A strong acid releases all its H<sup>+</sup> ions in solution

— Its ionisation reaction goes to completion

EG: HCl (g) + H<sub>2</sub>O (l) ⇌ H<sub>3</sub>O<sup>+</sup> (aq) + Cl<sup>-</sup> (aq)

— A weak acid partially ionises in solution and does not release all its H<sup>+</sup> ions — Some of its ions stay intact in solution

— Its ionisation reaction in water is reversible and reaches equilibrium at some point when a certain number of H<sup>+</sup> ions are produced

EG: CH<sub>3</sub>COOH (s) + H<sub>2</sub>O (l) ⇌ H<sub>3</sub>O<sup>+</sup> (aq) + CH<sub>3</sub>COO<sup>-</sup> (aq)

outline the historical development of ideas about acids including those of:

o Lavoisier

o Davy

o Arrhenius

ANTOINE LAVOISEIR:

— Lavoiseir was the first chemist to put forward a theory about acids

- He observed and showed that many non-metal oxides form acidic solutions when dissolved in water
- He hypothesised that Oxygen is responsible for the properties of acidity in these non metal compounds
- He also demonstrated that Oxygen is involved in combustion reactions
- Problem: However, Lavoiseirs theory failed to explain why metal oxides are not acidic

#### HUMPHRY DAVY

- Davy is known for the discovery of many alkali metals by electrolysis of their melted salts
- Davy electrolysed samples of HCl gas to produce H and Cl but no oxygen
- Davy proposed that the presence of Hydrogen is what gave acids their acidic properties
- Davy suggested that hydrogen could be replaced by a metal to form salt
- Problem: Did not explain why many hydrogen compounds were not acidic

#### SVANTE ARRHENIUS:

- Arrhenius observed that acidic solutions conducted electricity
- He proposed that acids release hydrogen ions in solution

— Arrhenius proposed that a base was a substance that produced Hydroxide ions in solution

— Arrhenius realised that acids and bases differ in respect to the degree of ionisation

— Arrhenius proposed that when acids neutralise a base, it is the H and OH that react to form neutral water

— Problem: Arrhenius failed in explaining why metallic oxides and carbonates are basic

outline the Brønsted-Lowry theory of acids and bases

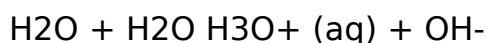
— The Bronsted Lowry theory explains many problems with the arrhenius theory

-It states:

— Acids are proton donors while Bases are proton acceptors

— Molecular acids dissolve in water to produce ions because a proton is donated from acid to the water forming hydronium ion. Thus water is a B-L base

— When molecular bases dissolve in water, water acts as a B-L acid and donates a proton to the molecular base to form hydroxide ion



Proton Proton

Donor Acceptor

describe the relationship between an acid and its conjugate base and a base and its conjugate acid

— When a B-L acid donates a proton to the base, the anion of the acid can act as a base as it could accept a proton and reform the original acid

— An acid has one more H<sup>+</sup> than its conjugate base

Eg: HF/F<sup>-</sup> is an acid base pair

When HF donates a proton to a base, The fluoride ion is formed. HF is a B-L acid

Fluoride ions can accept protons from an acid and form HF again. The Fluoride ion is acting as a base



Water is acting as the B-L base

— Acids and bases on the right of equation are called conjugates

— In B-L theory, each acid has a conjugate base and each base has a conjugate acid

identify a range of salts which form acidic, basic or neutral solutions and explain their acidic, neutral or basic nature

**ACIDIC SALTS:**

— Is formed when a weak base reacts with a strong acid

Eg: Ammonium chloride



$\text{Cl}^- + \text{H}_2\text{O}$  No Reaction

**NEUTRAL SALTS:**

— Formed when strong bases neutralise strong acids

— Neutral salts do not react with water to an appreciable extent resulting in unchanged pH of the water

— Eg: NaCl, KBr

**BASIC SALTS:**

— Formed when strong base reacts with a weak acid

Eg: Sodium acetate

— Sodium hydroxide is a strong base while acetic acid is a weak acid.

Therefore the salt will be basic

$\text{Na}^+ + \text{H}_2\text{O}$  No Reaction



identify amphiprotic substances and construct equations to describe their behaviour in acidic and basic solutions

— Amphiprotic species are those capable of behaving as proton donors and acceptors(acids and bases).

— Water is a very good example of an amphiprotic substance

— Another good example is Hydrogen Carbonate ion

PROTON ACCEPTOR:  $\text{HCO}_3^- (\text{aq}) + \text{H}_3\text{O}^+ (\text{aq}) \rightarrow \text{H}_2\text{CO}_3 (\text{aq}) + \text{H}_2\text{O} (\text{l})$

PROTON DONOR:  $\text{HCO}_3^- (\text{aq}) + \text{OH}^- (\text{aq}) \rightarrow \text{CO}_3^{2-} (\text{aq}) + \text{H}_2\text{O} (\text{l})$

identify neutralisation as a proton transfer reaction which is exothermic

— Neutralisation reactions are exothermic. This is because more energy is released in bond formation than in bond breaking

— As acids are proton donors and bases are proton acceptors, it is obvious that neutralisation reactions are PROTON TRANSFER REACTIONS.

— EG:  $\text{HCl} (\text{aq}) + \text{KOH} (\text{aq}) \rightarrow \text{KCl} (\text{aq}) + \text{H}_2\text{O} (\text{l})$

$\text{H}^+ (\text{aq}) + \text{OH}^- (\text{aq}) \rightarrow \text{H}_2\text{O} (\text{l})$

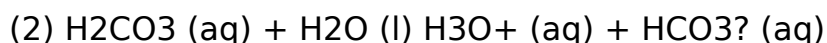
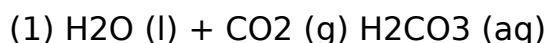
Hence, the proton is transferred to the hydroxide ion, forming water

qualitatively describe the effect of buffers with reference to a specific example in a natural system

- Buffers are prepared by dissolving equal quantities of a weak B-L acid and its conjugate base or vice versa in water.
- A buffer solution maintains a constant pH even after addition of acids and bases
- The pH remains constant due to the neutralisation reaction occurring between the acid and base which destroys the acidic and basic properties
- Buffers are vital in natural systems . Blood is a main example where a buffer system occurs.

#### CARBONIC ACID/HYDROGEN CARBONATE BUFFER:

- The equilibria associated with this buffer is:



- As carbon dioxide builds up in the plasma, concentration of carbonic acid increases.
- This causes equilibrium 2 to shift to the right to produce more hydronium ions
- The hydronium ion causes decrease in the pH of blood
- A healthy body can counteract this change

Le Chateliers principle states:



- Addition of any acid causes more hydronium to be produced
- The pH would not change because the Hydronium will react with the conjugate base to produce more of the weak acid as equilibrium shifts to the left.
- As a response the healthy body releases more  $\text{HCO}_3^-$  which shifts equilibrium to left as Hydronium ions become neutralised
- Carbon dioxide is released

#### 5. ESTERIFICATION IS A NATURALLY OCCURRING PROCESS WHICH CAN BE PERFORMED IN THE LABORATORY

describe the differences between the alkanol and alkanolic acid functional groups in carbon compounds

- Alkanols are a homologous group of organic compounds which contain the hydroxyl group (-OH) as their functional group attached to an alkyl group
- The general formula for alkanols is known as  $\text{C}_n\text{H}_{2n+1}\text{OH}$
- The hydroxyl group gives alkanols their polar properties
- Hydrogen bonding occurs because of the OH group
- Alkanols are soluble in water. However, as for alkanolic acids, the longer the carbon chain, the less soluble they are
- Reacting alkanols with alkanolic acid gives an ester

- Alkanoic acids are organic compounds containing a carboxyl group (-COOH) as the functional group attached to alkyl group
- The carboxyl group makes alkanolic acids polar
- Strong hydrogen bonds form between alkanolic acid molecules due to carboxyl group
- This means they are soluble in water and have higher melting and boiling points than corresponding alkanols.

identify the IUPAC nomenclature for describing the esters produced by reactions of straight-chained alkanolic acids from C1 to C8 and straight-chained primary alkanols from C1 to C8

- Naming alkanolic acids:

\* Count the number of carbons; taking the name of the parent alkane with the same number of carbons, drop the 'e' and add on '-oic acid'.

- Naming alkanols:

\* Similarly, count the number of carbons, take the parent alkane name, drop the 'e' and add on an '-ol'.

- Naming esters:

\* An ester is always in the following order: alkanol then alkanolic acid.

\* There are two different situations when esters would have to be named.

\* Given the alkanol and the alkanolic acid, name the ester:

> Firstly, take the alkanol and replace '-anol' with '-yl'. Secondly, take the alkanolic acid and replace '-oic acid' with '-oate'. Finally, place the 2 words together, alkanol then alkanolic acid, and you have named the ester.

explain the difference in melting point and boiling point caused by straight-chained alkanolic acid and straight-chained primary alkanol structures

— For the same number of Carbon atoms alkanolic acids have higher melting and boiling points than the corresponding alkanols

— The stronger the intermolecular forces the more tightly bound molecules are which requires more energy to break the bonds(i. e higher melting and boiling points)

— Alkanols experience dispersion forces and also experience electrostatic attraction between polar bonds

— Alkanolic acid experiences the strong