

Catholic High School

Pure Chemistry Prelim Exam Paper 1-2011

Q1:

At rtp

A=gas

B=liquid

C=liquid volatile

D=solid

→ Option **C** is correct

Q2: collection of dry NH₃

A: water displacement not suitable

B: Upwards displacement not suitable

C: Downwards displacement of air + CaO –Best setup

D: H₂SO₄ react with NH₃ not suitable

→ Option **C** is correct—Ans

Q3: Fractional distillation-Low BP distill over first

→ Option **A** is correct—Ans

Q4: Alloy=mixture of elements in solid solution

A **solid solution** is a [solid-state solution](#) of one or more [solutes](#) in a [solvent](#). Such a [mixture](#) is considered a solution rather than a [compound](#) when the [crystal structure](#) of the solvent remains unchanged by addition of the solutes, and when the mixture remains in a single [homogeneous phase](#). This often happens when the two elements (generally [metals](#)) involved are close together on the [periodic table](#); conversely, a chemical compound is generally a result of the non-proximity of the two metals involved on the periodic table.^[1]

A: mixture of compounds, compound, compound

B: compound, mixture of elements , element

C: element, element, compound

D: compound, mixture of compound, mixture of element.

→ Option **B** is correct

Q5: let x=% of isotope 63

$$63x + 65(1-x) = 63.5$$

$$65 - 63.5 = 2x \rightarrow x = 0.75$$

$$I_{63} : I_{65} = 0.75 : 0.25 = 3 : 1$$

→ Option **D** is correct—Ans

Q6:

P: 2,8,6 group 6

Q: 2,8,8,2 group 2 → ionic compound should be : PQ Isoelectronic ions

→ Option **D** is correct—Ans

Q7: Ionic compound physical properties

→ Option **B** is correct—Ans

Q8: Use PT to validate size of IONS

A: false, BaO both ions are 2+, 2- charge

B: true, LiBr both are 1 charge, from PT Br size >>> Li

C: false, SiO₂ covalent giant molecule

D: false, Zn should be metallic bond structure

→ Option **B** is correct—Ans

Q9: NH₃ structure (Warning: not clear if the inner shell electrons to be counted as well)

3 shared pairs of electrons, 1 lone pair → total 4 pairs of valence electrons for nitrogen

Electronic structure = 2,5

Total unshared electrons in N = 2 + 2 = 4

→ Option **C** is correct—Ans

Q10: No clear info if the bonds are ionic or covalent

From XY₃:

X from group 3 metal (if ionic bond), from group 5 non-metal (if covalent bond)

Y from group 1 metal (if ionic bond) or group 7 nonmetal (Ionic or covalent bond)

From ZX:

Z from group 5 nonmetal (if ionic bond), from group 5 non-metal (if covalent triple bond)

A: False : YZ₃ should be Y₃Z

B: True: Y₃Z

C: False: XYZ three elements

D: False: YZ valances not the same

→ Option **B** is correct –Ans

Q11: Metal + acid reaction

A) True: $\text{Fe} + \text{HCl} \rightarrow \text{FeCl}_2 + \text{H}_2$

B) False: PbSO₄ coated the metal stop further reaction

C) False: Cu non-reactive

D) False: $2\text{Fe} + 3\text{H}_2\text{O} \rightarrow \text{Fe}_2\text{O}_3 + 3\text{H}_2$ oxygen involved as well

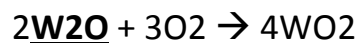
→ Option **A** is correct—Ans

Q12: compound the ratio of element is fixed thus mass by ratio

$0.191/0.239 = 0.450/X \rightarrow X = 0.563\text{g}$

→ Option **D** is correct—Ans

Q13:

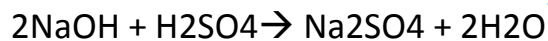


40 60 80

Mol ratio 2 3 4

→ Option **A** is correct—Ans

Q14:



Mol of $\text{H}_2\text{SO}_4 = 0.02 \times 0.2 = 0.004$ mol

Volume of $\text{NaOH} = (2 \times 0.004) / 0.1 = 0.08 \text{ dm}^3 = 80 \text{ cc}$

→ Option **D** is correct—Ans

Q15:

A: mol of H = $4 \times 20 / (12 + 4) = 5$

B: mol of H = $2 \times 36 / (16 + 2) = 4$

C: mol of H = $2 \times 10 / (2) = 10$

D: mol of H = $10 \times 40 / (12 \times 4 + 10) = 6.9$

→ Option **B** had the least mol of H—Ans

Q16:

Mol carbonate = $125 / (125) = \text{mol ZnO}$

Max mass ZnO = $1 * 81 = 81 \text{ g}$

Yield = $75 / 81 * 100\%$

→ Option **D** is correct—Ans

Q17: Amphoteric oxide react with OH⁻ ions

A: False: alkali such as CaO behavior

B: False: Acid base reaction

C: True: eg $\text{ZnO} + 2\text{NaOH} \rightarrow \text{Na}_2\text{ZnO}_2 + \text{H}_2\text{O}$

D: False: Alkali such as CaO behavior

→ Option **C** is correct—Ans

Q18:

A: CuSO_4 excess $\text{CuO} + \text{H}_2\text{SO}_4$ + crystallize

B: MgSO_4 excess $\text{MgO} + \text{H}_2\text{SO}_4$ + Crystallize

C: NaNO_3 use $\text{NaOH} + \text{HNO}_3$ titration + crystallize

D: ZnCl_2 excess $\text{ZnO} + \text{HCl}$ + crystallize

→ Option **C** is most suitable—Ans

Q19:

(NH₄)₂SO₄ Vs (NH₄)₂CO₃

A: aqueous NH₃ no reaction with both

B: NaOH + heat + salt → NH₃ produced due to presence of NH₄⁺ ions for both.

C: BaSO₄ and BaCO₃ are insoluble show up as white ppt

D: (NH₄)₂CO₃ + 2HCl → 2NH₄Cl + CO₂ (g) + H₂O give up CO₂ gas

→ Option **D** is correct—Ans

Q20: To produce CaSO₄ using CaCO₃ both insoluble salt

A: Not suitable as CaCO₃ not soluble

B: Not suitable CaSO₄ coated the CaCO₃ stop further reaction

C: Not suitable CaSO₄ coated the CaCO₃ stop further reaction

D: CaCO₃ + 2HNO₃ (excess) → Ca(NO₃)₂ + H₂O + CO₂

Ca(NO₃)₂ + Na₂SO₄ → CaSO₄ (ppt) + 2NaNO₃

→ Option **D** is correct—Ans

Q21:

A: T₁-T₂=6.3 to 4.3 too acidic

B: T₂-T₃=4.3 to 5.5 too acidic

C: T₃-T₄= 5.5 to 7.8 OK by 5.5 to 6.5 not good for sugar beet

D: T₄-T₅=7.8 to 7.0

→ Option C & D are OK but **D** is the best with narrow range—Ans

Q22: Test for RA by $K_2Cr_2O_7$ from orange to green or $KMnO_4$ purple to colorless

KI is test for OA → No change in color (Colorless)

$K_2Cr_2O_7$ / $KMnO_4$ test for RA → Orange to green/Purple to colorless

→ Option **B** is correct—Ans

Q23:

A: OS of H from 0 to +1, Oxygen from 0 to -2 Redox

B: OS of S from -2 to 0, Cl from 0 to -1 redox

C: No change in OS of all element, acid + base reaction

D: OS of Zn from 0 to 2+, Cu from 2+ to 0 redox

→ Option **C** is not a redox reaction—Ans

Q24:

Z less reactive than Zn, X & Y more reactive than Zn

Y more reactive than X

$$\Rightarrow Z < X < Y$$

→ Option **C** is correct—Ans

Q25:

A: No rusting as no oxygen

B: No rusting as no water and Oxygen

C: Ag less reactive than Fe thus no protection offered → heavy rusting

D: Mg more reactive than Fe thus Mg act as anode sacrificial metal to dissolve into solution (as electrolyte). Fe act as cathode thus no rusting occur.

→ Option **C** has fastest rusting

What is rusting?

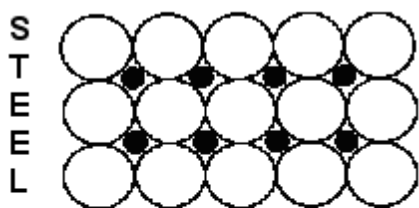
Corrosion is the loss of metallic properties of a metal due to oxidation and is accompanied by the formation of unwanted products. Copper, iron and aluminum metals all corrode over time losing strength, lustre and electrical conductivity.



The rusting of iron

Rusting is the corrosion of iron and readily occurs in the alloy steel. The formation of a reddish brown flakes which loosely adheres to the iron is called rust.

Steel is an alloy made of iron and carbon. The carbon atoms in steel greatly increase the strength of the metal. They prevent the iron atoms in the crystal lattice from slipping over one another.

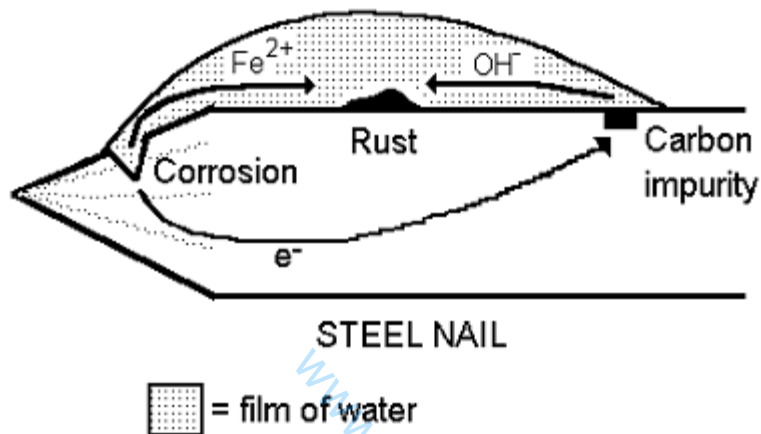


● = carbon atom

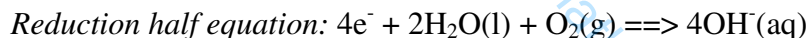
○ = iron atom

Steel is widely used in the manufacture of cars, white goods and the construction industry because it is much stronger than iron.

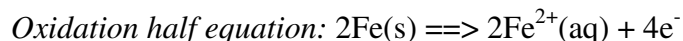
The carbon atoms in steel however, greatly decrease the ability of iron to resist corrosion.



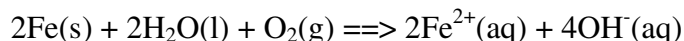
In the presence of oxygen and water a series of internal galvanic cells or batteries are created. The carbon impurities become the site of reduction.



The nail is most easily oxidised at points of stress, i.e. the tip or the head. At these points the crystal lattice is distorted and the iron atoms are easily oxidised.



The overall or net equation is



$Fe^{2+}(aq)$ and $OH^-(aq)$ ions migrate through the water by diffusion. Refer to the above diagram. When they meet they combine to produce the precipitate, iron(II) hydroxide, $Fe(OH)_2$, which is further oxidised to iron (III) hydroxide, $Fe(OH)_3$, and finally dehydrated to produce rust.

The chemistry of the reaction resulting in the formation of rust can be summarized as follows.

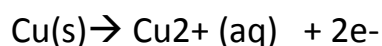
The chemical equations for rust formation

1. $2Fe(s) + 2H_2O(l) + O_2(g) \rightleftharpoons 2Fe^{2+}(aq) + 4OH^-(aq)$
2. $Fe^{2+}(aq) + 2OH^-(aq) \rightleftharpoons Fe(OH)_2(s)$
3. $Fe(OH)_2(s) \xrightarrow{O_2} Fe(OH)_3(s)$
4. $Fe(OH)_3(s) \xrightarrow{\text{dehydrates}} Fe_2O_3 \cdot nH_2O(s)$ or rust

The chemical formula for rust is $\text{Fe}_2\text{O}_3 \cdot n\text{H}_2\text{O}$

Q26:

Cu vs Silver : Copper more reactive thus act as Anode (-)



→ Option **B** is correct—Ans

Q27: electroplating → electrolysis → silver metal should be anode, object to be plated at cathode (which is commonly called (-) terminal of the power source)

→ Option **D** is correct.—Ans

Q28:

A: False : Cl_2 gas, I_2 solid at rtp

B: False: reactivity reduces down the group

C: False: more reactive Cl_2 will displace I^- ions from solution

D: True as Cl_2 has lower intermolecular bonding force (Van De Val forces) than I_2

→ Option **D** is correct—Ans

Q29: Noble gas usage

→ Option **C** is the essential properties to prevent reaction with the lamp filament.

Argon (Ar, atomic number 18) is the third most common gas in the world, even more so than carbon dioxide. The word "argon" means inactive, inert in Greek and refers to this gas in that it reacts with very few other elements in the periodic table. It has eight electrons in the outer shell, which make it very stable and resistant to reactions.

Argon is an odorless and colorless gas, found in the atmosphere to a small extent. It does not form chemical compounds and is heavier than air.

Argon was isolated by Sir William Ramsay and Lord Rayleigh in Scotland in 1894. They had come to the conclusion that there was another gas in the air apart from nitrogen, oxygen, and carbon dioxide because the nitrogen they got from chemical compounds was slightly lighter than nitrogen from the atmosphere. They conducted an experiment, removing all of the carbon dioxide, oxygen, water, and nitrogen from an air sample. Argon was the first noble gas that was discovered. Until 1957 its symbol was A.

Argon is produced by distilling liquid air. Liquid air is air, the temperature of which has been reduced to below freezing point, so it is condensed to a bluish moving liquid. The most common use for argon is as a shield in high-temperature industrial processes. It is very useful in this way because its inertia guarantees it will protect the welder or whatever the respective job in a high-temperature environment is. Argon keeps graphite from burning, which is why it is also used in graphite electric furnaces. It is also employed in incandescent and fluorescent lighting.

Argon is used whenever an inert gas is required, being a cheap alternative to nitrogen. When nitrogen is not inert enough, argon comes as its cheapest alternative. The element is also used when low thermal conductivity is sought as well as when electronic properties (e.g. emission spectrum or ionization) are required. While other noble gasses may serve the same purpose, this one is the cheapest to use. Argon is a byproduct from the production of both nitrogen and oxygen, whereby a cryogenic air separation device is used. Both substances have a large-scale industrial use. In addition, in its liquid form, the element has been employed in dark matter searches.

Argon is the noble gas making for a good atmosphere when air-sensitive materials are used. It is the most suitable as a shield and protection mechanism. It has a variety of other uses being the byproduct of liquid oxygen and liquid nitrogen, produced through air separation. Both liquid nitrogen and liquid oxygen are used on a large scale. Every other noble gas is produced this way too, with the exception of helium, but argon is the most viable because it is most abundant in the atmosphere. Argon is also used in the processing of reactive elements, such as titanium, and in

gas metal arc welding and gas tungsten arc welding. Nitrogen and oxygen must be excluded from these processes because they tend to damage the material.

Argon is also used in the poultry industry for mass culling due to outbreaks of infections and diseases or as a more humane slaughter tool. In addition, argon is used to put out fires and avoid incurring damage to equipment.

Q30: Se from group 6 similar to but less reactive than S & O

Na₂Se and Na₂SeO₄

→ Option **B** is correct—Ans

Q31:

A: True: adding some diluted H₂O₂ reduces overall concentration lead to slower reaction but add more reactant thus produces more O₂

B: False: lower temp will slow down reaction but not affecting the total O₂ produced

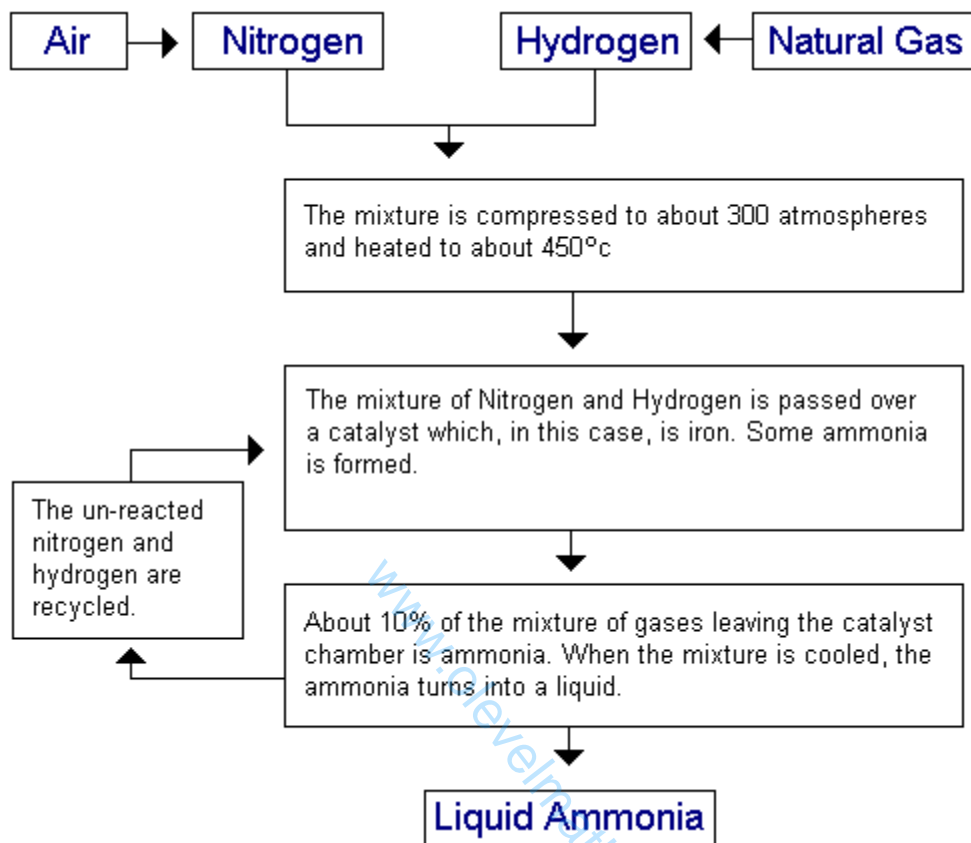
C: False : Catalyst will not alter the amount of O₂ produced

D: As C.

→ Option **A** is correct—Ans

Q32:

N₂ + 3H₂ → 2NH₃ exothermic



High pressure shift reaction to the right increasing yield

High temp shift reaction to the left reducing the yield but maintain a high SOR

→ Option **B** is the industrial standard setting with catalyst—Ans

Q33:

A: False: photosynthesis is endothermic

B: True: Acid/alkali reaction is exothermic

C: False: Melting of ice is endothermic

D: False: Evaporation process is endothermic

→ Option **B** is correct—Ans

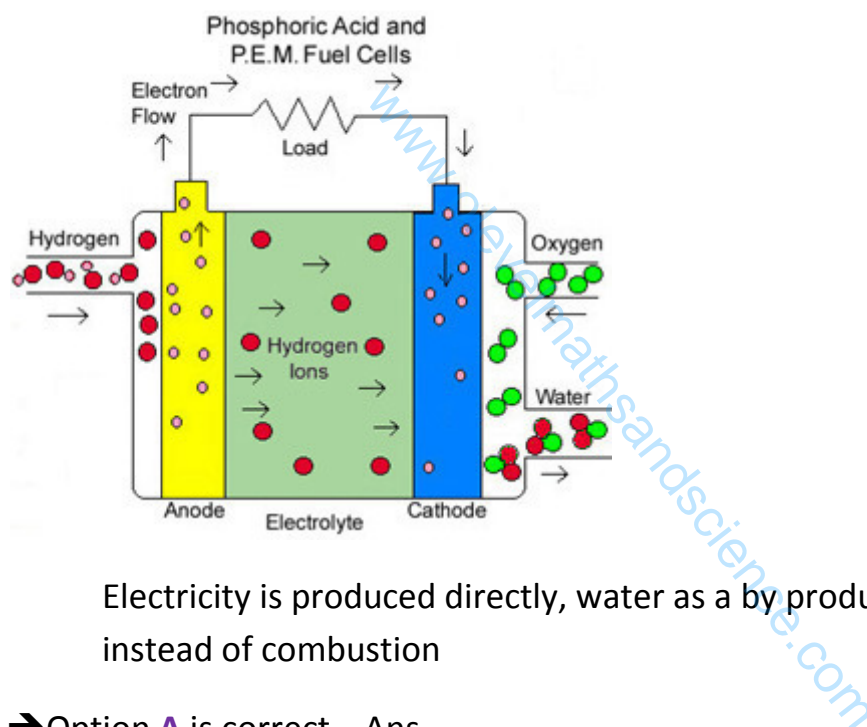
Q34:

1 mole of methane = $1 * (12+4) = 16 \text{ g}$

Total energy released = $16 * 56 = 896 \text{ kJ}$

→ Option **C** is correct – Ans

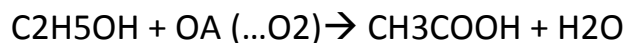
Q35: many type of H₂/O₂ fuel cells available depending on the electrolyte used



Electricity is produced directly, water as a by product, H₂.O₂ redox reaction instead of combustion

→ Option **A** is correct – Ans

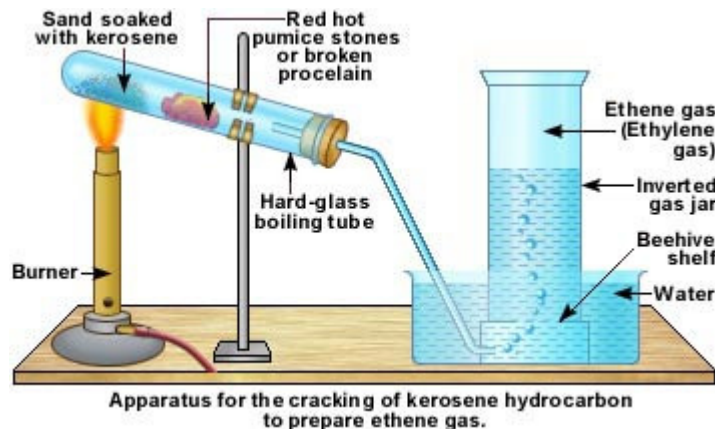
Q36: pH=4 == weak acid → ethanoic acid vapor



→ Option **A** is OA – Ans

Note: Al₂O₃ typically used as catalyst for cracking of alkanes, C is a reducing agents, yeast cannot survive while heated.

Q37: Cracking to breakdown heavy alkanes to lighter components.



→ Option **B** is correct—Ans

Q38:

SOME COMMON FUNCTIONAL GROUPS				
Formula	Name	Examples		
R-H	alkane	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$ methane	$\begin{array}{cccc} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & \\ \text{H} & \text{H} & \text{H} & \text{H} \end{array}$ butane	
			$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$ 2-methylpropane	
R-OH	alcohol	$\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{O}-\text{H} \\ & \\ \text{H} & \text{H} \end{array}$ ethanol	$\begin{array}{c} \text{H} & \text{H} & \text{H} \\ & & \\ \text{H}-\text{C} & -\text{C} & -\text{C}-\text{O}-\text{H} \\ & & \\ \text{H} & \text{H} & \text{H} \end{array}$ propan-1-ol	$\begin{array}{c} \text{H} & \text{O}-\text{H} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{H} \\ & \\ \text{H} & \text{H} \end{array}$ propan-2-ol
R-NH ₂	amine	$\begin{array}{c} \text{H} & \text{H} & \text{H} \\ & & \\ \text{H}-\text{C} & -\text{C} & -\text{N}-\text{H} \\ & & \\ \text{H} & \text{H} & \text{H} \end{array}$ ethylamine (aminoethane)	$\begin{array}{c} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & \\ \text{H} & \text{H} & \text{H} & \text{H} \end{array}$ 2-aminobutane	
R-X (X = F, Cl, Br, or I)	halogenoalkane	$\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{Br} \\ & \\ \text{H} & \text{H} \end{array}$ bromoethane	$\begin{array}{c} \text{Cl} & \text{Cl} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{H} \\ & \\ \text{H} & \text{H} \end{array}$ 1,2-dichloroethane	$\begin{array}{c} \text{Cl} & \text{H} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{H} \\ & \\ \text{Cl} & \text{H} \end{array}$ 1,1-dichloroethane
R-C(=O)-H	aldehyde	$\begin{array}{c} \text{H} & \text{O} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{H} \\ & \\ \text{H} & \end{array}$ ethanal	$\begin{array}{c} \text{H} & \text{H} & \text{O} \\ & & \\ \text{H}-\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & \\ \text{H} & \text{H} & \end{array}$ propanal	
R-C(=O)-R' (R' may be the same as or different to R)	ketone	$\text{H}_3\text{C}-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_3$ propanone	$\text{H}_3\text{C}-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_2-\text{CH}_2-\text{CH}_3$ pentan-2-one	$\text{H}_3\text{C}-\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_2-\text{CH}_3$ pentan-3-one
R-C(=O)-OH	carboxylic acid	$\text{H}-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}-\text{H}$ methanoic acid	$\text{C}_2\text{H}_5-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}-\text{H}$ propanoic acid	
[R-C(=O)-OR]	ester	$\begin{array}{c} \text{H} & \text{O} & \text{H} & \text{H} \\ & & & \\ \text{H}-\text{C} & -\text{C} & -\text{O}-\text{C} & -\text{C}-\text{H} \\ & & & \\ \text{H} & & \text{H} & \text{H} \end{array}$ ethyl ethanoate	$\text{H}-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}-\text{C}_2\text{H}_5$ propyl methanoate	

1: Alcohol

2: Carboxylic acid

3: Alcohol

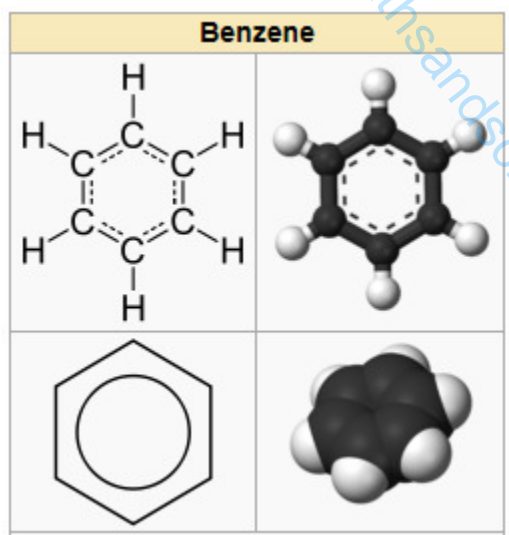
4: **Dimethyl ether** (DME), also known as **methoxymethane**, is the [organic compound](#) with the formula CH_3OCH_3 . The simplest [ether](#), it is a colourless gas that is a useful precursor to other organic compounds and an aerosol propellant. When combusted, DME produces minimal soot and CO, though HC and NO_x formation is significant. DME can act as a clean fuel when burned in engines properly optimized for DME.

→ Option **B** is correct.

Q39: Benzene, note the double line refer to C=C bond, each bend is a C-atom

$\text{C}_6\text{H}_6 \rightarrow (\text{CH})_6$

→ Option **A** is correct



Q40: Formation of polyester → Increase the molecular mass which affect the physical properties with elimination of H₂O so the composition changes as well.

→ Option **B** is correct –Ans

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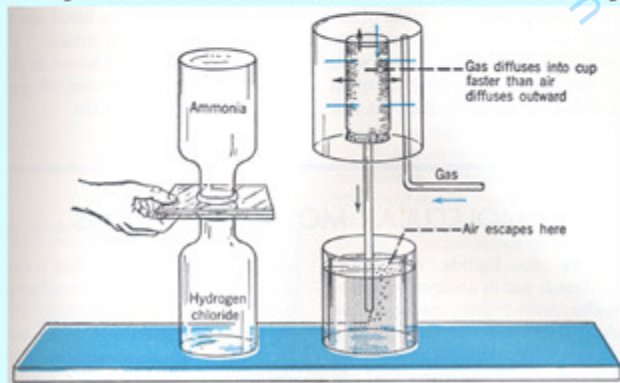
Pure Chemistry Prelim Exam Paper 2-2011

A1:

- a) Amphoteric metal ion: ZnSO_4 forming $\text{Zn}(\text{OH})_2$ ppt
- b) Insoluble salts : BaSO_4 , CaCO_3 , CuCO_3
- c) White carbonate: $\text{CaCO}_3 + \text{heat} \rightarrow \text{CaO} + \text{CO}_2$
- d) SO_2 acting as RA to turn $\text{K}_2\text{Cr}_2\text{O}_7$ orange to green
- e) Amphoteric oxide: Al_2O_3

Diffusion & Osmosis

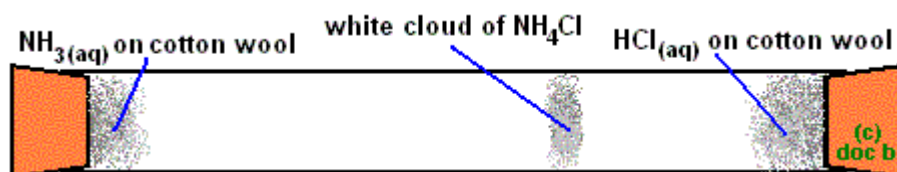
- 6. **Diffusion.** The intermingling of moving molecules.
Coloring in water, NH_3 gas on the loose. 50+50= 95!
- 7. **Osmosis.** Diffusion thru a porous membrane.
Graham's Law-- The rate of diffusion is inversely proportional to the square root of the molecular mass. *Heavy molecules diffuse more slowly.*



A2:

Rate of diffusion related to m_r : $\text{HCl } m_r=36.5$ $\text{NH}_3=17$

NH_3 diffuse faster thus ring of NH_4Cl solid form nearer to HCl end



A3: Balancing redox half reaction

a) OS of nitrogen from 0 to -3 \rightarrow reduction half reaction

b) $2\text{NO}_3^- + 12\text{H}^+ + 10\text{e}^- \rightarrow \text{N}_2 + 6\text{H}_2\text{O}$ reduction half reaction

The CA-WHe! Method

To balance redox half-reactions,

1. first balance the "central atom" (CA), usually one that is **not** O or H. Then,
2. add Water if needed to balance the **oxygens**.
3. Add H⁺ if needed to balance the **hydrogens**.
4. Add electrons to balance the **charge**.
5. *Check* that atoms and charge are the same on both sides.

A4:

(a) Both I_2 and MgCl_2 solid are non-conductor for electricity at rtp

(b) I_2 covalent bond, MgCl_2 ionic bond

© I_2 strong inter-atomic bond but weak intermolecular bond thus low MP. MgCl_2 strong crystal lattice structure thus high MP.

A5:

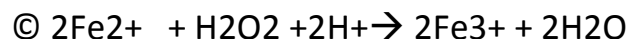
(a) higher concentration has higher change of molecular collision thus higher SOR.

(b) More energy release in bond forming than energy needed for bond breaking thus exothermic.

Hydrogen peroxide is commonly used (in very low concentrations, typically around 5%) to bleach human hair, hence the phrases "peroxide blonde" and "bottle blonde". It burns the skin upon contact in sufficient concentration. In lower concentrations (3%), it is used medically for cleaning wounds and removing dead tissue. Combined with urea as carbamide peroxide, it is used for whitening teeth.

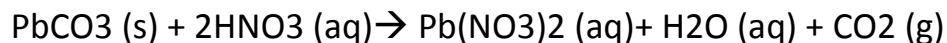
Hydrogen peroxide tends to decompose exothermically into water and oxygen gas. The rate of decomposition is dependent on the temperature and concentration of the peroxide, as well as the presence of impurities and stabilizers. The use of a catalyst (such as manganese dioxide, silver, or the enzyme catalase) vastly increases the rate of decomposition of hydrogen peroxide. High strength peroxide (also called high-test peroxide, or HTP) must be stored in a vented container to prevent the buildup of pressure leading to the eventual rupture of the container. In the 1930s and 40s, Hellmuth Walter pioneered methods of harnessing the rapid decomposition of hydrogen peroxide in gas turbines and rocket engines.

Hydrogen peroxide works best as a propellant in extremely high concentrations of 90% or higher.



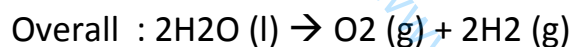
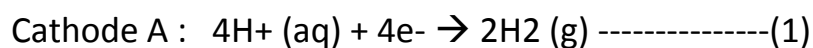
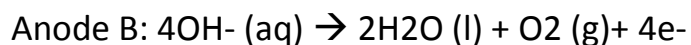
Test for Fe^{3+} ions by adding excess NaOH, reddish brown ppt formed instead of greenish ppt.

A6:

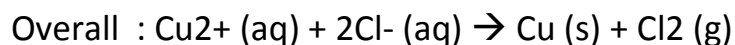
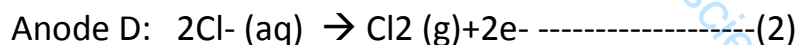
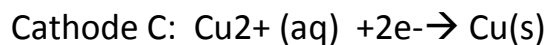


Use excess $\text{PbCO}_3 \rightarrow$ filter away excess \rightarrow Evaporate filtrate to obtain saturated solution \rightarrow cool filtrate to crystallize $\text{Pb}(\text{NO}_3)_2 \rightarrow$ filter crystal \rightarrow rinse with distilled water \rightarrow Dry on filter paper

A7: Electrolysis



Q=Concentrated CuCl_2



Volume of H_2 was 140 cc, mol of $\text{H}_2 = 0.14/24$,

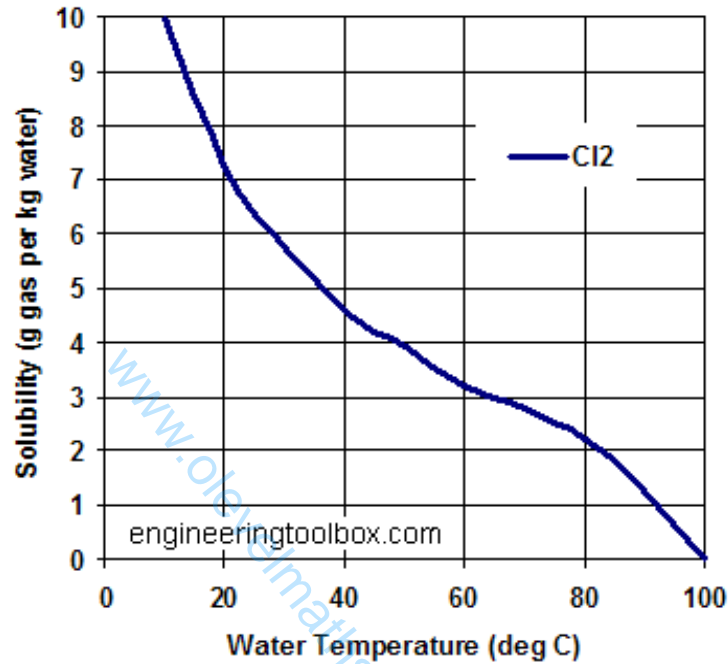
mol of e^- flow through the circuit = $0.28/24$ mol

mol of Cl_2 produced = $0.5 * 0.28/24 = 0.14/24$

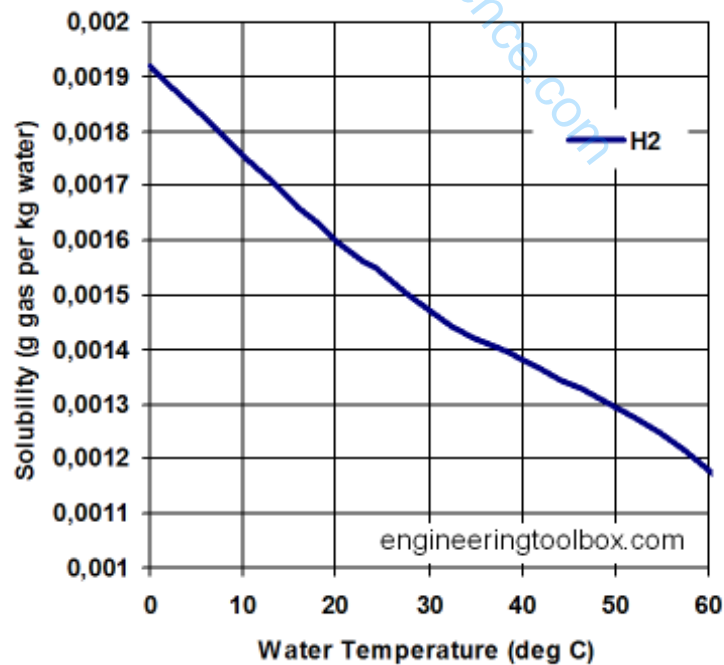
volume of Cl_2 expected = 140 cc but only 120 cc collected:

At electrode D, Cl_2 are soluble in water thus a lower volume was obtained.

Solubility of Chlorine Gas - Cl_2 - in Water



Solubility of Hydrogen Gas - H_2 - in Water



A8:

(a) Fractional distillation

(b) Different components had difference BP thus they can be separated from the column by condensation at different temp range.

© Naphtha are raw feedstock for petrochemical industry.

A9:

(a) Weak acid does not dissociated completely when dissolve in water thus giving lower concentration of H⁺ ions in the solution.

(b) CH₃CH₂CH₂COOH

	C	H	O
	0.18g	0.03g	0.08g
Mol	$0.18/12=0.015$	$0.03/1=0.03$	$0.08/16=0.005$
Ratio	3	6	1

Empirical formula= C₃H₆O

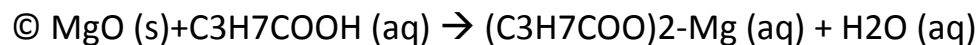
Mr of (C₃H₆O)_n = (12*3+6+16)n=116

N=2 Molecular formula → C₆H₁₂O₂

Condensation reaction as follows:



Structural formula of the ester as:

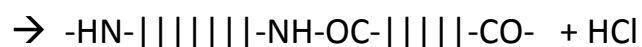
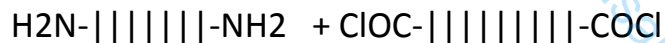


Magnesium Butanoate

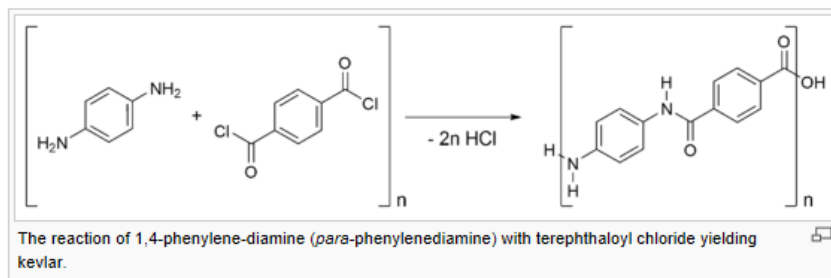
A10:

(a) monomer as : $\text{CF}_2=\text{CF}_2$ convert to Teflon by addition polymerization

(b) Condensation polymerization : elimination of smaller element such as H_2O from the monomer in the process of polymerization.



Kevlar is synthesized in solution from the monomers 1,4-phenylene-diamine (*para*-phenylenediamine) and terephthaloyl chloride in a condensation reaction yielding hydrochloric acid as a byproduct. The result has liquid-crystalline behavior, and mechanical drawing orients the polymer chains in the fiber's direction. Hexamethylphosphoramide (HMPA) was the solvent initially used for the polymerization, but for safety reasons, DuPont replaced it by a solution of *N*-methyl-pyrrolidone and calcium chloride. As this process was patented by Akzo (see above) in the production of Twaron, a patent war ensued.^[9]



Kevlar (poly *para*phenylene terephthalamide) production is expensive because of the difficulties arising from using concentrated sulfuric acid, needed to keep the water-insoluble polymer in solution during its synthesis and spinning.^[citation needed]

Several grades of Kevlar are available:

1. *Kevlar K-29* – in industrial applications, such as cables, asbestos replacement, brake linings, and body/vehicle armor.
2. *Kevlar K49* – high modulus used in cable and rope products.
3. *Kevlar K100* – colored version of Kevlar
4. *Kevlar K119* – higher-elongation, flexible and more fatigue resistant.
5. *Kevlar K129* – higher tenacity for ballistic applications.
6. *Kevlar AP* – has 15% higher tensile strength than K-29.^[10]
7. *Kevlar XP* – lighter weight resin and KM2 plus fiber combination.^[11]
8. *Kevlar KM2* – enhanced ballistic resistance for armor applications.^[12]

© Paper Chromatography to separate mixture of amino acid: how to develop different amino acids to make them visible?

Carrying out paper chromatography

Background

Chromatography is used to separate mixtures of substances into their components. All forms of chromatography work on the same principle.

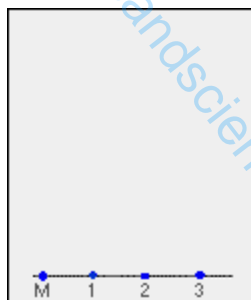
They all have a **stationary phase** (a solid, or a liquid supported on a solid) and a **mobile phase** (a liquid or a gas). The mobile phase flows through the stationary phase and carries the components of the mixture with it. Different components travel at different rates. We'll look at the reasons for this further down the page.

In paper chromatography, the stationary phase is a very uniform absorbent paper. The mobile phase is a suitable liquid solvent or mixture of solvents.

Producing a paper chromatogram

You probably used paper chromatography as one of the first things you ever did in chemistry to separate out mixtures of coloured dyes - for example, the dyes which make up a particular ink. That's an easy example to take, so let's start from there.

Suppose you have three blue pens and you want to find out which one was used to write a message. Samples of each ink are spotted on to a pencil line drawn on a sheet of chromatography paper. Some of the ink from the message is dissolved in the minimum possible amount of a suitable solvent, and that is also spotted onto the same line. In the diagram, the pens are labelled 1, 2 and 3, and the message ink as M.

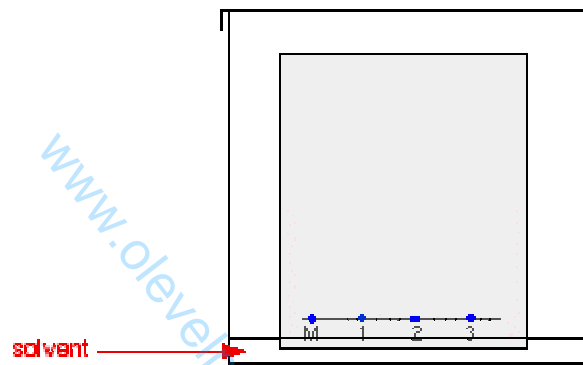


Note: The chromatography paper will in fact be pure white - not pale grey. I'm forced to show it as off-white because of the way I construct the diagrams. Anything I draw as pure white allows the background colour of the page to show through.

The paper is suspended in a container with a shallow layer of a suitable solvent or mixture of solvents in it. It is important that the solvent level is below the line with the spots on it. The next diagram doesn't show details of how the paper is suspended because there are too many possible ways of doing it and it

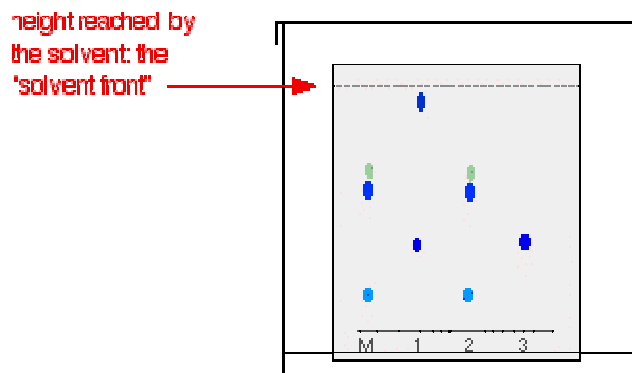
clutters the diagram. Sometimes the paper is just coiled into a loose cylinder and fastened with paper clips top and bottom. The cylinder then just stands in the bottom of the container.

The reason for covering the container is to make sure that the atmosphere in the beaker is saturated with solvent vapour. Saturating the atmosphere in the beaker with vapour stops the solvent from evaporating as it rises up the paper.



As the solvent slowly travels up the paper, the different components of the ink mixtures travel at different rates and the mixtures are separated into different coloured spots.

The diagram shows what the plate might look like after the solvent has moved almost to the top.



It is fairly easy to see from the final chromatogram that the pen that wrote the message contained the same dyes as pen 2. You can also see that pen 1 contains a mixture of two different blue dyes - one of which *might* be the same as the single dye in pen 3.

R_f values

Some compounds in a mixture travel almost as far as the solvent does; some stay much closer to the base line. The distance travelled relative to the solvent is a constant for a particular compound as long as you keep everything else constant - the type of paper and the exact composition of the solvent, for example.

The distance travelled relative to the solvent is called the R_f value. For each compound it can be worked out using the formula:

$$R_f = \frac{\text{distance travelled by compound}}{\text{distance travelled by solvent}}$$

For example, if one component of a mixture travelled 9.6 cm from the base line while the solvent had travelled 12.0 cm, then the R_f value for that component is:

$$\begin{aligned} R_f &= \frac{9.6}{12.0} \\ &= 0.80 \end{aligned}$$

In the example we looked at with the various pens, it wasn't necessary to measure R_f values because you are making a direct comparison just by looking at the chromatogram.

You are making the assumption that if you have two spots in the final chromatogram which are the same colour and have travelled the same distance up the paper, they are most likely

the same compound. It isn't necessarily true of course - you could have two similarly coloured compounds with very similar R_f values. We'll look at how you can get around that problem further down the page.

What if the substances you are interested in are colourless?

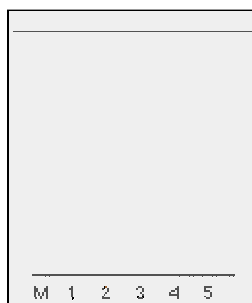
In some cases, it may be possible to make the spots visible by reacting them with something which produces a coloured product. A good example of this is in chromatograms produced from amino acid mixtures.

Suppose you had a mixture of amino acids and wanted to find out which particular amino acids the mixture contained. For simplicity we'll assume that you know the mixture can only possibly contain five of the common amino acids.

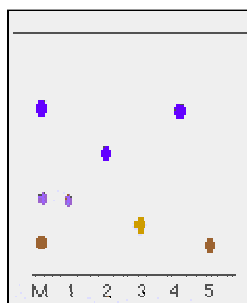
A small drop of a solution of the mixture is placed on the base line of the paper, and similar small spots of the known amino acids are placed alongside it. The paper is then stood in a suitable solvent and left to develop as before. In the diagram, the mixture is M, and the known amino acids are labelled 1 to 5.

The position of the solvent front is marked in pencil and the chromatogram is allowed to dry and is then sprayed with a solution of **ninhydrin**. Ninhydrin reacts with amino acids to give coloured compounds, mainly brown or purple.

The left-hand diagram shows the paper after the solvent front has almost reached the top. The spots are still invisible. The second diagram shows what it might look like after spraying with ninhydrin.



before spraying with ninhydrin



after spraying with ninhydrin

There is no need to measure the R_f values because you can easily compare the spots in the mixture with those of the known amino acids - both from their positions and their colours.

In this example, the mixture contains the amino acids labelled as 1, 4 and 5.

And what if the mixture contained amino acids other than the ones we have used for comparison? There would be spots in the mixture which didn't match those from the known amino acids. You would have to re-run the experiment using other amino acids for comparison.

B11:

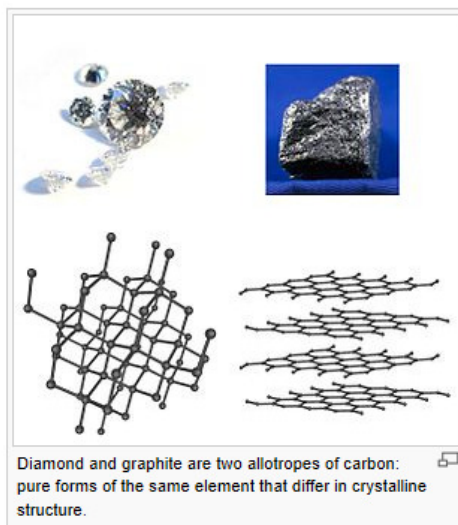
(a) What are Allotropes ?

Allotropy or **allotropism** is the property of some **chemical elements** to exist in two or more different forms, known as **allotropes** of these elements. Allotropes are different structural modifications of an element;^[1] the **atoms** of the element are **bonded** together in a different manner.

For example, the **allotropes of carbon** include **diamond** (where the carbon atoms are bonded together in a **tetrahedral** lattice arrangement), **graphite** (where the carbon atoms are bonded together in sheets of a **hexagonal lattice**), **graphene** (single sheets of graphite), and **fullerenes** (where the carbon atoms are bonded together in spherical, tubular, or ellipsoidal formations).

The term allotropy is used for elements only, not for **compounds**. The more general term, used for any crystalline material, is **polymorphism**. Allotropy refers only to different forms of an element within the same **phase** (i.e. different **solid**, **liquid** or **gas** forms); the changes of state between solid, liquid and gas in themselves are not considered allotropy.

For some elements, allotropes have different molecular formulae which can persist in different phases – for example, two **allotropes of oxygen** (**dioxygen**, O₂ and **ozone**, O₃), can both exist in the solid, liquid and gaseous states. Conversely, some elements do not maintain distinct allotropes in different phases – for example **phosphorus** has **numerous solid allotropes**, which all revert to the same P₄ form when melted to the liquid state.

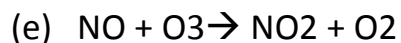


Element	Allotropes
Carbon	<ul style="list-style-type: none"> • Diamond - an extremely hard, transparent crystal, with the carbon atoms arranged in a tetrahedral lattice. A poor electrical conductor. An excellent thermal conductor. • Lonsdaleite - also called hexagonal diamond. • Graphite - a soft, black, flaky solid, a moderate electrical conductor. The C atoms are bonded in flat hexagonal lattices (graphene), which are then layered in sheets. • Linear acetylenic carbon (Carbyne) • Amorphous carbon • Fullerenes, including Buckminsterfullerene, aka "buckyballs", such as C₆₀. • Carbon nanotubes - allotropes of carbon with a cylindrical nanostructure.
Phosphorus:	<ul style="list-style-type: none"> • White phosphorus - crystalline solid P₄ • Red phosphorus - polymeric solid • Scarlet phosphorus • Violet phosphorus • Black phosphorus - semiconductor, analogous to graphite • Diphosphorus
Oxygen:	<ul style="list-style-type: none"> • dioxygen, O₂ - colorless (faint blue) • Ozone, O₃ - blue • Tetraoxygen, O₄ - metastable • Octaoxygen, O₈ - red
Sulfur:	<ul style="list-style-type: none"> • Sulfur has a large number of allotropes, second only to carbon
Selenium:	<ul style="list-style-type: none"> • "Red selenium," cyclo-Se₈ • Gray selenium, polymeric Se • Black selenium

(b) Ozone layer block harmful UV radiation from sunlight.

© CFC production was significantly reduced from year 1994 and the amount of ozone has recovered.

(d) The amount of ozone reduction correspond to the increase CFC production was very clear from the data. With reduction in CFC production, the problem of ozone depletion was reduced.



OS of nitrogen change from +2 to + 4, OS of Oxygen change from 0 to -2 → redox

(f) 1990, CFC produce=230,000,000 kg

Mole of $\text{CFCl}_3 = \frac{230 \times 10^9}{(12 + 35.5 \times 3 + 19)} = 1.673 \times 10^9 \text{ mol} = \text{mol of Cl atom present in ozone layer}$

Mass of Cl = $\frac{1.673 \times 10^9}{(35.5 \times 1000,000)} = 47.12 \text{ tonnes}$

B12:

P- had -OH & -COOH functional group

Q- also had -OH & -COOH function group

(a) Similarity: weak acid behavior

Difference: Saturated vs Unsaturated hydrocarbon

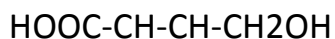
(b) NO as they do not has the same molecular formula.

© One possible isomer for P is :

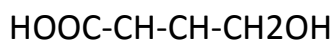


(d) Unsaturated Q can be converted to P using hydrogenation using nickel as catalyst.

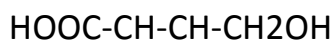
(e) P can be condensation polymerized but Q can be addition polymerized into:



|

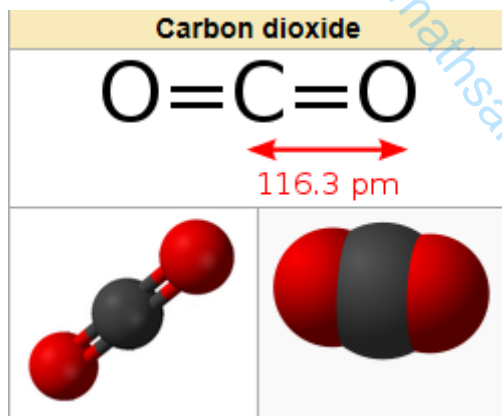


|



B13:

(a) CO is toxic



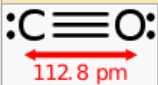

(b) $\text{CO}_2 =$ 4 shared pairs of electrons for each C

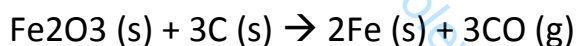
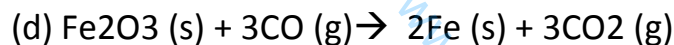
© CO, 3 shared pairs of electrons and 1 lone pairs. C does not achieve noble gas configuration. One of the triple bond is dative with both shared electrons contributed by Oxygen.

Carbon monoxide (CO), also called **carbonous oxide**, is a colorless, odorless, and tasteless gas that is slightly lighter than air. It can be toxic to humans and animals when encountered in higher concentrations, although it is also produced in normal animal metabolism in low quantities, and is thought to have some normal biological functions. In the atmosphere however, it is short lived and spatially variable, since it combines with oxygen to form carbon dioxide and ozone.

Carbon monoxide consists of one **carbon** atom and one **oxygen** atom, connected by a triple bond that consists of two **covalent bonds** as well as one **dative covalent bond**. It is the simplest **oxocarbon**. In **coordination complexes** the carbon monoxide **ligand** is called **carbonyl**.

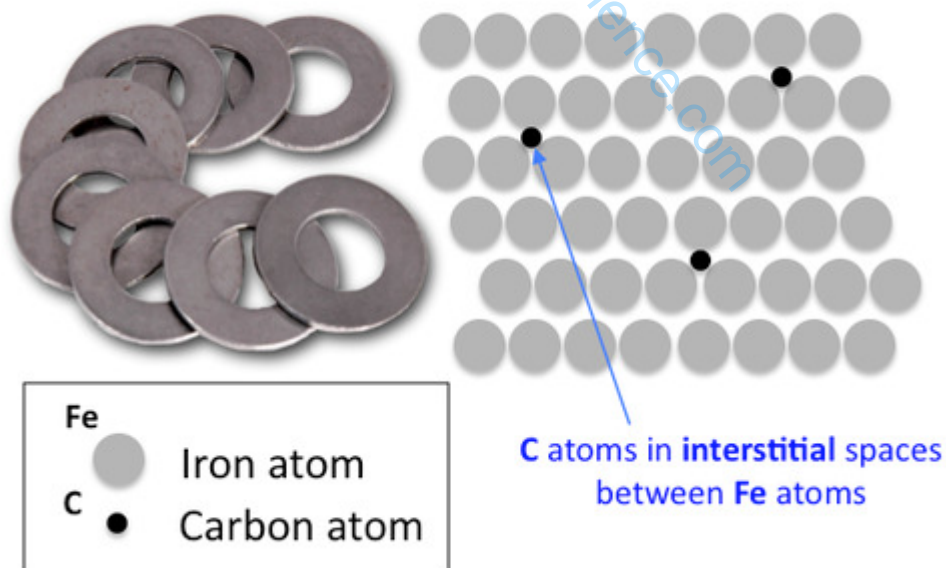
Carbon monoxide is produced from the partial oxidation of **carbon**-containing compounds; it forms when there is not enough oxygen to produce **carbon dioxide** (CO₂), such as when operating a **stove** or an **internal combustion engine** in an enclosed space. In the presence of oxygen, carbon monoxide burns with a blue flame, producing carbon dioxide.^[1] **Coal gas**, which was widely used before the 1960s for domestic lighting, cooking, and heating, had carbon monoxide as a significant constituent. Some processes in modern technology, such as **iron smelting**, still produce carbon monoxide as a byproduct.^[2]

Carbon monoxide	
	
Preferred IUPAC name [hide]	
Carbon monoxide	
Other names [hide]	
Carbon monooxide Carbonous oxide Carbon(II) oxide Carbonyl	
Identifiers	
CAS number	630-08-0 ✓
DiskChem	781 ✓



(e) High carbon steel alloy structure:

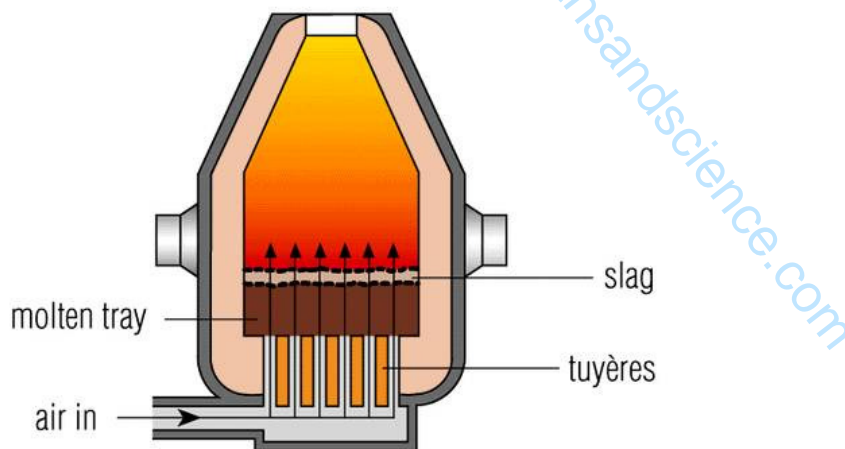
Steel: An iron-carbon alloy



(f) Treatment of pig-iron:

Production and Refining

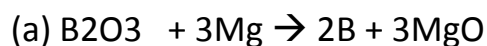
Iron is produced in the United States chiefly from oxide ores. For many years rich hematite ores were produced by open-pit mining in the Mesabi Range near Lake Superior. However, these ores have been largely depleted, and iron is now produced from low-grade ores that are treated to improve their quality; this process is called beneficiation. Iron ores are refined in the blast furnace. The product of the blast furnace is called pig iron and contains about 4% carbon and small amounts of manganese, silicon, phosphorus, and sulfur. About 95% of this iron is processed further to make steel, often by the open-hearth process or the **Bessemer process**, but more recently in the United States and other countries by the basic oxygen process or by an electric arc furnace. The balance is cast in sand molds into blocks called pigs. It is further processed in iron foundries (see casting).



First cheap method of making steel, invented by Henry Bessemer in England in 1856. It has since been superseded by more efficient steel-making processes, such as the basic-oxygen process. In the Bessemer process compressed air is blown into the bottom of a converter, a furnace shaped like a cement mixer, containing molten pig iron. The excess carbon in the iron burns out, other impurities form a slag, and the furnace is emptied by tilting.

Removal of carbon and other impurities make the iron more malleable (Lower strength)

OR B13



Mg more reactive than B thus displace B from its oxide

(b) In the presence of O_2 , Mg will react with O to form MgO instead

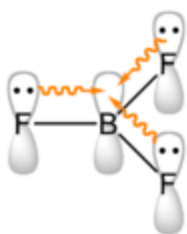
© Pure Boron had distinct MP, thus test for MP.

(d) BF_3 contains 3 shared pairs of electrons without lone pairs, not a noble gas configuration.

The geometry of a molecule of BF_3 is trigonal planar. The D_{3h} symmetry conforms with the prediction of VSEPR theory. The molecule has no dipole moment by virtue of its high symmetry. The molecule is isoelectronic with the carbonate anion, CO_3^{2-} .

BF_3 is commonly referred to as "electron deficient," a description that is reinforced by its exothermic reactivity toward Lewis bases.

In the boron trihalides, BX_3 , the length of the B-F bonds (1.30 Å) is shorter than would be expected for single bonds,^[3] and this shortness may indicate stronger B-X π -bonding in the fluoride. A facile explanation invokes the symmetry-allowed overlap of a p orbital on the boron atom with the in-phase combination of the three similarly oriented p orbitals on fluorine atoms.^[3]



(e) Boron carbide: very hard solid and high MP similar to diamond and silicon carbide.

$$\text{Mol of } B_4C = 112 \times 1000 / (4 \times 11 + 12)$$

$$\text{Mass of C needed} = 12 \times 7 \times 112 / (56) = 168 \text{ kg}$$

Properties

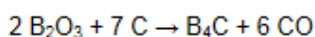
[edit]

Boron carbide is known as a robust material having high hardness, high cross section for absorption of [neutrons](#) (i.e. good shielding properties against neutrons), stability to [ionizing radiation](#) and most chemicals.^[3] Its [Vickers hardness](#) (38 GPa) and [fracture toughness](#) ($3.5 \text{ MPa}\cdot\text{m}^{1/2}$) approach the corresponding values for diamond (115 GPa and $5.3 \text{ MPa}\cdot\text{m}^{1/2}$).^[6]

Preparation

[edit]

Boron carbide was first synthesized by [Henri Moissan](#) in 1899,^[5] by reduction of [boron trioxide](#) either with [carbon](#) or [magnesium](#) in presence of carbon in an electric [arc furnace](#). In the case of carbon, the reaction occurs at temperatures above the melting point of B₄C and is accompanied by liberation of large amount of [carbon monoxide](#).^[7]



If magnesium is used, the reaction can be carried out in a [graphite furnace](#), and the magnesium byproducts are removed by treatment with acid.^[8]

Uses

[edit]

[Padlocks](#)

Personal and vehicle anti-ballistic [armor plating](#).

[Grit blasting](#) nozzles.

[High-pressure water jet](#) cutter nozzles.

Scratch and wear resistant coatings.

Cutting tools and dies.

End of paper