# 01 Experimental design

## MCQs

07ZZ01-01

**B**

I: $SO_2$ is heavier than air (mainly nitrogen and oxygen gas), therefore the $SO_2$ collected into the measuring cylinder would fall and hence unable to collect.

II: As $SO_2$ is heavier than air, it would collect at the bottom of the measuring cylinder and not escape.

III: $SO_2$ is soluble in water.

$SO_2\,(g) + H_2O\,(l) \rightarrow H_2SO_3\,(aq)$

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07ZZ01-02

**A**

$CO_2$: As $CO_2$ is heavier than air, it is able to collect at the bottom of a measuring cylinder. Hence Method 1 is feasible. $CO_2$ is soluble in water, forming $H_2CO_3$. Therefore Method 2 is out.

$H_2$, $O_2$: These two gases are sparingly soluble in water, therefore Method 2 is the most ideal to collect them.

$NH_3$: This gas is soluble, thus Method 2 is out. As it weighs lighter than air, Method 3 would be a better way to collect rather than Method 1.

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07ZZ01-03

**D**

To investigate the reaction of barium with water, the barium has to be submerged in the water.

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07ZZ01-04

**B**

When ammonium chloride is heated, ammonia gas and hydrogen chloride are formed. Calcium hydroxide reacts with the hydrogen chloride, thus allowing the ammonia gas to be detected.

$2NH_4Cl\,(s) + Ca(OH)_2\,(s) \rightarrow 2NH_3\,(g) + CaCl_2(s) + 2H_2O\,(l)$

A good drying agent for ammonia gas would be calcium oxide.

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01-1-M-05

**C**

Measuring cylinders are used for **rough** measurements of liquid.

Burettes are used to measure a **varying** and **accurate** amount of liquid that is **added** to another liquid.

Pipettes are used to transfer an **accurate** volume of liquid.

M08-01-23

**C** Ernest Rutherford

Ernest Rutherford published his atomic theory describing the atom as having a central positive nucleus surrounded by negative orbiting electrons. This model suggested that most of the mass of the atom was contained in the small nucleus, and that the rest of the atom was mostly empty space. Rutherford came to this conclusion following the results of his famous gold foil experiment.

M08-01-24

**B**

| | |
|---|---|
| 2.8.1 | 12 |

23 = Nucleon number

= Number of protons + Number of neutrons

11 = Proton number

M08-01-25

**C** The number of valence electrons is 4

M08-01-26

**D** II, III and IV

Na 11 electrons

Ne 10 electrons

Na+ 10 electrons as it is positively charged

Mg+ 10 electron as it is positively charged

02-2-M-36

**C**

$^{1}_{1}H$ – proton = 1; neutron = (1 – 1) = 0

$^{2}_{1}H$ – proton = 1; neutron = (2 – 1) = 1

$^{3}_{1}H$ – proton = 1; neutron = (3 – 1) = 2

$^{4}_{2}H$ – proton = 2; neutron = (4 – 2) = 2

# Questions – 2.2

07ZZ02-40

(a) Isotopes are atoms of the same element but have different number of neutrons.

(b) Isotopes have slightly different physical properties due to the difference in weight but identical chemical properties because they have the same number and arrangement of electrons.

(c) Relative atomic mass

$= 0.9052 \times 20 + 0.0031 \times 21 + 0.0917 \times 22$

$= 20.2$ (ans)

07ZZ02-41

(a) (i) Y is a Group I metal. Therefore it is very reactive and thus has to be stored in paraffin oil.

(ii) A noble gas X is used as it is inert.

(iii) Non-metals like W form acidic oxides.

(b) Y reacts violently with water, and effervescence is seen.

(c) (i) This is because element R is below P in the group, which implies that R is more reactive.

(ii) The oxide of R would not conduct electricity in the solid state but it can in the molten state, when its ions are mobile.

07ZZ02-42

(a) 2.8.8.1

(b) Y belongs to Group VII. It has 7 electrons in the outermost shell.

(c) (i) $2X\ (s) + Br_2\ (l) \rightarrow 2XBr\ (aq)$

(ii) $2X\ (s) + O_2\ (g) \rightarrow X_2O\ (s)$

# ❷•❺ Covalent bonding

## MCQs

07ZZ02-68

**D**

Element Y forms ions of charge −1. Both X and Y are non-metal. Therefore they will form a covalent compound.

X requires two electrons to obtain the octet electronic configuration. Hence, one X atom will share one electron each with two Y atoms to obtain the noble gas configuration.

07ZZ02-69

**A**

A bond formed between a metal and a non-metal is an ionic bond, whereby electrons are transferred from the metal to the non-metal.

Noble gases do not share electrons with another atom as they have already obtained the noble gas configuration.

Covalent bonds are formed by sharing electrons between non-metals.

07ZZ02-70

**D**

A: Giant covalent compounds do not conduct electricity.

B: Q is an ionic compound as it conducts electricity only in the liquid state. However, ionic compounds do not conduct electricity via electrons

C: S is not a macromolecule because it conducts electricity.

M06-01-24

**C** Magnesium and element Y form an ionic compound, $MgY_2$.

M08-01-06

**B** A bond formed when non-metal atoms share electrons to achieve a stable electron arrangement.

M08-01-10

**C** Magnesium oxide, MgO

Ethanol, sulphur dioxide and tetrachloromethane are covalent compounds.

M08-01-40

**B** Each oxygen atom accepts two electrons from the carbon atom

Each oxygen atom shares two pairs of electrons forming a double covalent bond.

02-5-M-08

**D**

Covalent bond is formed by mutual sharing of a pair or more electrons.

Since there are no free electrons as in the case of ionic bond, a simple covalent molecule does not conduct electricity, whether it is in the solid or molten state.

Simple covalent molecules tend to be gases, volatile liquids with low boiling points or low melting point solids.

M07-01-23

**B** 4 mol of aluminum atoms react with 3 mol of oxygen molecules

M07-01-36

**C** 4.8 $dm^3$ $H_2$

Number of moles × Molar volume ($dm^3$ $mol^{-1}$)
= volume of gas ($dm^3$)

Number of moles of $H_2 = \frac{4.8}{24\ dm^3 mol^{-1}} = 0.2mol$

1 molecule of $H_2$ = 2 atoms

Therefore, number of moles of H atoms
= 2 × 0.2 mol = 0.4mol

M07-01-37

**C** 1 molecule of carbon dioxide gas is given off

M08-01-30

**A** 1 mol of neon

Ammonia, chlorine gas and nitrogen gas are molecules, not atoms

M08-01-36

**B** Lead (II) oxide = $PbO_2$

M08-01-38

**A** 0.30mol

Number of moles = $\frac{\text{Mass}}{\text{Molar mass}}$

The relative molecular mass of copper (II) nitrate
= 64 + 2[14 + 3(16)] = 188

The number of moles of copper(II)nitrate
= $\frac{56.4}{188}$
= 0.30mol

M08-01-41

**B** 16

Let the relative atomic mass of element A = a

3a = 4carbon atoms

3a = 4(12)

a = 16

M08-01-42

**D** 11.70g

The empirical mole for sodium:

$\frac{2.3}{23} = 0.1$ mol

By referring to the chemical equation, 2 mol of sodium chloride is formed when 2 mol of sodium reacts with excess chlorine.

Let $x$ = mass of sodium chloride

$\frac{x}{58.5} = 0.2$

$x = 0.2 \times 58.5 = 11.7g$

M08-01-47

**B** 2.0g

Number of moles for sulphuric acid
= 50.0$cm^3$ × 1.0mol $dm^{-3}$
= 0.05$dm^3$ × 1.0mol $dm^{-3}$
= 0.05 mol

Number of moles for CuO = $\frac{6}{80} = 0.075mol$

Therefore, the excess of CuO = 0.075 – 0.05
= 0.025 mol

Mass of CuO left = 0.025 × 80 = 2 g

03-1-M-63

**B** calcium

$A_r$ of F is 19

Hence $A_r$ of X = 78 – (19×2) = 40

$A_r$ of argon and calcium is 40

However, argon is inert and does not form compound with fluorine.

07ZZ04-37

(a) $O_2\,(g) + 2H_2\,(g) \rightarrow 2H_2O\,(l)$

(b) The product water that is formed does not contribute to pollution.

Electricity is produced indefinitely as the reactants are continuously being fed into the fuel cell.

The fuel cell operates at a high efficiency.

07ZZ04-38

(a) The ions present are $Ag^+$, $NO_3^-$, $K^+$, $I^-$, $H^+$ and $OH^-$.

(b) It is to allow current to pass through the filter paper.

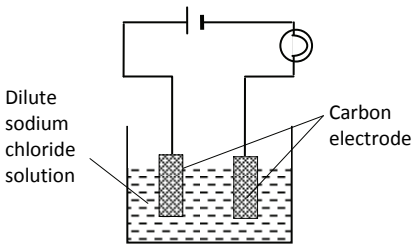
(c) Silver iodide

(d) $Ag^+$ ions moves faster and thus travel a longer distance. Therefore, the precipitate formed will be nearer to the cathode.

M05-02-09

(a) The iron key can be electroplated with nickel by electrolysis. Iron key acts as cathode and nickel acts as anode. Nickel(II) sulphate solution is used as electrolyte.

(b)




In the sodium chloride solution, the ions present are $Na^+$, $Cl^-$, $H^+$ and $OH^-$ ions. After the switch is on, $Na^+$ and $H^+$ ions will be attracted to the cathode. The $H^+$ ions will be discharged to produce hydrogen gas given it is located at a lower position in the electrochemical series compared to $Na^+$ ions:

$$2H^+ + 2e^- \rightarrow H_2$$

Anode will attract $Cl^-$ and $OH^-$ ions. The $OH^-$ ions will be discharged to produce oxygen gas given it is located at a lower position in the electrochemical series:

$$4OH^- \rightarrow 2H_2O + 4e^-$$

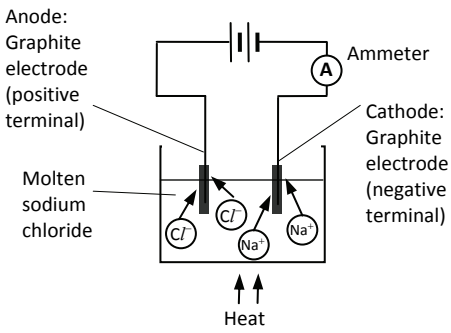
M06-02-10

(a) Sodium chloride

(b) Anode: $2Cl^- \rightarrow Cl_2 + 2e^-$

Cathode: $Na^+ + e^- \rightarrow Na$ (either one)

(c)




(d) When electrolysis happens, the positive terminal will attract the chloride ions and the negative terminal will attract sodium ions. $Cl^-$ ions is discharged by releasing electron to form chlorine gas at the anode:

$$2Cl^- \rightarrow Cl_2 + 2e^-$$

The discharged electron flows through the wire to the cathode. While at the cathode, $Na^+$ ion is discharged by accepting electrons to form sodium:

$$Na^+ + e^- \rightarrow Na$$

Eventually, sodium will be obtained at the cathode and chloride gas will be obtained at the anode.

04-1-Q-16

(a) The ions are mobile.

(b) It is a molecular structure and has no ions.

(c) Add water, stir and then filter.

(d) (i) C

(ii) Graphite

(iii) Negative electrode: Zn
Positive electrode: $Cl_2$

(iv) Acidify by adding nitric acid
Add aqueous silver nitrate
A white precipitate is observed

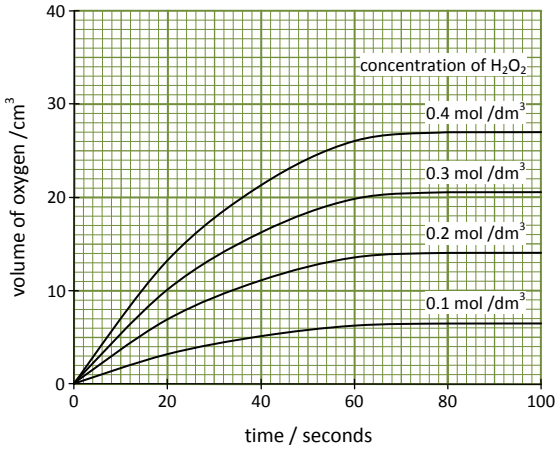
06-1-Q-10

(a) (i) Enzyme is a protein which speeds up a reaction

(ii) $2H_2O_2 \rightarrow 2H_2O + O_2$

(b) (i) Increasing the concentration of hydrogen peroxide increases the rate of reaction.

(ii)




(iii) volume – 26 cm$^3$

time – 20 s

(c) (i) Loss of oxygen.

(ii) sulfuric acid + calcium hydroxide $\rightarrow$ calcium sulfate + water

(iii) Add aqueous silver nitrate. A pale yellow precipitate is observed.

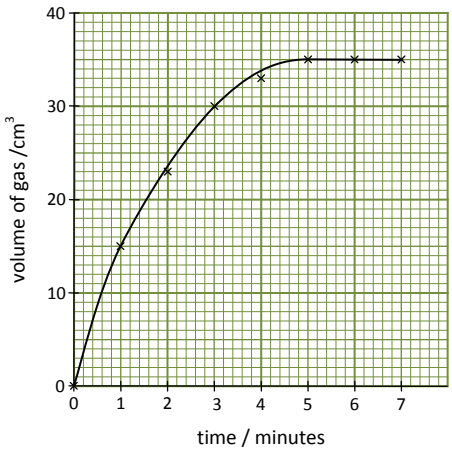
The white precipitate is filtered and rinsed with distilled water. It is then pressed between sheets of filter papers to dry.

(c) Orange juice. (i) It is a weak acid, so it does not harm skin. (ii) It is less corrosive. (iii) It can neutralise the alkali, without harming skin.

07-1-Q-10

(a) lower the test tube into the HC*l*.

(b) (i)




Curve of best fit drawn, including the 0-0 point.

(ii) The volume of gas stays the same after 5 minutes because the reaction is complete and the hydrochloric acid has been used up.

(c) (1) concentration; (2) increases; (3) decreases; (4) speed.

(d) Step 1 – filter off the excess zinc

Step 2 – heat filtrate to crystallisation point

Step 3 – dry crystals with filter paper

07ZZ07-30

**D**

A: Although zinc hydroxide is soluble in excess NaOH, the yield of zinc carbonate will be low as carbon dioxide gas is not very soluble.

B: A precipitate of zinc hydroxide is formed.

C: Calcium carbonate does not dissolve in water.

D: Zinc sulphate dissolves in water to form $Zn^{2+}$ and $SO_4^{2-}$ ions. The $Zn^{2+}$ ions combine with $CO_3^{2-}$ ions form aqueous sodium carbonate to form the precipitate zinc carbonate.

07ZZ07-31

**D**

Ammonium chloride sublimes when heated to form ammonia and hydrogen chloride gas.

07ZZ07-32

**C**

C is the best answer as it converts the solid calcium oxide into a soluble salt before adding the sulphuric acid to precipitate the final product.

Note: The precipitation method is the best method to prepare insoluble salts.

M05-01-06

**B** Sulphur dioxide

When gas sulphur dioxide is passed through acidified potassium dichromate solution, it will change the solution colour from orange to green.

M06-01-27

**C** Preparation of insoluble salt

Potassium iodide solution reacts with lead(II) nitrate solution to form insoluble lead(II) iodide.

M06-01-41

**C** Nessler reagent Dilute nitric acid and silver nitrate

Chloride ion can be tested by adding dilute nitric acid and silver nitrate solution. A white precipitation is formed. Ammonium ion can be tested by Nessler reagent. A yellow coloration indicates the presence of ammonia; at higher concentrations, a brown precipitate may form.

07-2-M-13

**D**

At area B on the graph, the acid and alkali started to react to form salt and water. At area D, the acid and alkali would have been fully neutralised , with excess acid present together with the salt.

07-2-M-14

**C** 2 and 3

Hydrated copper(II) sulfate loses water to form anhydrous copper(II) sulfate, a white substance. There is no reduction reaction in the process.

The (II) in the name copper(II) sulfate refers to the oxidation state of the metal. In this case, the oxidation state of copper is +2.

The reaction is reversible, indicated by the symbol $\rightleftharpoons$.

M06-01-21

**A** *P*

For element from period 3, it has three shells occupied with electrons. An amphoteric oxide can react with both acids and alkalis to form salts and water.

M07-01-25

**D** The attraction of the nucleus for electrons in the shells increases.

When the proton number increases, the attractive force between the nucleus and the electrons in the outermost shell becomes stronger. The electrons are pulled closer to the nucleus.

M08-01-14

**D** The number of shells with electrons increases

In the Periodic Table of Elements, when going down Group I, (a) the atomic size increases, (b) the melting and boiling points decrease, and (c) the density of elements increases.

M08-01-27

**A** I and IV

Atoms A and B have 2.8.1 and 2.8.8.1 electron arrangements that fall under Group I.

08-1-M-15

**C** number of outer shell electrons

Elements in the Periodic Table are arranged such that the number of outer shell electrons increases by one across the period.

# Questions – 8.1

M05-02-01

(a) (i) D

(ii) E

(iii) B

(b) E, C, D, B and A

(c) 2.4

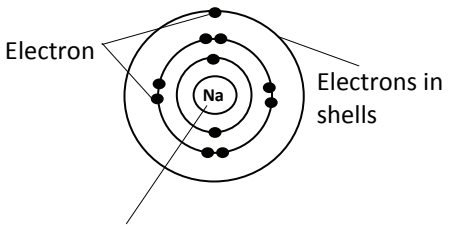
(d) $D^-$

(e) Both C and E have the same number of electron shells filled with electrons

(f) The red litmus paper turns blue.

(g) Transition elements.

M06-02-9




The element is sodium

M08-03-02

(a) **Objective of experiment**

Comparing the reactivity of lithium, sodium and potassium with water

(b) (i) **Manipulated variable**

Different types of metals

(ii) **Responding variable** – Reactivity of metals

(iii) **Constant variable** – Volume of water, size of the metal used

(c) **The hypothesis**

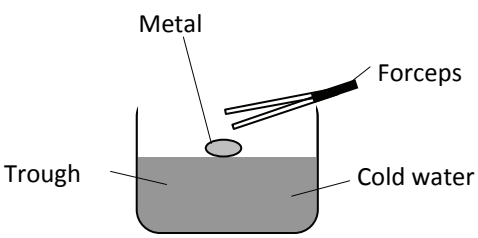
As going down Group I, the reactivity of these metals towards water increases.

(d) **List of substances and apparatus**

Forceps, knife, trough, filter paper, water, lithium, sodium, potassium and red litmus paper

(e) **Procedure of the experiment**

1. Lithium is cut with a knife
2. The oil on lithium is cleared using a piece of filter paper
3. The lithium is dropped into a trough that contains water by using a pair of forceps. Observation is recorded.
4. The solution is tested with red litmus paper when the reaction stops.
5. Steps 1 to 4 are repeated using sodium and potassium respectively. The size of metals used is to be constant throughout the experiment.




(f) Tabulation of data

| Metal | Observation |
|---|---|
| Lithium | Moves slowly on the water surface with a little fizzing. Red litmus paper turns blue |
| Sodium | Moves rapidly on the water surface with a 'hissing' sound. Red litmus paper turns blue |
| Potassium | Moves very rapidly on the water surface. It ignites with a lilac flame 'pop' and a 'hissing' sound. Red litmus paper turns blue |

Conclusion:

The reactivity of metals with water increases from lithium → sodium→ potassium

08-2-Q-07

(a) (i) lithium + water → lithium hydroxide + hydrogen

(ii) $2Na + 2H_2O \rightarrow 2NaOH + H_2$

(b) Order of reactivity is potassium > sodium > lithium

Observation when these metals react with water:

- float on surface
- effervescence
- fizzes

(c) (i) anode – E
electrolyte – A

(ii) positive electrode – $Cl_2$
negative electrode – Na

(iii) graphite

(d) conduct electricity and soft

08-2-Q-08

(a) (i) Chlorine's boiling point is below room temperature, at –35°C.

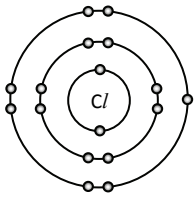
(ii) Bromine has melting point of –7°C which is below room temperature and boiling point of +59°C which is above room temperature.

(b) Atomic radius increases going down the group from chlorine to iodine.

(c) 0.06 – 0.08 (actual = 0.071)

(d) yellow-green

(e)




(f) (i) $Cl_2 + 2KBr \rightarrow 2KCl + Br_2$

(ii) Iodine is less reactive than bromine.

# ❽•❸ Transition elements

## MCQs

07ZZ08-19

**A**

A transition metal should have a high melting point, high electrical conductivity and high density.

07ZZ08-20

**B**

The oxidation state of Cr in $Na_2CrO_4$ is +6.

07ZZ08-21

**C**

A characteristic of transition metals is that they exhibit variable oxidation states.

07ZZ08-22

**C**

Transition metals are very hard, with high density, high melting points and boiling points.

M07-01-06

**A** They do not conduct heat

Transition elements are metals. They are good conductors of heat and electricity.

M08-01-11

**C**

Transition elements (a) form coloured ions or compounds, (b) show different oxidation numbers in their compounds, (c) good catalysts, and (d) can form complex ion.

08-3-M-07

**D**

Transition elements have high melting points and they form coloured compounds.

# ❾•❸ Extraction of metals

## MCQs

07ZZ09-36

**D**

Calcium oxide is basic and reacts with acidic impurities such as silicon dioxide to produce slag.

$CaO + SiO_2 \rightarrow CaSiO_3$

07ZZ09-37

**C**

A less reactive metal will be reduced more easily.

07ZZ09-38

**A**

Burning of plastics will release toxic fumes.

07ZZ09-39

**C**

Lead is too reactive for its oxide to be decomposed only by heating. More reactive metals will form more stable oxides.

09-3-M-05

**B**

The methods used for metal extraction depends on its position in the reactivity series.

Zinc is the most reactive metal out of the three while copper is the least reactive. Hence, zinc is the most difficult to be extracted, followed by iron, then copper.

Iron can be reduced by heating strongly with a reducing agent like coke (carbon). This process is called smelting.

## Questions – 9.3

07ZZ09-40

(a) $2ZnS\ (s) + 3O_2\ (g) \rightarrow 2ZnO\ (s) + 2SO_2\ (g)$

No. of moles of ZnS = No. of moles of $SO_2$

$$= \frac{128\,000\ g}{32 + 16 \times 2} = 2000\ mol$$

Mass of ZnS $= 2000 \times (65 + 32) = 194\,000$ g

$= 194$ kg (ans)

(b) Zinc oxide can be heated with coke to obtain zinc metal.

(c) Sand (silicon dioxide) can be removed by adding calcium oxide. Calcium oxide reacts with sand to produce slag.

$CaO + SiO_2 \rightarrow CaSiO_3$

(d) (i) Sulphuric acid is added to zinc oxide to produce zinc sulphate.

(ii) Metals ions which are less reactive than zinc should be removed from the solution before electrolysis. These ions can be removed by adding a reactive metal into the solution.

07ZZ09-41

(a) (i) Carbon acts as the reducing agent. It removes oxygen atoms from silicon, thus silicon is reduced.

(ii) Crystallization should take place in an inert atmosphere to avoid the introduction of impurities.

(b) It is because both iron and aluminium are non-renewable resources. Furthermore, using electrolysis to obtain the two metals is an expensive process.

07ZZ10-09

**B**

Catalytic converters reduce oxides of nitrogen to nitrogen gas.

07ZZ10-10

**A**

B: Sulphur dioxide contributes to the formation of acid rain.

C: Carbon dioxide causes global warming.

D: Nitrogen dioxide causes acid rain.

10-1-M-11

**C**

1: Carbonates are alkali in nature and hence will not react with another alkali

2: Carbonates decomposes when heated to give an oxide and carbon dioxide

3: Complete combustion of methane gives off carbon dioxide

4: Carbonates do not react with oxygen

# Questions – 10.1

07ZZ10-11

(a) (i) Oxides of nitrogen emissions are the lowest during idle as the temperature of the engine is low. Therefore, there is <u>insufficient</u> energy to dissociate the oxygen molecules into atoms to initiate the free-radical reaction with nitrogen to produce oxides of nitrogen.

(ii) As the temperature of the engine is low, the rate of combustion of hydrocarbons is low.

(b) A high air/fuel ratio implies that more oxygen is available in the engine during combustion. Thus most carbon monoxide would be oxidized into carbon dioxide in an oxygen-rich environment.

(c) (i) Carbon dioxide, water and nitrogen

(ii) Nitrogen and carbon dioxide gas

07ZZ10-12

(a) CFCs deplete the ozone layer. When the CFC molecules rise up to the upper atmosphere, they are decomposed by sunlight to form chlorine atoms. Chlorine atoms will destroy the ozone layer.

(b) $C_2F_2Cl_2$

07ZZ10-13

(a) $CO_2\ (g) + H_2O\ (l) \rightarrow H_2CO_3\ (aq)$

A weak acid is produced.

(b) Carbon dioxide and water are the expected products.

(c) Sulphurous acid is the first product.

$SO_2\ (g) + H_2O\ (l) \rightarrow H_2SO_3\ (aq)$

(d) Nitrogen oxide and nitrogen dioxide lead to the formation of nitric acid.

(e) $CaCO_3\ (s) + H_2SO_4\ (aq) \rightarrow CaSO_4\ (s) + CO_2\ (g) + H_2O\ (l)$

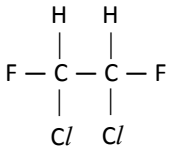
The acid is neutralized and carbon dioxide gas is produced as a result.

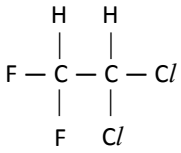
No. of C*l* atoms = 2(2+1) – 2 – 2

= 2

Hence the molecular formula of CFC-132 is $C_2H_2F_2Cl_2$.

(c)





(d) When the CFC molecules rise up to the upper atmosphere, they are decomposed by sunlight to form chlorine atoms. Chlorine atoms will destroy the ozone layer.

(e) The three elements are carbon, hydrogen and fluorine. HFCs are safe alternatives to CFCs as there is no chlorine atoms present in HFCs.

10-1-Q-12

(a) (i) sulfur + oxygen → sulfur dioxide

(ii)

| | |
|---|---|
| $SO_2$ is oxidised to $SO_3$ | ✓ |
| $SO_2$ is reduced to $SO_3$ | |
| $O_3$ is reduced to $O_2$ | ✓ |
| $O_3$ is oxidised to $O_2$ | |

(iii) $H_2O$

(b) sulfuric acid reacts with calcium carbonate in a neutralisation reaction, with $CO_2$ being released

(c) harms organisms in lakes

# 11•1 Fuels and crude oil

## MCQs

07ZZ11-01

**D**

Fossil fuel is non-renewable and not all are in liquid form, such as coal.

07ZZ11-02

**A**

Bitumen is the heaviest fraction and hence has the largest molecules.

07ZZ11-03

**B**

Different petroleum fraction has different densities and boiling points.

07ZZ11-04

**B**

The cracking of hexane ($C_6H_{14}$) yields two lighter products - butane ($C_4H_8$) and ethane ($C_2H_6$)

11-1-M-05

**C**

Fuel oil is used for domestic heating.

Kerosene is used as fuel for jet aircraft.

Naphtha is used as raw material for cracking and petro-chemicals.

Refinery gas is used for domestic heating and cooking.

## Questions – 11.1

07ZZ11-05

The fractions of petroleum were separated through the process of fraction distillation. Inside the fractionating column, or the distillation tower, the oil is heated to about 400°C. It vapourises and separates into components or fractions according to weight and boiling point.

07ZZ11-06

(a) A fraction of petroleum indicates a mixture of hydrocarbon molecules that boils over a certain range of temperature which can be separated by fraction distillation.

(b) Based on the position of the fraction extracted from the distillation column, the boiling temperature is: A > B > C. The molecular size of the three factions also has the same ranking.

(c) If fraction B is petrol, then fraction A must be petroleum gas and fraction C is naphtha.

(d) The main use of petrol is to power motor vehicles.

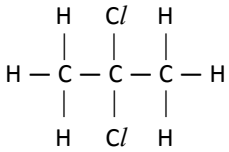
07ZZ11-07

The common formula of alkane is $C_nH_{2n+2}$. The relative molecular weight of A is 44, so solving the equation:

$12n + 2n + 2 = 44$

$\Rightarrow n = 3$. Therefore, A is $C_3H_8$.

The common formula for alkene is $C_nH_{2n}$, the relative molecular weight is 42. Using the same method as A, we obtain n as 3 for B, hence the molecular formula of B is $C_3H_8$.



07ZZ11-14

**C**

A: S is more viscous than P as S has a higher boiling point than P, which implies that the intermolecular forces of attraction in S are stronger.

B: S contains heavier molecules which contribute to stronger intermolecular forces of attraction. This results in a higher boiling point.

D: Smaller alkanes have a higher demand than larger ones.

07ZZ11-15

**D**

Isomers have the same molecular formula but different structural formulae.

07ZZ11-16

**D**

A: The second member of the homologous series has more number of bonds than the first member.

B: They do not have the same empirical formula. They have a general formula.

C: The number of carbon atoms increases down the homologous series.

M05-01-14

**A** Bromobutane

Straight-chained butane is named based on the longest continuous carbon chain. Therefore the isomers with four carbon atoms are named as butane.

M06-01-15

**B** Alkane

Saturated hydrocarbons are made up entirely of single bonds and are all bonded to hydrogen.

Alcohol is an organic compound in which the hydroxyl functional group (–OH) is bound to a carbon atom.

Alkene is an unsaturated organic compound containing at least one carbon–carbon double bond.

Carboxylic acid is an organic acid which has at least one carboxyl group. The general formula of a carboxylic acid is R–COOH.

M08-01-12

**B** $C_nH_{2n+2}$

Alkanes consist only of hydrogen and carbon atoms, all bonded by single bonds, and the carbon atoms are not joined in cyclic structures but instead form an open chain. They have the general chemical formula $C_nH_{2n+2}$.

11-2-M-13

**C**

A complete combustion of a hydrocarbon will produce carbon dioxide and water.

However, an incomplete combustion will produce carbon monoxide and water.

$$2C_2H_6 + 5O_2 \rightarrow 4CO + 6H_2O$$

C: The number of H atoms is 31, which is less than $17 \times 2 = 34$. Thus, there should be more than one region of unsaturation in the compound.

D: There are no C═C bonds in this molecule.

07ZZ11-28

**C**

Since G decolourises aqueous bromine, it is a positive test for alkenes.

Butane has four C atoms. Its products are methane and G after cracking. Since methane contains only 1 C atom, G should contain 3 C atoms. Hence G is propene.

Propene reacts with hydrogen in the presence of nickel catalyst to produce its corresponding alkane, which is propane.

M05-01-16

**A**

Unsaturated hydrocarbons have one or more double or triple bonds between carbon atoms.

Those with one or more double bonds are called alkenes. Those with one double bond have the formula $C_nH_{2n}$ (assuming non-cyclic structures).

Those containing triple bonds are called alkynes, with general formula $C_nH_{2n-2}$.

M05-01-29

**B**

In an addition reaction, the carbon-carbon double bonds in alkenes are broken to allow other atoms to add onto the carbon atoms to form a single product.

M07-01-14

**B** Carbon dioxide and water

$C_2H_4(g) + 6O_2(g) \rightarrow 4CO_2(g) + 4H_2O(l)$

M07-01-15

**C** Hydrogenation

$C_5H_{10}(g) + H_2(g) \rightarrow C_2H_{12}(g)$

M08-01-18

**A**

Monounsaturated fatty acids are fatty acids that have one double bond in the fatty acid chain and all the remainder of the carbon atoms in the chain are single-bonded. Polyunsaturated fatty acids, on the other hand, have more than one double bond.

☺ Saturated fatty acids have all the hydrogen that the carbon atoms can hold, and therefore, have no double bonds between the carbons.

11-3-M-16

**A**

Ethane:
- is a gas
- burns in oxygen
- does not react with aqueous bromine

Ethene:
- is a gas
- burns in oxygen
- decolourises aqueous bromine

C: Ethanol is oxidized to ethanoic acid by heating ethanol with a mixture of sulphuric acid and potassium dichromate(VI).

07ZZ11-46

**B**

The wine is being oxidized by air to form ethanoic acid, which has a sour taste.

M05-01-15

**B** Dehydration

Dehydration of an alcohol will produce alkene gas.

M06-01-14

**A** Carbon dioxide and ethanol

$C_6H_{12}O_6\ (aq) \xrightarrow{yeast} 2C_2H_5OH\ (aq) + 2CO_2\ (g)$

M06-01-16

**A** Ethanol

Most alcohols can be dehydrated to alkenes, using a suitable dehydrating agent. Suitable dehydrating agents include aluminium oxide and concentrated sulphuric acid.

However, in this sort of reaction it is the presence of a hydroxyl group on one carbon atom, *and a hydrogen atom on a neighbouring carbon atom*, which are needed for the elimination reaction to take place, resulting in the creation of a carbon/carbon double bond.

Methanol only has one carbon atom, so no double bond can be formed, therefore methanol cannot be dehydrated in the same way.

M07-01-13

**B**

Alcohols consist of the hydroxyl group, –OH and its general formula is $C_n\ H_{n+1}\ OH$, where $n = 1,2,3…$

11-4-M-17

**A**

Ethanol can be formed by the addition reaction of ethene and steam.

$C_2H_4\ (g) + H_2O\ (g) \xrightarrow{catalyst} C_2H_5OH\ (l)$

Ethanol can be formed by fermentation of glucose:

$C_6H_{12}O_6(aq) \xrightarrow{catalyst} 2C_2H_5OH(aq) + 2CO_2(g)$

Ethanol burns in air to forms carbon dioxide and water:

$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$

# ❶❶•❼ Mixed questions

## MCQs

11-7-M-01

**C**

The compound consists of 2 functional groups:

– alkene C═C double bond

– carboxylic acid —COOH group

# Questions – 11.7

07ZZ11-89

(a)

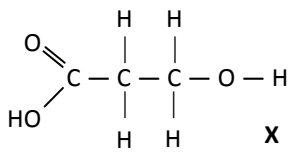
| | C | H | O |
|---|---|---|---|
| % mass | 40.0 | 6.7 | 53.3 |
| No. of mol | $\frac{40.0}{12}$ $= 3.33$ | $\frac{6.7}{1}$ $= 6.70$ | $\frac{53.3}{16}$ $= 3.33$ |
| Ratio | 1 1 | $\frac{6.70}{3.33}$ $= 2$ | 1 1 |

The empirical formula of X is $CH_2O$.

$$n = \frac{90}{12+1\times2+16} = 3$$

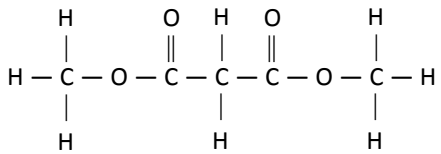
Therefore, the molecular formula of X is $C_3H_6O_3$.

(b) Since X can react with sodium carbonate, X has a carboxylic acid group. Y contains 2 carboxylic groups, thus X contains an alcohol group so that after oxidation, X will obtain 2 carboxylic groups.



**X**

(c)

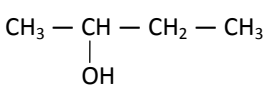


07ZZ11-90

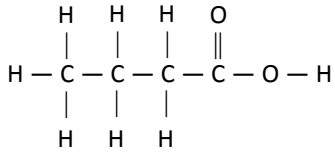
(a) (i) Sodium butoxide

$CH_3—CH_2—CH_2—CH_2—O^-Na^+$

(ii)

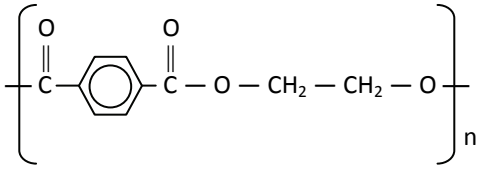


(iii) Butanoic acid



(b) (i) Condensation polymers are formed when monomers react together, producing a small molecule like water in the process.

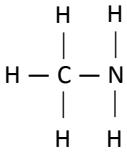
(ii)



(iii) Compound A is not difunctional, i.e. it does not have 2 functional groups.

07ZZ11-91

(a)



(b) No. It is because there is no C═C bond in methylamine.

(c) A white solid will be formed.

(d) At a higher temperature, the gas particles will possess more kinetic energy, resulting in more collisions which will lead to reactions.

Conversely, a decrease in temperature will decrease the rate of reaction.

07ZZ11-92

(a) B: Methyl propanoate

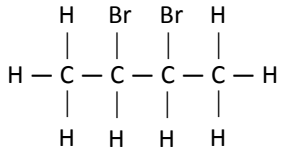
C: Butanoic acid

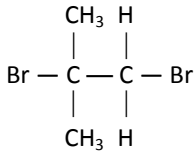
(b) Nickel catalyst, heat to 180°C

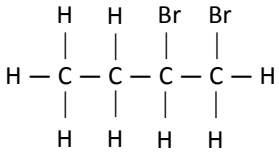
(c) Step 1: Addition reaction of butane with steam in the presence of a catalyst.

Step 2: Oxidize the product from Step 1 with acidified potassium dichromate(VI).

(d)







11-7-Q-05

(a) – The sugar dissolves in the water

– There is movement of sugar particles in the solution

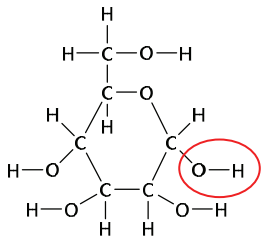
– The movement of the particles is random

– The particles constantly collide with water molecules, causing the particles in the solution to spread out

(b) (i) 3

(ii) 12

(iii)



(iv) Carbon dioxide

(v) – Add yeast to the sugar solution

– keep the sugar solution in an air tight container so that no oxygen is present

(vi) Ethanol can be used as a solvent, fuel or antiseptic.