National 5 Chemistry – SQA past paper questions

Marks

Unit 1 – Chemical Changes and Structure
Key Area - Rates of Reaction

1. A student investigated the reaction between dilute sulphuric acid and sodium carbonate.
(*a*). One experiment involved measuring the volume of carbon dioxide produced when solid sodium carbonate was used.

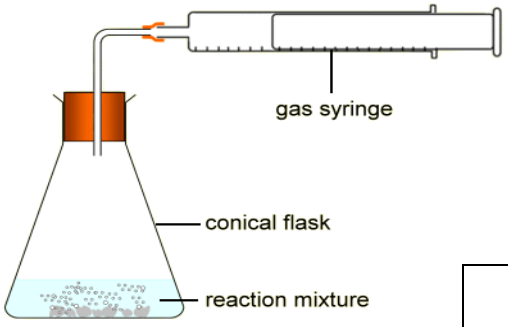
Time/s	0	10	30	40	50	60	70
Volume of carbon dioxide/cm^3	0	12	29	34	36	37	37

(i) Draw a line graph of these results. **(2)**
Use appropriate scales to fill most of the graph paper provided.

(ii) The experiment was repeated at a higher temperature.
The volume and concentration of sulphuric acid and the mass of sodium carbonate were kept the same.
On your graph sketch what this reaction would look like. **(1)**

(b). Calculate the average rate in cm^3/s of carbon dioxide produced in the first 40 seconds. **(2)**

2.



A reaction was set up as shown above of magnesium with dilute sulphuric acid.

The table shows the volume of hydrogen gas produced over fifty seconds

Time/s	**Volume of gas/cm^3**
0	0
10	20
20	40
30	55
40	65
50	72

Calculate the average rate of reaction in cm^3/s between 10-20 seconds. **(2)**

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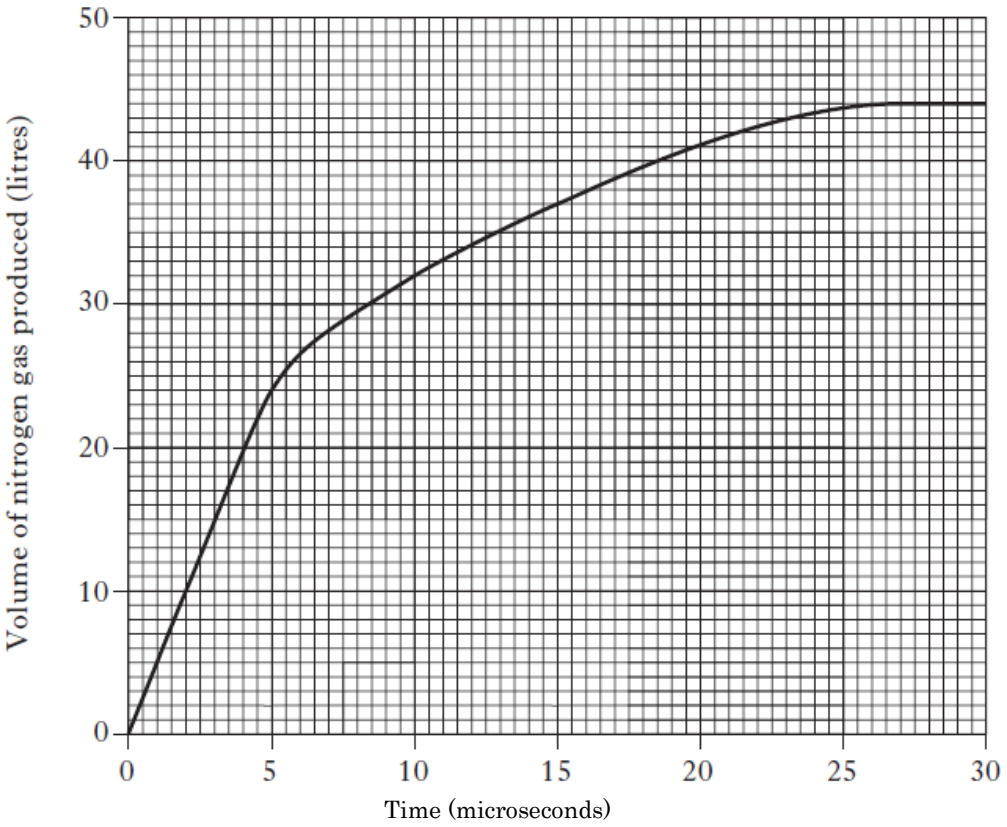
3. Rapid inflation of airbags in cars is caused by the production of nitrogen gas. The graph gives information on the volume of gas produced over 30 microseconds.



(a) (i) Calculate the average rate of reaction between 2 and 10 microseconds.

(1)

_____***litres per microsecond***

(ii) At what time has half of the final volume of nitrogen gas been produced?

_____***microseconds*** **(1)**

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4. Egg shells are made up mainly of calcium carbonate. A pupil carried out an experiment to react egg shells with dilute hydrochloric acid. A gas was produced.
The volume of gas produced during the reaction was measured and the results noted in the table shown.

Plot these results as a line graph.
Use appropriate scales to fill most of the graph paper provided.

(2)

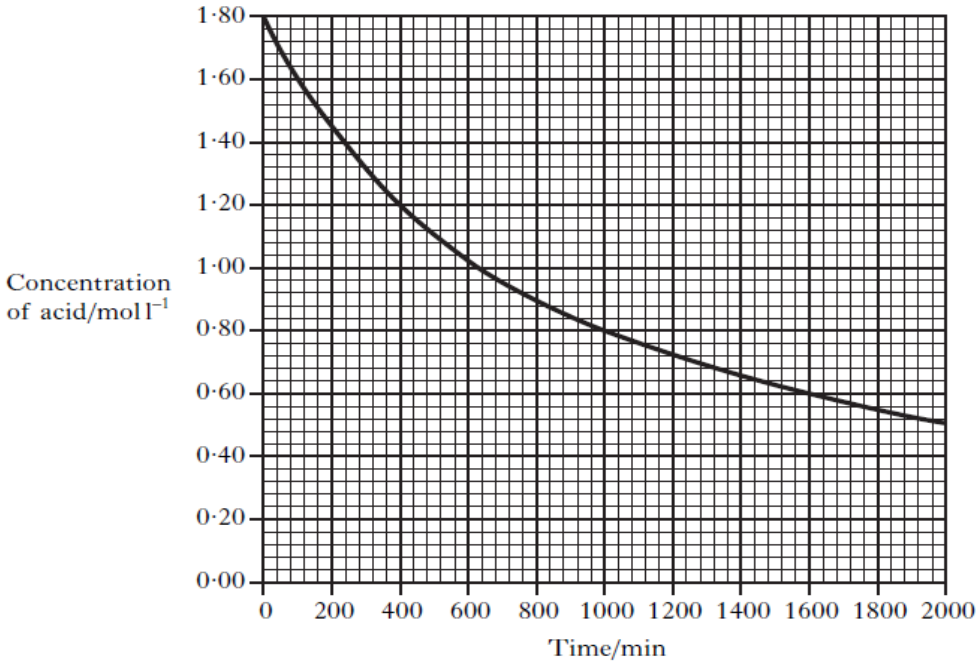
Time (min)	Volume of gas (cm3)
0	0
2	47
4	92
6	114
8	118
10	118

---

5. Chloromethane, CH_3Cl, can be produced by reacting methanol solution with dilute hydrochloric acid using a solution of zinc chloride as a catalyst.

$CH_3OH(aq) + HCl(aq) \text{-------}> CH_3Cl(aq) + H_2O(l)$

The graph shows how the concentration of the hydrochloric acid changed over a period of time when the reaction was carried out at 20 °C.



Marks

(i) Calculate the average rate, in mol l–1 min–1, in the first 400 minutes. **(1)**

(ii) From the graph above, sketch a curve to show how the concentration of hydrochloric acid would change over time if the reaction is repeated at 30°C. **(1)**

Unit 1 – Chemical Changes and Structure
Key Area – Atomic Structure and bonding related to properties of materials

1. Hydrogen gas is made up of diatomic molecules.
Draw a diagram to show how the electrons are arranged in a molecule of hydrogen, H_2. **(1)**

---

(1)

2. (a) Aluminium oxide is used as a catalyst to speed up the reaction.
(i) Suggest another reason for using a catalyst.

(1)

(ii) Write the formula for aluminium oxide.

(1)

(iii) What is the charge on the aluminium ion from the above formula?

---

(1)

3. Ammonium phosphate is also used as a fertiliser.
Write the **ionic** formula for ammonium phosphate.

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4. A student investigated how the concentration of sodium chloride in water affected the freezing point.

(a) What type of bond is broken in sodium chloride when it dissolves in water? **(1)**

(b) The table shows information about the freezing point of different sodium chloride solutions.

Concentration of sodium chloride solution (mol/l)	0	0·09	0·18	0·27	0·37	0·46
Freezing point (°C)	0	– 0·2	– 0·5	– 0·8	– 1·1	– 1·5

(1)

Describe the relationship between the concentration and freezing point.

(1)

(c) Predict the freezing point of a 0·55 mol/l sodium chloride solution.

_____°C

---

5. Tritium is a naturally occurring isotope of hydrogen. It can be represented as

$$^{3}_{1}\mathbf{H}$$

(a) Complete the table to show the number of particles in an atom of tritium.

Type of particle	Number of particles
proton	
neutron	
electron	

(1)

(b) Hydrogen has three isotopes.

Isotope of hydrogen	Mass number
protium	1
deuterium	2
tritium	3

The relative atomic mass of hydrogen is 1.
Which isotope of hydrogen is the most abundant? **(1)**

National 5 Chemistry – SQA past paper questions

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6. The properties of a substance depend on its type of bonding and structure.
There are four types of bonding and structure.

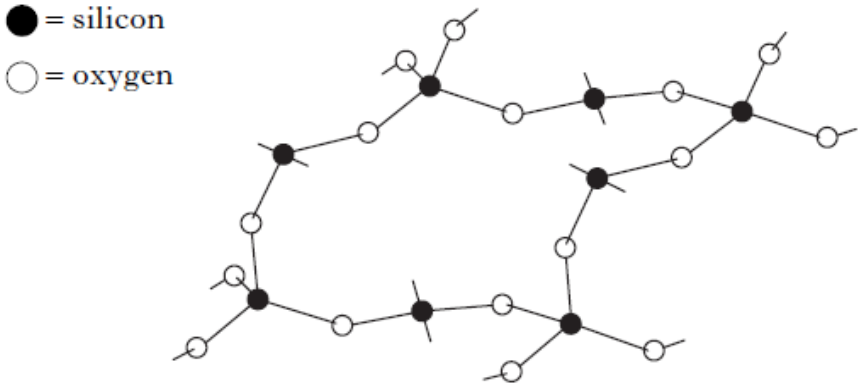
Discrete covalent molecular	**Covalent network**	**Ionic lattice**	**Metallic lattice**

(a). Complete the table to match up each type of bonding and structure with its properties. **(1)**

Bonding and structure type	Properties
	do not conduct electricity and have high melting points
	have high melting points and conduct electricity when liquid but not when solid
	conduct electricity when solid and have a wide range of melting points
	do not conduct electricity and have low melting points

(2)

(*b*) A section of a covalent network compound is shown below.



(1)

Write the formula for this covalent network compound.

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Unit 1 – Chemical Changes and Structure
Key Area – Formulae and reaction quantities

1. Hydrogen peroxide is a useful bleaching agent and is contained in many hair dyes. Over time, the hair dye becomes less effective as the hydrogen peroxide decomposes forming water and oxygen.

The equation for the decomposition of hydrogen peroxide is: **(1)**

$$H_2O_2(aq) \longrightarrow O_2(g) + H_2O(l)$$

(*a*) Balance this equation.

(b) When 34 g of hydrogen peroxide decomposes, 12 litres of oxygen is produced.
Calculate the volume of oxygen produced when 1·7 g of hydrogen peroxide decomposes. **(1)**

---

2. Urea reacts with water, breaking down to form carbon dioxide and ammonia.

$$\underset{\text{Urea}}{H_2NCONH_2} + H_2O \longrightarrow CO_2 + 2NH_3$$

Calculate the mass of ammonia produced, in grams, when 90 g of urea breaks down. **(2)**

---

3. Metal salts can be produced by different methods.

(*a*) Lead(II) iodide can be produced by reacting lead(II) nitrate solution with sodium iodide solution.
The equation for this reaction is:

$$Pb(NO_3)_2(aq) + NaI(aq) \longrightarrow PbI_2(s) + NaNO_3(aq)$$

Balance the above equation.

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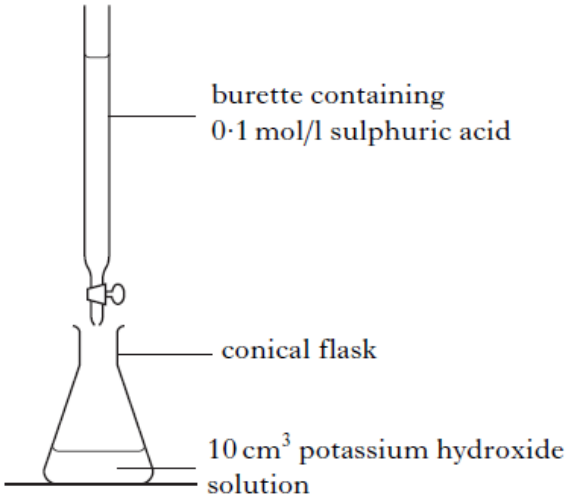
(b) Potassium sulphate can be produced by titrating potassium hydroxide solution with dilute sulphuric acid.



The average volume of sulphuric acid used in the titration is 20cm^3.

(i). Calculate the number of moles of sulphuric acid used.

(1)

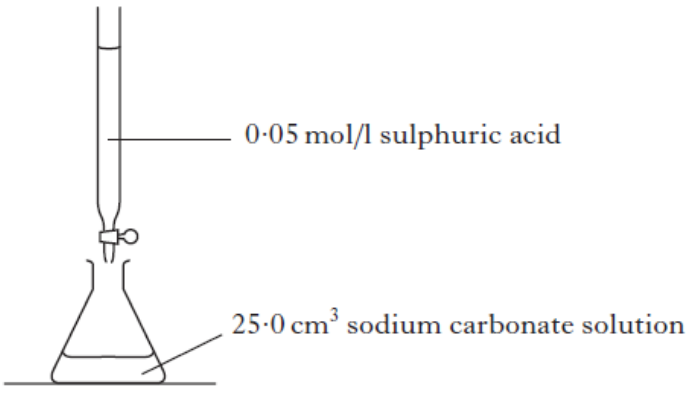
(ii). The equation for the reaction is:

$$H_2SO_4 + 2KOH \longrightarrow K_2SO_4 + 2H_2O$$

Using your answer from part (b)(i), calculate the number of moles of potassium hydroxide in the 10cm^3 sample of potassium hydroxide solution.

(1)

4. (a) Another experiment involved determining the concentration of sodium carbonate solution by titration.



The results showed that 20 cm^3 of sulphuric acid was required to neutralise the sodium carbonate solution.

(1)

(i) Calculate the number of moles of sulphuric acid in this volume.

(ii) One mole of sulphuric acid reacts with one mole of sodium carbonate.

(1)

National 5 Chemistry – SQA past paper questions

Using your answer from part (*a*)(i), calculate the concentration, in mol/l, of the sodium carbonate solution. **Marks**

Unit 1 – Chemical Changes and Structure
Key Area – Acids and Bases

1. An alkaline solution contains:
   - **A** hydroxide ions but no hydrogen ions
   - **B** equal numbers of hydrogen and hydroxide ions
   - **C** more hydroxide ions than hydrogen ions
   - **D** more hydrogen ions than hydroxide ions.

(1)

---

2. When hydrochloric acid with a pH of 3 is diluted with water to give a solution with a pH of 6, the concentration of:
   - **A** $H^+(aq)$ ions decreases
   - **B** $OH^-(aq)$ ions decreases
   - **C** $H^+(aq)$ ions and the concentration of $OH^-(aq)$ ions become equal
   - **D** $H^+(aq)$ ions and the concentration of $OH^-(aq)$ ions remain unchanged.

(1)

---

3. Which of the following compounds is a base?
   - **A** Sodium carbonate
   - **B** Sodium chloride
   - **C** Sodium nitrate
   - **D** Sodium sulphate

(1)

4. When sulphur dioxide dissolves in water in the atmosphere "acid rain" is produced.

Circle the correct phrase to complete the sentence.

Compared with pure water, acid rain contains { ***higher*** / ***lower*** / ***the same*** } ***concentration of hydrogen ions***.

(1)

---

5. The salt copper(II) nitrate can be produced as shown.

$$\mathbf{X + 2HNO_3 \text{ ----> } Cu(NO_3)_2 + CO_2 + H_2O}$$

Name substance **X**.

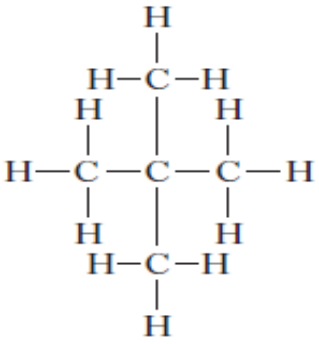
(1)

National 5 Chemistry – SQA past paper questions

Marks

Unit 2 – Nature's Chemistry
Key Area – Homologous Series

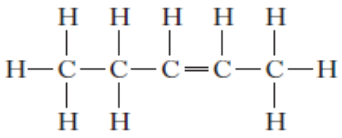
1.



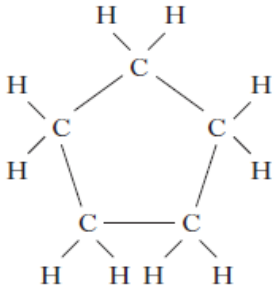
Which of the following compounds is an isomer of the one shown?

(1)

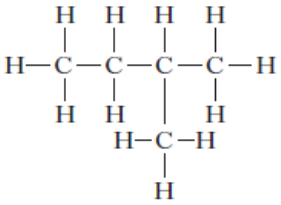
A



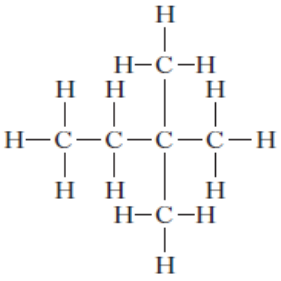
B



C



D



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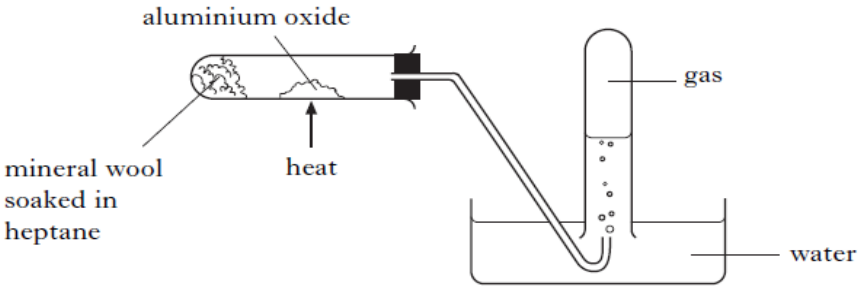
2. Heptane can be cracked as shown.



One of the reactions which takes place is:

C_7H_{16} ---> C_4H_{10} + C_3H_6

The product C_3H_6 decolourises bromine solution quickly.

Draw a structural formula for an isomer of C_3H_6, which would **not** decolourise bromine solution quickly. **(1)**

National 5 Chemistry – SQA past paper questions

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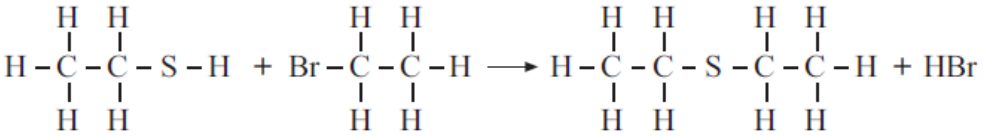
3. Ethylthioethane belongs to a homologous series of compounds called thioethers.

(*a*) What is meant by a homologous series?

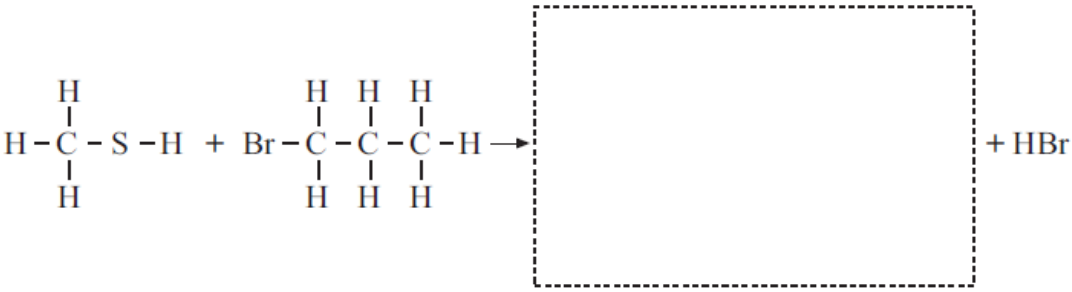
(1)

Ethylthioethane is formed when ethylthiol reacts with bromoethane as shown.



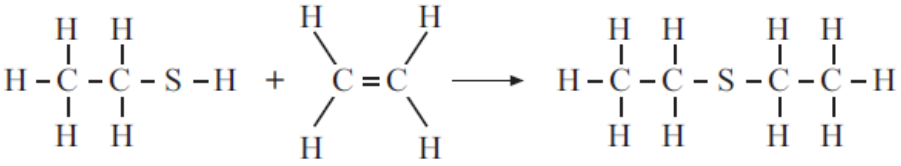
ethylthiol bromoethane ethylthioethane hydrogen bromide

(b) Draw the **full** structural formula for the thioether produced in the following reaction.



(1)

(c) Ethylthioethane can also be formed by the reaction of ethylthiol with ethene.



ethylthiol ethene ethylthioethane

Suggest a name for the ***type*** of chemical reaction taking place.

(1)

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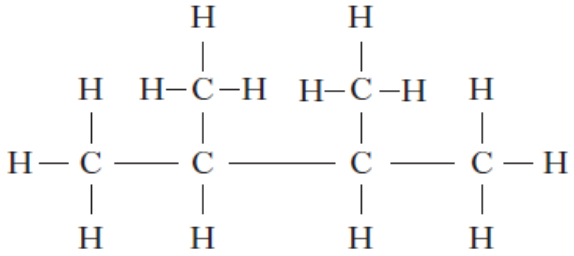
Marks

4. Petrol contains the following molecule:



Name this molecule **(1)**

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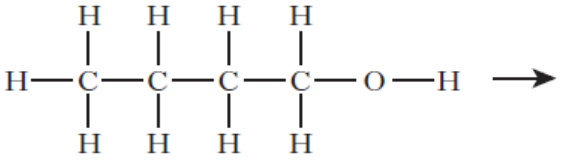
5. Draw the structure of the hydrocarbon: 2,5,5-trimethylhept-1-ene **(1)**

Unit 2 – Nature's Chemistry
Key Area – Everyday Consumer Products

1. When alkanols are oxidised alkanoic acids are produced.

ethanol ethanoic acid

(a). Draw the **full** structural formula for the alkanoic acid produced when butanol is oxidised.



butanol butanoic acid **(1)**

National 5 Chemistry – SQA past paper questions

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(b) Esters are produced when alkanols react with alkanoic acids.
The table gives information on esters.

Alkanol	Alkanoic acid	Ester
methanol	ethanoic acid	methyl ethanoate
ethanol	propanoic acid	ethyl propanoate
propanol	methanoic acid	propyl methanoate
butanol	ethanoic acid	butyl ethanoate
pentanol	butanoic acid	**X**

Suggest a name for **X**. **(1)**

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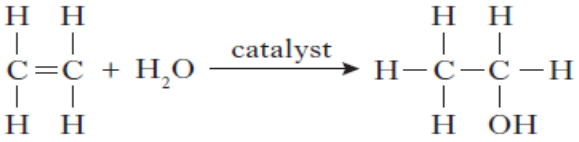
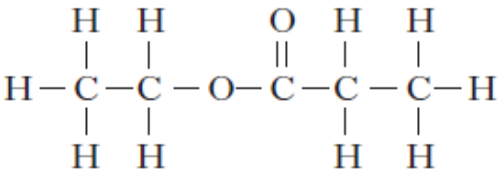
2. (*a*) Ethanol can be manufactured from ethene as shown in the following addition reaction.



What other name can be given to this type of addition reaction? **(1)**

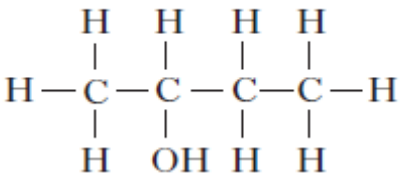
(b) Ethanol can be used to make esters which can be used as flavourings for food. The following ester is used to give ice cream a rum flavour.

Name this ester: **(1)**



(c) Butan-2-ol is another member of the alkanol family.

Draw the **full** structural formula for an isomer of Butan-2-ol **(1)**

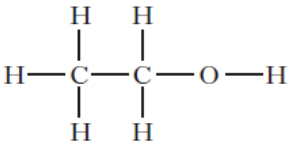


Butan-2-ol

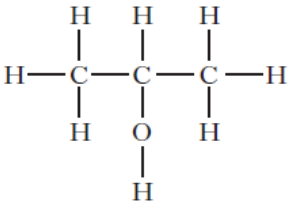
National 5 Chemistry – SQA past paper questions

Marks

3. An antibacterial hand gel contains two alkanols, ethanol and propan-2-ol.



ethanol



propan-2-ol

Alkanols are a homologous series containing carbon, hydrogen and oxygen.
Suggest a general formula for alkanols. **(1)**

Unit 2 – Nature's Chemistry
Key Area – Energy from Fuels

1. The alkanals are a homologous series of compounds that all contain the elements carbon, hydrogen and oxygen.

   The combustion of alkanals releases energy:

Name of alkanal	Heat energy released when one mole burns (kJ)
methanal	510
ethanal	1056
propanal	1624
butanal	2304

(i) Make a general statement linking the amount of heat energy released and the number of carbon atoms in the alkanal molecules. **(1)**

(ii) Predict the amount of heat energy released, when 1 mole of pentanal burns. **(1)**

---

2. The enthalpies of combustion of some alcohols are shown in the table.

Name of alcohol	Enthalpy of combustion/kJ mol^{-1}
methanol	–727
ethanol	–1367
propan-1-ol	–2020

(1)

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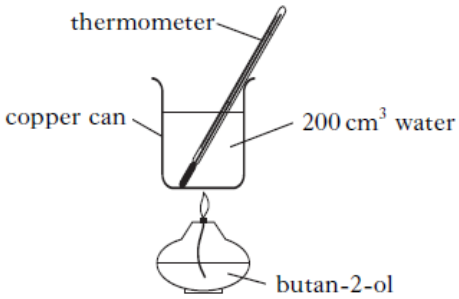
(a) Using this data, predict the enthalpy of combustion of butan-1-ol, in kJ mol^{-1}.

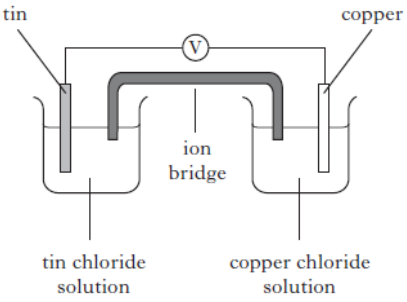
(b) A value for the enthalpy of combustion of butan-2-ol, C_4H_9OH, can be determined experimentally using the apparatus shown.



Mass of butan-2-ol burned	=	1·0 g
Temperature rise of water	=	40 °C

Use these results to calculate the enthalpy of combustion of butan-2-ol, in kJ **(3)**

Unit 3 – Chemistry in Society
Key Area – Metals

1. 

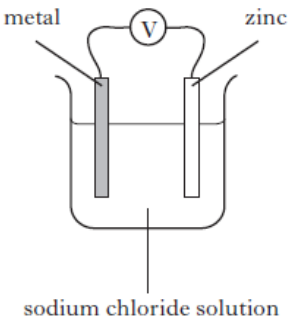
In the cell shown electrons flow through

A the solution from copper to tin
B the solution from tin to copper
C the wires from copper to tin
D the wires from tin to copper **(1)**

---

2. Which of the following metals, when linked to zinc, would give the highest cell voltage?
(You may wish to use the data booklet to help you.)

A Copper
B Iron
C Magnesium
D Tin



(1)

National 5 Chemistry – SQA past paper questions

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3. When a metal element reacts to form a compound the metal is:

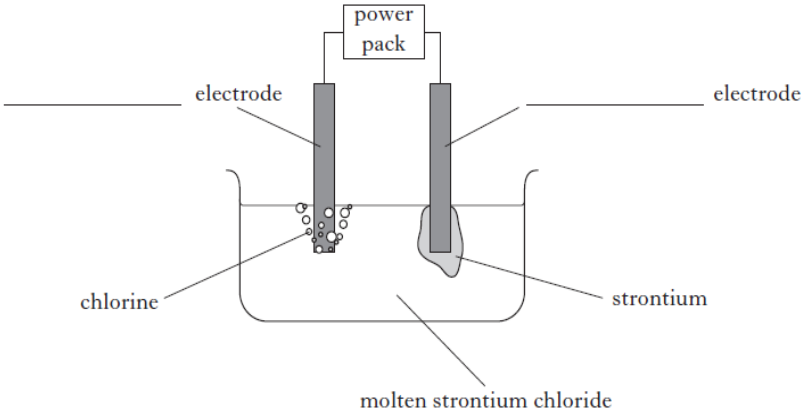
A displaced
B oxidised
C precipitated
D reduced

(1)

---

4. Strontium can be extracted from the compound strontium chloride using electrolysis.

Label the diagram to show the **charge** on each electrode.



(1)

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5. Titanium is extracted from its ore in the Kroll process. One step in this process involves the displacement of titanium chloride by sodium metal.

The equation is shown.

$4Na + TiCl_4 \text{ --->} 4NaCl + Ti$

During the displacement, sodium atoms, Na, form sodium ions, Na^+.
Write the ion-electron equation for this change.

(1)

---

6. Zinc displaces copper from copper(II) sulphate solution.
The equation for the reaction is:

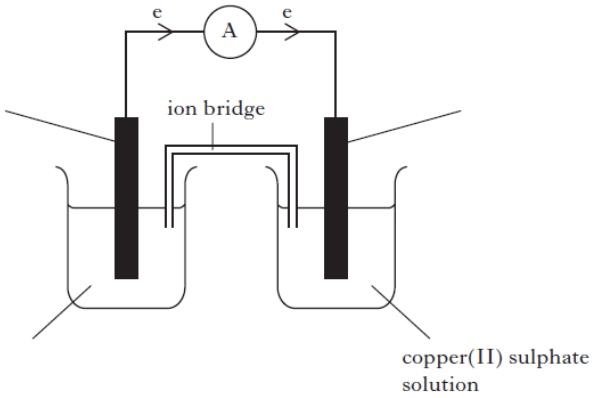
$$Zn(s) + Cu^{2+}(aq) + SO_4^{2-}(aq) \longrightarrow Zn^{2+}(aq) + SO_4^{2-}(aq) + Cu(s)$$

(a) Circle the spectator ion in the above equation.

(b) Write the ion-electron equation for the **oxidation** step in this reaction.
You may wish to use the data booklet to help you.

Marks

(c) The reaction can also be carried out in a cell



(1)

(i) Complete the **three labels** on the diagram.

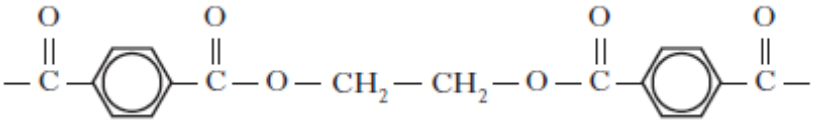
(ii) What is the purpose of the ion bridge?

(1)

Unit 3 – Chemistry in Society
Key Area – Properties of Plastics

1. Polyethene terephthalate (PET) is used to make plastic bottles which can easily be recycled by heating and reshaping.

A section of the PET structure is shown.



Which line in the table best describes PET?

	Type of polymer	Property
A	addition	thermoplastic
B	condensation	thermosetting
C	addition	thermosetting
D	condensation	thermoplastic

(1)

National 5 Chemistry – SQA past paper questions

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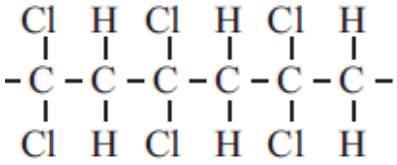
2. Polyvinyldichloride (PVDC) is a plastic used in food packaging.
The structure of part of a PVDC molecule is shown.

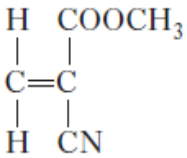


(a) Draw the **full** structural formula for the monomer used to make PVDC. **(1)**

(b) Name a toxic gas produced when PVDC burns. **(1)**

---

3. The monomer in superglue has the following structure.

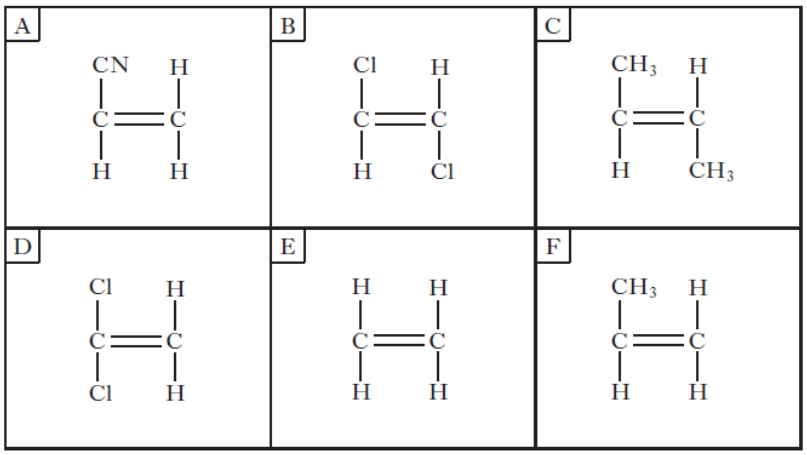


(a) Draw a section of the polymer, showing **three** monomer units joined together **(1)**

(b) The polymer does **not** change shape on heating. What term is used to describe this type of polymer? **(1)**

---

4. The grid shows the structural formulae of some monomers:



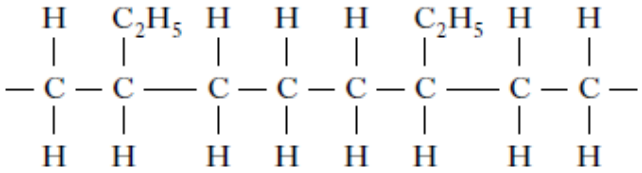
(a) Identify the monomer used to make (poly)propene **(1)**

(1)

National 5 Chemistry – SQA past paper questions

(b) Identify the monomer which reacts with hydrogen to form ethane. **Marks**

5. Part of a polymer is shown



Which two alkenes were used to make this polymer?

A Ethene and propene
B Ethene and butene
C Propene and butene
D Ethane and butene **(1)**

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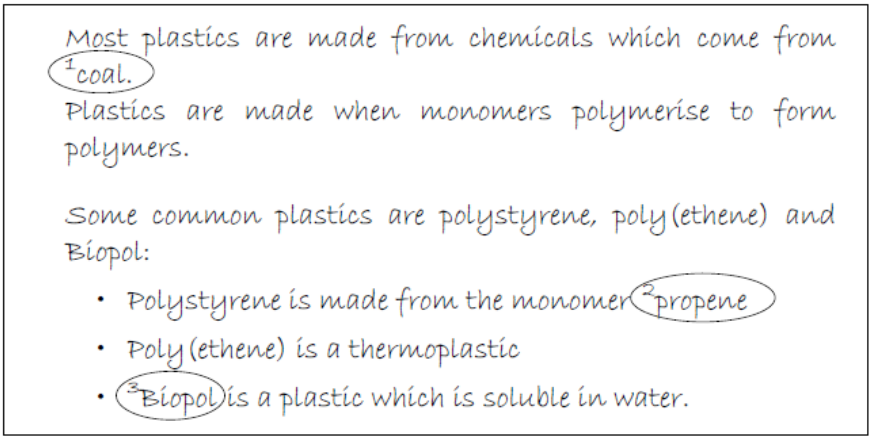
6. When marking a student's report on plastics, the teacher circled three errors.
The marked report is shown:



Most plastics are made from chemicals which come from [1]coal.

Plastics are made when monomers polymerise to form polymers.

Some common plastics are polystyrene, poly(ethene) and Biopol:

- Polystyrene is made from the monomer [2]propene
- Poly(ethene) is a thermoplastic
- [3]Biopol is a plastic which is soluble in water.

Correct the circled errors:

1_____

2_____

3_____ **(3)**

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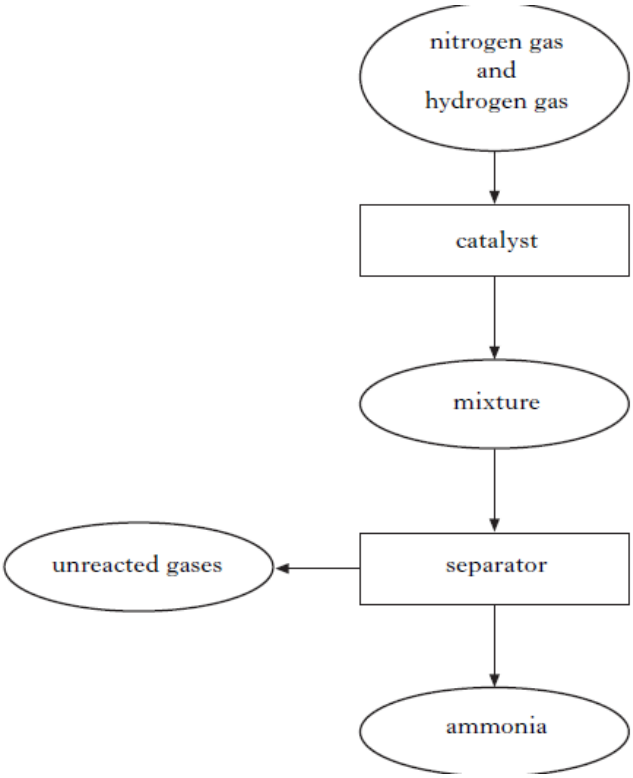
Marks

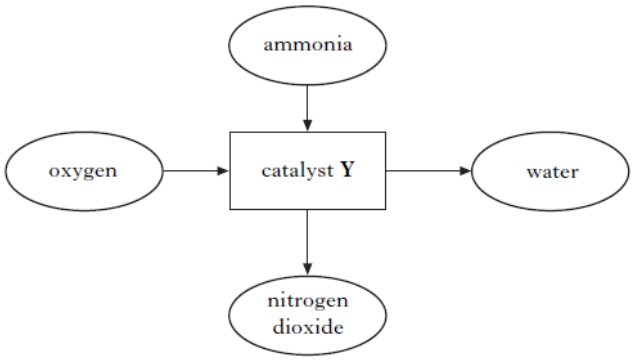
Unit 3 – Chemistry in Society
Key Area – Fertilisers

1. Catalysts can be used in different processes.
(a) The flow diagram shows the steps involved in the Haber process.



On the flow diagram above draw an arrow to show how the process is made more effective and cost efficient. **(1)**

(b) Ammonia can be used to produce nitrogen dioxide as shown.



(i). Name catalyst Y **(1)**

(ii). Why is it **not** necessary to continue to supply heat once the reaction has started? **(1)**

National 5 Chemistry – SQA past paper questions

Marks

2. Ammonia is produced in the Haber Process.
Temperature and pressure are both factors that affect the percentage of ammonia produced.

Temperature/°C	Percentage yield of ammonia
200	88
300	67
400	49
500	18

Suggest a reason why 500 °C is the temperature chosen to operate an industrial ammonia plant rather than 200 °C. **(1)**

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3. Calculate the percentage, by mass, of potassium in potassium sulphate, K_2SO_4.
Show your working clearly.

(2)

Unit 3 – Chemistry in Society
Key Area – Nuclear Chemistry

1. Which particle will be formed when an atom of $^{211}_{83}Bi$ emits an α-particle and the decay product then emits a β-particle?

A $^{207}_{82}Pb$

B $^{208}_{81}Tl$

C $^{209}_{80}Hg$

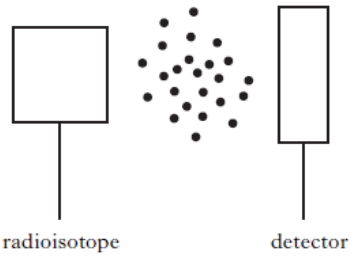
D $^{210}_{79}Au$

(1)

---

2. Some smoke detectors make use of radiation which is very easily stopped by tiny smoke particles moving between the radioactive source and the detector.
The most suitable type of radioisotope for a smoke detector would be:

A an alpha-emitter with a long half-life
B a gamma-emitter with a short half-life



(1)

National 5 Chemistry – SQA past paper questions

C an alpha-emitter with a short half-life
D a gamma-emitter with a long half-life.

Marks

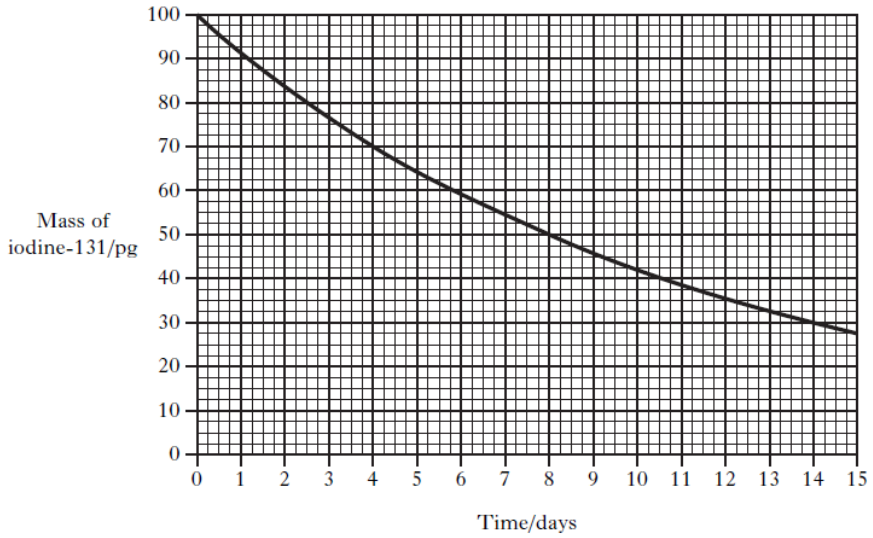
3. The element iodine has only one isotope that is stable. Several of the radioactive isotopes of iodine have medical uses. Iodine-131, for example, is used in the study of the thyroid gland and it decays by beta emission.

(a) Complete the nuclear equation for the beta decay of iodine-131.

$$^{131}_{53}\mathrm{I} \quad \rightarrow$$

(1)

(b) The graph shows how the mass of iodine-131 in a sample changes over a period of time.



(2)

What is the half life of this isotope?

(1)

---

4. Phosphorus-32 and strontium-89 are two radioisotopes used to study how far mosquitoes travel.
(a) Strontium-89 decays by emission of a beta particle.
Complete the nuclear equation for the decay of strontium-89.

(1)

$$^{89}\mathrm{Sr} \rightarrow$$

National 5 Chemistry – SQA past paper questions

*Sources – **Unit 1***
Rates of reaction
Atomic Theory
- *2011 SG C Q18(c) – changed to Aluminium oxide*
- *2012 SG C Q18*
- *2011 Int 2 B Q1*
- *2013 Int 2 B Q4*

Formulae
- *2011 SG C Q17(b)*
- *2011 SG C Q20(a)i, (c)ii*
- *2013 SG C Q18(b) i*
- *2011 Int 2 B Q3(a) & (d)*

Acids and Bases
- *2011 SG C Q14(a)*
- *2013 Int 2 A Q18*
- *2013 Int 2 A Q20*
- *2013 Int 2 A Q22*

Unit 2
Homologous Series
- *2011 SG C Q16(a)*
- *2013 Int 2 A Q10*

Consumer Products
- *2013 SG C Q15(a), (c) & (d)*
- *2012 Int 2 B Q7 (a) & (c)*

Energy from Fuels
- *2012 Int 2 B Q5(b)i &ii*
- *2011 Higher B Q14(b)*

Unit 3
Metals
- *2013 SG C Q14*
- *2013 Int 2 A Q26*
- *2013 Int 2 A Q27*
- *2013 Int 2 A Q29*
- *2013 Int 2 B Q15(b)*

Plastics
- *2011 SG C Q13(a)*
- *2012 SG C Q20(a) & (b)*
- *2013 SG C Q6*
- *2009 Higher A Q6*
- *2012 Int 2 A Q16*
- *2011 Int 2 Q7*

Feritilisers
- *2011 SG C Q19(a) & (b)*
- *2012 SG C Q12(a) & (c)*
- *2012 SG C Q15(c)*

Nuclear
- *2011 Higher A Q40*

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- *2011 Higher B Q12(a), (b) & (c)i*
- *2012 Higher B Q4(a), (b)i & (c)*
- *2010 Higher A Q40*