

Y12 Chemistry Homework Book 2

Organic and Physical Chemistry

Name:

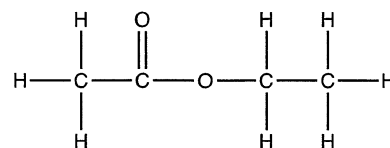
Teacher:

GCSE Transition

What topics did you find difficult?



- 1 Ethyl ethanoate is an ester made by reacting ethanol with ethanoic acid in the presence of concentrated sulfuric acid.



- a Draw a ring around the functional group in the ester.
- b Give the role of the concentrated sulfuric acid.
- 2 Complete this table with the names, structures and functional groups of some organic compounds.

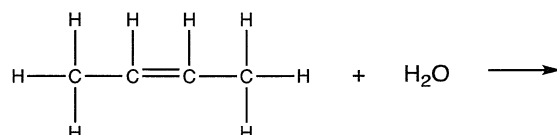
displayed formula			$\begin{array}{c} \text{H} \\ | \\ \text{H} - \text{C} - \text{O} - \text{H} \\ | \\ \text{H} \end{array}$	$\begin{array}{c} \text{H} & \text{H} \\ | & | \\ \text{H} - \text{C} & - \text{C} - \text{H} \\ | & | \\ \text{H} & \text{H} \end{array}$
name	propene	ethanoic acid		
functional group				

- 3 Identify the functional group in each of the following organic compounds.

molecule	add bromine water	add sodium	add sodium carbonate	is it miscible with water?	functional group
A	yellow-orange	fizzes	no reaction	✓	
B	colourless	no reaction	no reaction	✗	
C	yellow-orange	fizzes	fizzes	✓	

- 4 Butene reacts with steam in the presence of concentrated phosphoric acid at high temperature and pressure to form an alcohol.

- a Name two names for the type of reaction taking place.
- b Complete the equation for this reaction.



- c Give two potential uses for the alcohol formed.

- 1
- 2



1 Complete the table to show the formula and structure type (use ✓s) of the following substances.

(8)

Substance	Formula	Monatomic	Simple molecular	Giant covalent	Ionic	Metallic
ammonia						
iodine						
lithium bromide						
potassium						
aluminium hydroxide						
diamond						
buckminsterfullerene						
helium						

2 Convert these quantities into the units shown.

- a) 25 cm^3 to dm^3 (1)
- b) 500 cm^3 to m^3 (1)
- c) 100 kPa to Pa (1)
- d) 89 mg to g (1)
- e) -196°C to K (1)
- f) 0.102 nm to m (1)

3 Write a balanced equation for each of these reactions.

(8)

- a) copper(II) carbonate + nitric acid

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- b) magnesium oxide + hydrochloric acid

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- c) silane (SiH_4) + oxygen

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- d) calcium + hydrochloric acid

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4 Write an ionic equation for each of these reactions. (6)

a) precipitation of lead(II) iodide when solutions of potassium iodide and lead(II) nitrate are mixed

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b) acid-base reaction between sulfuric acid and lithium hydroxide

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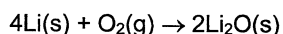
c) redox reaction between solution of iron(II) nitrate and zinc metal

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5 Complete the table about these atoms and ions. (2)

atom / ion	atomic number	mass number	protons	neutrons	electrons
$^{31}_{15}\text{P}^{3-}$					
			35	46	36

6 Which is the limiting reagent and what mass of lithium oxide is formed when 1.0 g of lithium is heated with 1.3 g of oxygen?



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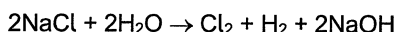
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..... (4)

7 Calculate the percentage atom economy to form chlorine in this reaction.



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..... (2)

8 Calculate the mass of one atom of ^7Li . (Avogadro constant, $L = 6.022 \times 10^{23} \text{ mol}^{-1}$)

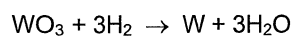
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..... (1)

- 9 In a reaction, 115 g of tungsten was formed from 200 g of tungsten oxide. Calculate the percentage yield.



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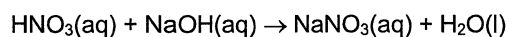
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(4)

- 10 In a titration, it was found that 25.00 cm³ of 0.100 mol dm⁻³ sodium hydroxide reacts with 26.38 cm³ of nitric acid. Calculate the concentration of the nitric acid solution in mol dm⁻³.



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(3)

- 11 Draw stick diagrams and dot-cross diagrams for each of these molecules.

(8)

	NH ₃	CO ₂	HBr	N ₂
stick diagram				
dot-cross diagram				

12 Explain each of the following.

- a) Magnesium chloride has a high melting point.

 (3)
- b) Copper conducts electricity.

 (3)
- c) Methane has a low boiling point.

 (3)
- d) Aluminium oxide conducts electricity when molten but not as a solid.

 (3)
- e) Helium has a very low boiling point.

 (3)

Area	Strength	To develop	Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Write formulae (ionic)			Can do solution calculations		
Good SPG			Write formulae (other)			Can find % atom economy		
Shows full working			Write balanced equations			Can find % yield		
Explanations are clear			Write ionic equations			Can work out PNE numbers in atoms/ions		
Convert units			Identify structure type of substances			Can draw stick diagrams		
Work to appropriate sig figs			Understands Avogadro constant			Can draw dot-cross diagrams		
Gives units when appropriate			Can work out formula mass			Good understand of structure & bonding		
			Find moles from mass (and vice versa)			Use of terms: atoms / molecules / ions / e ⁻		
			Can do reacting mass calculations			Use of terms: bonds / forces		
			Understands limiting reagents					

Introduction to organic chemistry

Nomenclature
T 1. Draw structural, displayed and skeletal formulas for given organic compounds
T 2. Apply IUPAC rules for nomenclature to name organic compounds limited to chains and rings with up to six carbon atoms each
T 3. Apply IUPAC rules for nomenclature to draw the structure of an organic compound from the IUPAC name limited to chains and rings with up to six carbon atoms each.
Isomerism
T 1. Define the term structural isomer
T 2. Draw the structures of chain, position and functional group isomers
T 3. Define the term stereoisomer
T 4. Draw the structural formulas of E and Z isomers
T 5. Apply the CIP priority rules to E and Z isomers.
Alkanes
T 1. Alkanes are saturated hydrocarbons.
T 2. Petroleum is a mixture consisting mainly of alkane hydrocarbons that can be separated by fractional distillation.
T 3. Cracking involves breaking C–C bonds in alkanes.
T 4. Thermal cracking takes place at high pressure and high temperature and produces a high percentage of alkenes
T 5. Catalytic cracking takes place at a slight pressure, high temperature and in the presence of a zeolite catalyst and is used mainly to produce motor fuels and aromatic hydrocarbons
T 6. Explain the economic reasons for cracking alkanes.
T 7. Combustion of alkanes and other organic compounds can be complete or incomplete.
T 8. The internal combustion engine produces a number of pollutants including NO _x , CO, carbon and unburned hydrocarbons.
T 9. The gaseous pollutants from internal combustion engines can be removed using catalytic converters.
T 10. Combustion of hydrocarbons containing sulfur leads to sulfur dioxide that causes air pollution.
T 11. Explain why sulfur dioxide can be removed from flue gases using calcium oxide or calcium carbonate.
T 12. explain free radical substitution reactions as a mechanism involving initiation, propagation and termination steps.

Exam booklet reflection:

WWW

EBI

Checked by teacher

Doddle quiz homework:

Introducing organic

Score:

Alkanes

Score:

AS LEVEL CHEMISTRY

TOPIC 7 – INTRODUCTION TO ORGANIC CHEMISTRY

TEST

Answer all questions

Max 50 marks

Name	.....	
Mark	...../50	.....%	Grade

1. (a) (i) Name the process used to separate petroleum into fractions.

.....

- (ii) Give the molecular formula for an alkane with nine carbon atoms.

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- (iii) Write an equation for the complete combustion of the alkane $C_{11}H_{24}$

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- (iv) Write an equation for the incomplete combustion of $C_{11}H_{24}$ to produce carbon and water only.

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(4)

- (b) Alkenes can be produced by cracking the naphtha fraction obtained from petroleum.

- (i) Write an equation for the thermal cracking of one molecule of $C_{10}H_{22}$ to give one molecule of propene and one molecule of an alkane only.

.....

- (ii) Draw the structure of the chain isomer of but-1-ene.

(2)

- (c) The alkanes and the alkenes are examples of homologous series of compounds. One feature of an homologous series is the gradual change in physical properties as the relative molecular mass increases. State **two** other general features of an homologous series of compounds.

Feature 1

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Feature 2

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(2)

(Total 8 marks)

2. **Q** and **R** have the molecular formula C_6H_{12}

Both are branched-chain molecules and none is cyclic.

Q can represent a pair of geometrical isomers.

R can represent another pair of geometrical isomers different from **Q**.

Draw one possible structure for one of the isomers of each of **Q** and **R**.

Structure of Q

Structure of R

(Total 2 marks)

3. Four isomers with the formula C_4H_9OH are given below:

Isomer	Name
$CH_3CH_2CH_2CH_2OH$	butan-1-ol
$ \begin{array}{c} CH_3 \\ | \\ CH_3 - C - CH_3 \\ | \\ OH \end{array} $	2-methylpropan-2-ol
$ \begin{array}{c} CH_3 - CH - CH_2OH \\ | \\ CH_3 \end{array} $	
$ \begin{array}{c} CH_3CH_2 - CH - CH_3 \\ | \\ OH \end{array} $	

(i) Complete the naming of the isomers in the table above.

(ii) Name the type of isomerism shown by these four isomers.

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(Total 3 marks)

4. Draw and name the geometrical E-Z isomers of pent-2-ene.

Isomer 1

Isomer 2

Name

Name

(Total 2 marks)

5. Octane is the eighth member of the alkane homologous series.

- (a) State **two** characteristics of a homologous series.

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(2)

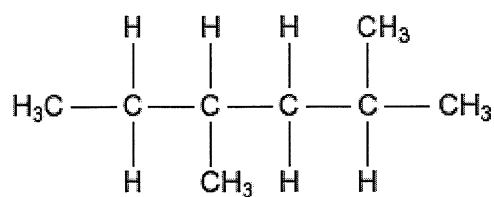
- (b) Name a process used to separate octane from a mixture containing several different alkanes.

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(1)

- (c) The structure shown below is one of several structural isomers of octane.



Give the meaning of the term structural isomerism.
Name this isomer and state its empirical formula.

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(4)

- (d) Suggest why the branched chain isomer shown above has a lower boiling point than octane.

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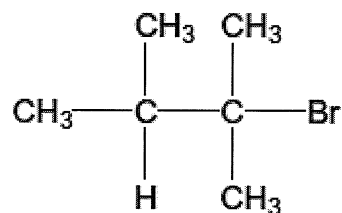
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(2)
(Total 9 marks)

6. (a) The structure of the bromoalkane **Z** is



Give the IUPAC name for **Z**.

Give the general formula of the homologous series of straight-chain bromoalkanes that contains one bromine atom per molecule.

Suggest **one** reason why 1-bromohexane has a higher boiling point than **Z**.

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(3)

- (b) Draw the displayed formula of 1,2-dichloro-2-methylpropane.

State its empirical formula.

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(2)

(Total 5 marks)

7. (a) The hydrocarbon but-1-ene (C_4H_8) is a member of the homologous series of alkenes. But-1-ene has structural isomers.

(i) State the meaning of the term *structural isomers*.

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(2)

(ii) Give the IUPAC name of the **position** isomer of but-1-ene.

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(1)

(iii) Give the IUPAC name of the **chain** isomer of but-1-ene.

.....

(1)

(iv) Draw the displayed formula of a **functional group** isomer of but-1-ene.

(1)

- (b) But-1-ene burns in a limited supply of air to produce a solid and water only.

(i) Write an equation for this reaction.

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(1)

(ii) State **one** hazard associated with the solid product in part (b)(i).

.....

(1)

- (c) One mole of compound **Y** is cracked to produce two moles of ethene, one mole of but-1-ene and one mole of octane (C_8H_{18}) only.

(i) Deduce the molecular formula of **Y**.

.....

(1)

(ii) Other than cracking, give **one** common use of **Y**.

.....

(1)

- (d) In cars fitted with catalytic converters, unburned octane reacts with nitrogen monoxide to form carbon dioxide, water and nitrogen only.

(i) Write an equation for this reaction.

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(1)

(ii) Identify a catalyst used in a catalytic converter.

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(1)

(Total 11 marks)

8. Two stereoisomers of but-2-ene are formed when 2-bromobutane reacts with ethanolic potassium hydroxide.

(i) Explain what is meant by the term *stereoisomers*.

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(ii) Draw the structures and give the names of the **two** stereoisomers of but-2-ene.

Stereoisomer 1

Stereoisomer 2

Name *Name*

(iii) Name this type of stereoisomerism.

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(5)

(Total 5 marks)

9. The number of structural isomers of molecular formula C_4H_9Br is

- A 5
- B 4
- C 3
- D 2

(Total 1 mark)

10. An alkane contains 30 hydrogen atoms per molecule. Its empirical formula is

- A C_6H_{15}
- B C_7H_{15}
- C $C_{14}H_{30}$
- D $C_{15}H_{30}$

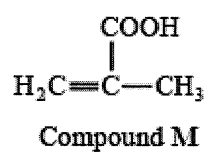
(Total 1 mark)

11. The correct systematic name for
$$\begin{array}{c} \text{CH}_2\text{CH}_3 \\ | \\ (\text{CH}_3)_2\text{CHC}=\text{CCH}_3 \\ | \\ \text{CH} \end{array}$$
 is

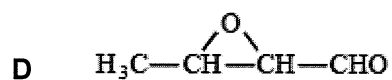
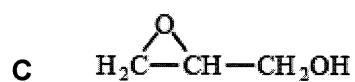
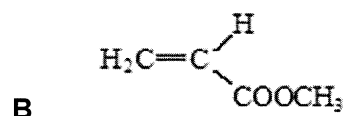
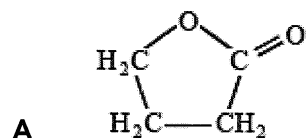
- A 2-ethyl-3,4-dimethylpent-2-ene
- B 4-ethyl-2,3-dimethylpent-3-ene
- C 2,3,4-trimethylhex-3-ene
- D 3,4,5-trimethylhex-3-ene

(Total 1 mark)

12.



Which one of the following is **not** a structural isomer of Compound **M**?



(Total 1 mark)

13. The number of structural isomers of $\text{C}_3\text{H}_2\text{Cl}_6$ is

A 2

B 3

C 4

D 5

(Total 1 mark)

Bonding

Bonding
T 1. Predict the charge on a simple ion using the position of the element in the Periodic Table
T 2. Construct formulas for ionic compounds.
T 3. Represent a covalent bond using a line
T 4. Represent a co-ordinate bond using an arrow.
T 5. Metallic bonding involves attraction between delocalised electrons and positive ions arranged in a lattice.
T 6. Relate the melting point and conductivity of materials to the type of structure and the bonding present
T 7. Explain the energy changes associated with changes of state
T 8. Draw diagrams to represent structures involving specified numbers of particles.
T 9. Explain the shapes of, and bond angles in, simple molecules and ions with up to six electron pairs (including lone pairs of electrons) surrounding the central atom.
T 10. Use partial charges to show that a bond is polar
T 11. Explain why some molecules with polar bonds do not have a permanent dipole.
T 12. Explain the existence of forces between familiar and unfamiliar molecules
T 13. Explain how melting and boiling points are influenced by intermolecular forces.

Exam booklet reflection:

WWW

EBI

Checked by teacher

Doddle quiz homework:

Bonding

Score:

AS LEVEL CHEMISTRY

TOPIC 3 – STRUCTURE, BONDING AND THE PERIODIC TABLE TEST

Answer all questions

Max 50 marks

Name	.....	
Mark	...../50	.....%	Grade

1. Iodine and diamond are both crystalline solids at room temperature. Identify one similarity in the bonding, and one difference in the structures, of these two solids. Explain why these two solids have very different melting points.

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(Total 6 marks)

2. The table below shows the electronegativity values of some elements.

Element	H	C	N	O
Electronegativity	2.1	2.5	3.0	3.5

- (a) State the meaning of the term *electronegativity*.

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(2)

- (b) State the strongest type of intermolecular force in the following compounds.

Methane (CH₄)

Ammonia (NH₃)

(2)

- (c) Use the values in the table to explain how the strongest type of intermolecular force arises between two molecules of ammonia.

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(3)

- (d) Phosphorus is in the same group of the Periodic Table as nitrogen.
A molecule of PH_3 reacts with an H^+ ion to form a PH_4^+ ion.
Name the type of bond formed when PH_3 reacts with H^+ and explain how this bond is formed.

Type of bond

Explanation

.....

.....

(3)

- (e) Arsenic is in the same group as nitrogen. It forms the compound AsH_3 .
Draw the shape of an AsH_3 molecule, including any lone pairs of electrons. Name the shape made by its atoms.

Shape

Name of shape

(2)

- (f) The boiling point of AsH_3 is -62.5°C and the boiling point of NH_3 is -33.0°C .
Suggest why the boiling point of AsH_3 is lower than that of NH_3 .

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(1)

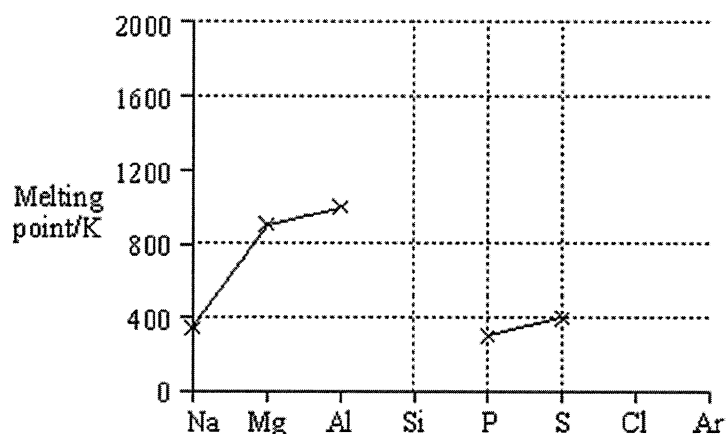
- (g) Balance the following equation which shows how AsH_3 can be made.



(1)

(Total 14 marks)

3. (a) The diagram below shows the melting points of some of the elements in Period 3.



- (i) On the diagram, use crosses to mark the approximate positions of the melting points for the elements silicon, chlorine and argon. Complete the diagram by joining the crosses.

- (ii) By referring to its structure and bonding, explain your choice of position for the melting point of silicon.

.....

- (iii) Explain why the melting point of sulphur, S_8 , is higher than that of phosphorus, P_4 .

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(8)

- (b) State and explain the trend in melting point of the Group II elements Ca–Ba.

Trend

Explanation

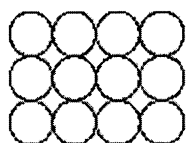
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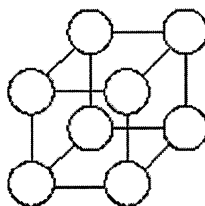
(Total 11 marks)

4. At room temperature, both sodium metal and sodium chloride are crystalline solids which contain ions.

(a) On the diagrams for sodium metal and sodium chloride below, mark the charge for each ion.



Sodium metal



Sodium chloride

(2)

(b) (i) Explain how the ions are held together in solid sodium metal.

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(ii) Explain how the ions are held together in solid sodium chloride.

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(iii) The melting point of sodium chloride is much higher than that of sodium metal. What can be deduced from this information?

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(3)

(c) Compare the electrical conductivity of solid sodium metal with that of solid sodium chloride. Explain your answer.

Comparison

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Explanation

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(3)

(d) Explain why sodium metal is malleable (can be hammered into shape).

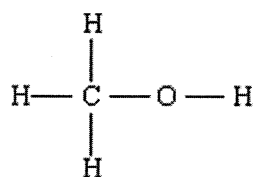
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(1)

(Total 9 marks)

5. (a) Methanol has the structure



Explain why the O–H bond in a methanol molecule is polar.

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(2)

- (b) The boiling point of methanol is +65 °C; the boiling point of oxygen is –183 °C. Methanol and oxygen each have an *M_r* value of 32. Explain, in terms of the intermolecular forces present in each case, why the boiling point of methanol is much higher than that of oxygen.

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(3)

(Total 5 marks)

6. Predict which one of the following has the highest boiling temperature.

- A $\text{CH}_3\text{COOCH}_2\text{CH}_3$
B $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
C $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
D $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$

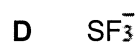
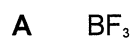
(Total 1 mark)

7. Which one of the following has a shape which is **not** influenced by a lone pair of electrons?

- A CH_3OH
B H_2F^+
C BF_3
D NF_3

(Total 1 mark)

8. Which one of the following molecules or ions is pyramidal in shape?

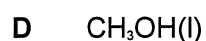
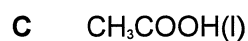
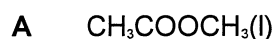


(Total 1 mark)

9. The ester methyl ethanoate is hydrolysed as shown in the following equation.

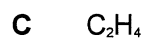


Which one of the following compounds from the reaction mixture has no hydrogen bonding between its molecules when pure?



(Total 1 mark)

10. Which one of the following molecules is **not** planar?



(Total 1 mark)

Reactions of organic compounds

Mechanisms

T 1. In free radical mechanisms the unpaired electron in a radical is represented by a dot

T 2. Write balanced equations for the steps in a free-radical mechanism.

T 3. The formation of a covalent bond is shown by a curly arrow that starts from a lone electron pair or from another covalent bond

T 4. The breaking of a covalent bond is shown by a curly arrow starting from the bond.

Halogenoalkanes

T 1. Outline the mechanisms of substitution reactions with the nucleophiles OH^- , CN^- and NH_3

T 2. Explain why the carbon-halogen bond enthalpy influences the rate of reaction.

T 3. In elimination reactions explain the role of the reagent as both nucleophile and base

T 4. Outline the mechanisms of elimination reactions.

Alkenes

T 1. Bonding in alkenes involves a double covalent bond, a centre of high electron density.

T 2. Outline the mechanisms for addition reactions including HBr , H_2SO_4 and Br_2

T 3. Explain the formation of major and minor products by reference to the relative stabilities of primary, secondary and tertiary carbocation intermediates.

T 4. Draw the repeating unit of a polymer from a monomer structure

T 5. Draw the repeating unit from a section of the polymer chain

Alcohols

T 1. Explain the meaning of the term biofuel

T 2. Justify the conditions used in the production of ethanol by fermentation of glucose

T 3. Write equations to support the statement that ethanol produced by fermentation is a carbon-neutral fuel and give reasons why this statement is not valid

T 4. Outline the mechanism for the formation of an alcohol by the reaction of an alkene with steam in the presence of an acid catalyst

T 5. Discuss the environmental (including ethical) issues linked to decision making about biofuel use.

T 6. Write equations for these oxidation reactions (equations showing $[\text{O}]$ as oxidant are acceptable)

T 7. Explain how the method used to oxidise a primary alcohol determines whether an aldehyde or carboxylic acid is obtained

T 8. Use chemical tests to distinguish between aldehydes and ketones including Fehling's solution and Tollens' reagent.

T 9. Outline the mechanism for the elimination of water from alcohols.

Reactions of organic compounds

Exam booklet reflection:

WWW

EBI

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Doddle quiz homework:

Haloalkanes

Score:

Alkenes 1

Score:

Alkenes 2

Score:

Alcohols

Score:

AS LEVEL CHEMISTRY

TOPIC 8 – REACTIONS OF ORGANIC COMPOUNDS TEST

Answer all questions

Max 50 marks

Name	.....	
Mark	...../50	.....%	Grade

1. Trifluoromethane (CHF_3) can be used to make the refrigerant chlorotrifluoromethane (CClF_3).

(a) Chlorotrifluoromethane is formed when trifluoromethane reacts with chlorine.



The reaction is a free-radical substitution reaction similar to the reaction of methane with chlorine.

- (i) Write an equation for each of the following steps in the mechanism for the reaction of CHF_3 with Cl_2

Initiation step

.....

First propagation step

.....

Second propagation step

.....

Termination step to form hexafluoroethane

.....

(4)

- (ii) Give **one** essential condition for this reaction.

.....

(1)

- (b) In some refrigeration systems, CHF_3 has replaced CClF_3 because of concerns about ozone depletion.

- (i) Identify the species formed from CClF_3 that is responsible for the catalytic decomposition of ozone in the upper atmosphere.

.....

(1)

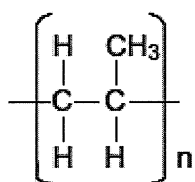
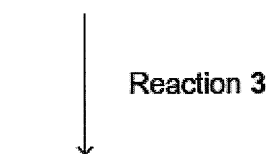
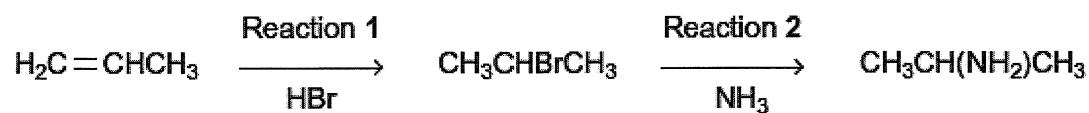
- (ii) Write an overall equation to represent the decomposition of ozone into oxygen.

.....

(1)

(Total 7 marks)

2. Consider the following reactions.



substance X

(a) Name and outline a mechanism for Reaction 1.

Name of mechanism

Mechanism

(5)

(b) Name and outline a mechanism for Reaction 2.

Name of mechanism

Mechanism

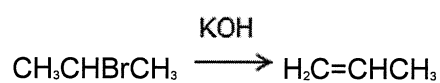
(5)

- (c) State the type of reaction in Reaction 3.
Give the name of substance X.

.....
.....
.....

(2)

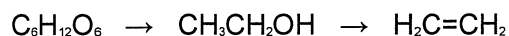
- (d) The haloalkane produced in Reaction 1 can be converted back into propene in an elimination reaction using ethanolic potassium hydroxide.



Outline a mechanism for this conversion.

(3)
(Total 15 marks)

3. Glucose can be used as a source of ethanol. Ethanol can be burned as a fuel or can be converted into ethene.



glucose ethanol ethene

- (a) Name the types of reaction illustrated by the two reactions above.

Glucose to ethanol

Ethanol to ethene (2)

- (b) (i) State what must be added to an aqueous solution of glucose so that ethanol is formed.

.....

- (ii) Identify a suitable catalyst for the conversion of ethanol into ethene.

..... (2)

- (c) (i) State the class of alcohols to which ethanol belongs.

.....

- (ii) Give **one** advantage of using ethanol as a fuel compared with using a petroleum fraction.

..... (2)

- (d) Most of the ethene used by industry is produced when ethane is heated to 900°C in the absence of air. Write an equation for this reaction.

..... (1)

- (e) Name the type of polymerisation which occurs when ethene is converted into poly(ethene).

..... (1)

(Total 8 marks)

4. In an investigation of the chemical properties of alcohols, a mixture of ethanol and acidified potassium dichromate(VI) is heated in a conical flask in a water bath.

(a) Explain why a water bath is used to heat the mixture.

.....
.....

(1)

(b) Describe the colour change which would be observed.

.....
.....

(1)

(Total 2 marks)

5. (a) Ethanol can be manufactured by the direct hydration of ethene and by the fermentation of sugars.

(i) State what is meant by the term *hydration*.

.....

(ii) Give **one** advantage and **one** disadvantage of manufacturing ethanol by fermentation rather than by hydration.

Do **not** include energy consumption or cost.

Advantage

.....

Disadvantage

.....

(3)

(b) Ethanol can be oxidised to an aldehyde and to a carboxylic acid.

(i) Draw the structure of this aldehyde and of this carboxylic acid.

Structure of aldehyde

Structure of carboxylic acid

(ii) Give a suitable reagent and reaction conditions for the oxidation of ethanol to form the carboxylic acid as the major product.

Reagent

Conditions

.....

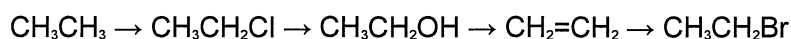
(5)

(c) (i) Draw the structure of an alcohol containing four carbon atoms which is resistant to oxidation.

(ii) Draw the structure of an alcohol containing four carbon atoms which can be oxidised to a ketone.

(2)
(Total 10 marks)

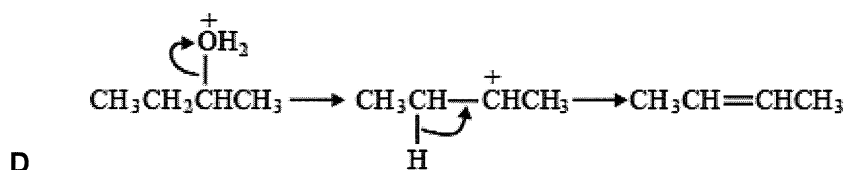
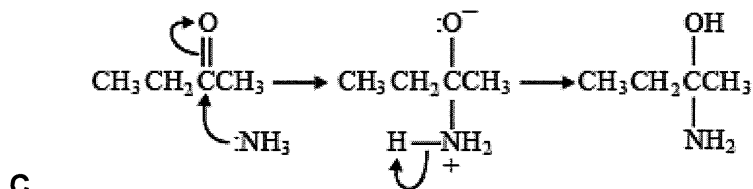
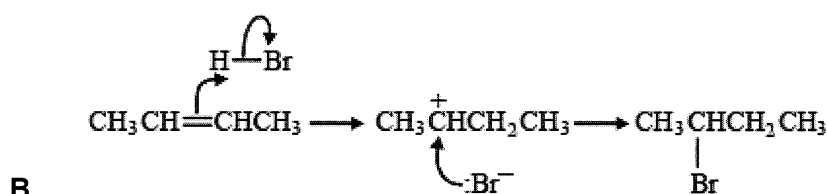
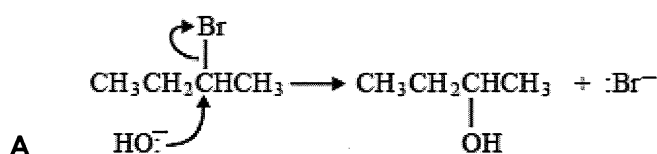
6. Which one of the following mechanisms is **not** involved in the reaction sequence below?



- A electrophilic addition
 B electrophilic substitution
 C nucleophilic substitution
 D free-radical substitution

(Total 1 mark)

7. In which of the following is a curly arrow used incorrectly?



(Total 1 mark)

8. Which one of the following statements explains best why fluoroalkanes are the least reactive haloalkanes?

- A Fluorine is much more electronegative than carbon.
 B The F^- ion is the most stable halide ion.
 C The C-F bond is the most polar carbon-halogen bond.
 D The C-F bond is the strongest carbon-halogen bond.

(Total 1 mark)

9. Which one of the following conversions does **not** represent a reduction?

- A propene \rightarrow propane
- B propanal \rightarrow propan-1-ol
- C propanal \rightarrow propanoic acid
- D propanone \rightarrow propane

(Total 1 mark)

10. Which one of the following isomers is not oxidised under mild reaction conditions?

- A $(\text{CH}_3)_2\text{CHCH}(\text{OH})\text{COCH}_3$
- B $(\text{CH}_3)_2\text{C}(\text{OH})\text{CH}_2\text{COCH}_3$
- C $(\text{CH}_3)_2\text{CHCH}(\text{OH})\text{CH}_2\text{CHO}$
- D $(\text{CH}_3)_2\text{C}(\text{OH})\text{CH}_2\text{CH}_2\text{CHO}$

(Total 1 mark)

11. Which one of the following alcohols forms a mixture of alkenes when dehydrated?

- A propan-1-ol
- B propan-2-ol
- C pentan-1-ol
- D pentan-2-ol

(Total 1 mark)

12. Which one of the following **cannot** be produced by oxidation of propan-1-ol?

- A carbon dioxide
- B propanone
- C propanal
- D propanoic acid

(Total 1 mark)

13. 25.0 cm³ of ethanedioic acid required 22.5 cm³ of 0.100 mol dm⁻³ potassium hydroxide solution for complete neutralisation.

The concentration of ethanedioic acid is

- A 0.0225 mol dm⁻³
- B 0.0450 mol dm⁻³
- C 0.0560 mol dm⁻³
- D 0.0900 mol dm⁻³

(Total 1 mark)

Analysis of organic compounds

Organic analysis
T 1. Identify the functional groups using reactions in the specification. Including alcohols, aldehydes, alkenes and carboxylic acids.
T 2. Use precise atomic masses and the precise molecular mass to determine the molecular formula of a compound
T 3. Use infrared spectra and the Chemistry Data Sheet or Booklet to identify particular bonds, and therefore functional groups, and also to identify impurities.

Exam booklet reflection:

WWW

EBI

Checked by teacher

Doddle quiz homework:

Practical techniques and methods

Score:

Analytical techniques

Score

AS LEVEL CHEMISTRY

TOPIC 9 – ANALYSIS OF ORGANIC COMPOUNDS

TEST

Answer all questions

Max 50 marks

Name	.....	
Mark	...../50	.....%	Grade

1. Ethanol can be oxidised slowly to ethanal. State how a sample of ethanol could be tested to confirm the presence of ethanal. State what you would observe.

Test

Observation

(Total 2 marks)

2. In each of the following questions, you should draw the structure of the compound in the space provided.

- (a) Draw the structure of the alkene that would form 1,2-dibromo-3-methylbutane when reacted with bromine.

(1)

- (b) Draw the structure of the alcohol with molecular formula $C_4H_{10}O$ that is resistant to oxidation by acidified potassium dichromate(VI).

(1)

- (c) Draw the structure of the alkene that has a peak, due to its molecular ion, at $m/z = 42$ in its mass spectrum.

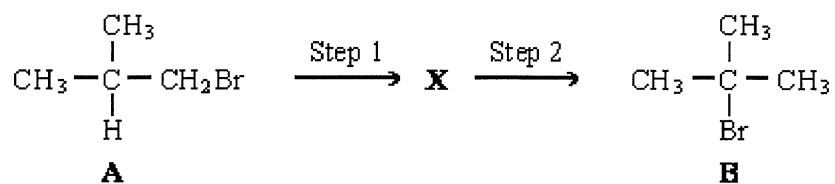
(1)

- (d) Draw the structure of the organic product with $M_r = 73$, made from the reaction between 2-bromobutane and ammonia.

(1)

(Total 4 marks)

3. The conversion of compound **A** into compound **B** can be achieved in two steps as shown below.



The intermediate compound, **X**, has an absorption at 1650 cm^{-1} in its infra-red spectrum.

- (a) Identify compound **X**. Explain your answer.

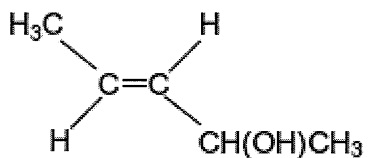
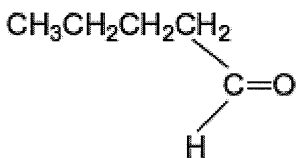
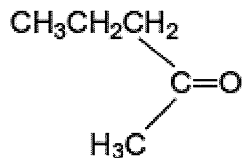
.....

(2)

- (b) For each step in this conversion, give the reagents and essential conditions required and outline a mechanism.

(11)
 (Total 13 marks)

4. The table below shows the structures of three isomers with the molecular formula $C_5H_{10}O$

<p>Isomer 1</p> 	<p>(<i>E</i>)-pent-3-en-2-ol</p>
<p>Isomer 2</p> 	<p>pentanal</p>
<p>Isomer 3</p> 	

- (a) Complete the table by naming Isomer 3.

(1)

- (b) State the type of structural isomerism shown by these three isomers.

.....

(1)

- (c) The compound (*Z*)-pent-3-en-2-ol is a stereoisomer of (*E*)-pent-3-en-2-ol.

- (i) Draw the structure of (*Z*)-pent-3-en-2-ol.

(1)

- (ii) Identify the feature of the double bond in (*E*)-pent-3-en-2-ol and that in (*Z*)-pent-3-en-2-ol that causes these two compounds to be stereoisomers.

.....

(1)

- (d) A chemical test can be used to distinguish between separate samples of Isomer 2 and Isomer 3.

Identify a suitable reagent for the test.

State what you would observe with Isomer 2 and with Isomer 3.

Test reagent

Observation with Isomer 2.....

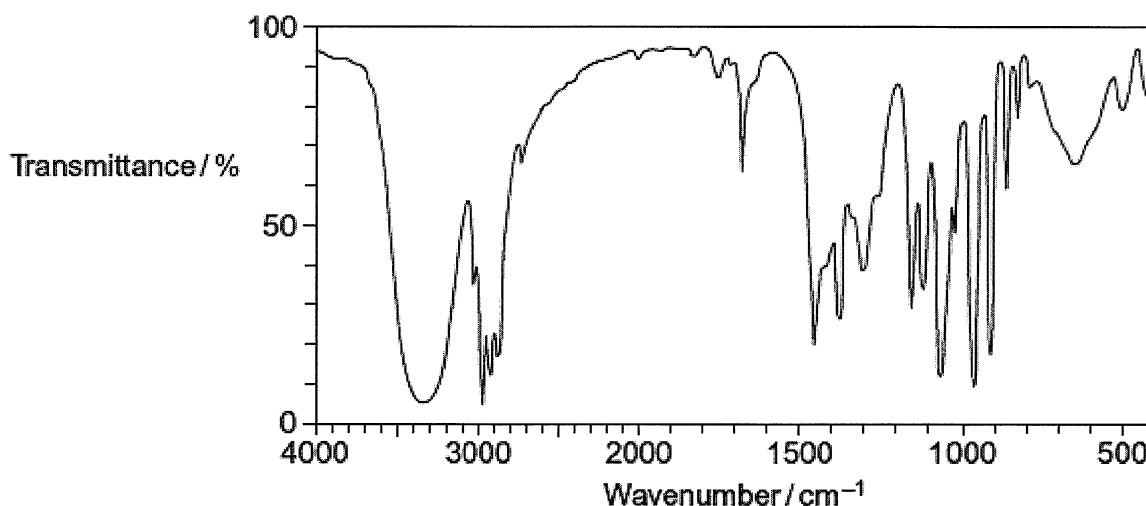
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Observation with Isomer 3.....

.....

(3)

- (e) The following is the infrared spectrum of one of the isomers 1, 2 or 3.



- (i) Deduce which of the isomers (1, 2 or 3) would give this infrared spectrum. You may find it helpful to refer to **Table 1** on the Data Sheet.

.....

(1)

- (ii) Identify two features of the infrared spectrum that support your deduction. In each case, identify the functional group responsible.

Feature 1 and functional group

.....

.....

Feature 2 and functional group

.....

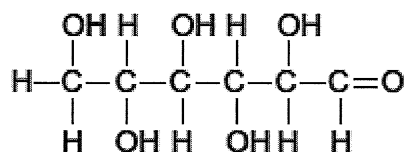
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(2)

(Total 10 marks)

5. Glucose is an organic molecule. Glucose can exist in different forms in aqueous solution.

(a) In aqueous solution, some glucose molecules have the following structure.

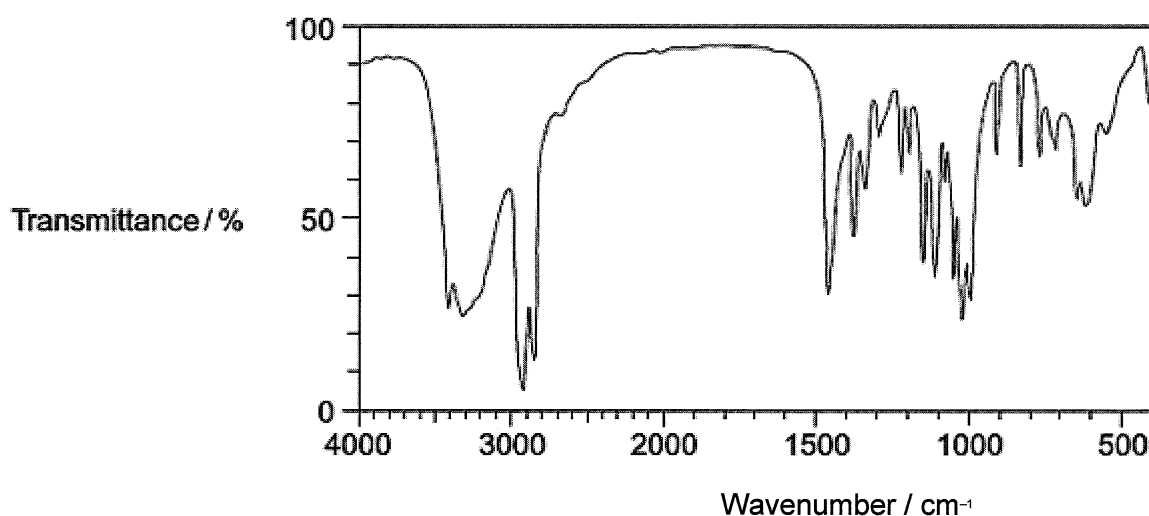


(i) Deduce the empirical formula of glucose.

.....

(1)

(ii) Consider the infrared spectrum of solid glucose.



State why it is possible to suggest that in the solid state very few molecules have the structure shown.

You may find it helpful to refer to **Table 1** on the Data Sheet.

.....

.....

(1)

(b) In the absence of oxygen, an aqueous solution of glucose can be fermented to produce ethanol for use in alcoholic drinks.

Write an equation for this fermentation reaction.

Give **two** other essential conditions for the production of ethanol in this fermentation.

Equation

.....

Condition 1

Condition 2

(3)

- (c) Any ethanol present in the breath of a drinker can be detected by using a breathalyser.
The ethanol is converted into ethanoic acid. The breathalyser has negative and positive electrodes. A current is measured and displayed in terms of alcohol content.

The earliest breathalysers used laboratory chemicals to oxidise the ethanol to ethanoic acid. Detection was by a colour change.

Identify a reagent or combination of reagents that you would use in the laboratory to oxidise ethanol to ethanoic acid.

State the colour **change** that you would expect to see.

Reagent or combination of reagents

Colour change

(2)

- (d) The fermentation of glucose from crops is the main method for the production of ethanol. The product is called bioethanol. The European Union has declared that bioethanol is carbon-neutral.

- (i) Other than carbon-neutrality, state the **main** advantage of the use of glucose from crops as the raw material for the production of ethanol.

.....
.....

(1)

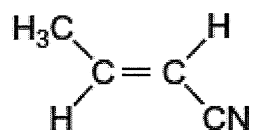
- (ii) Give *one* disadvantage of the use of crops for the production of ethanol.

.....
.....

(1)

(Total 9 marks)

6. The alkene (*E*)-but-2-enenitrile is used to make acrylic plastics.
The structure of (*E*)-but-2-enenitrile is



- (a) (i) Draw the structure of (*Z*)-but-2-enenitrile.

(1)

- (ii) Identify the feature of the double bond in the *E* and *Z* isomers that causes them to be stereoisomers.

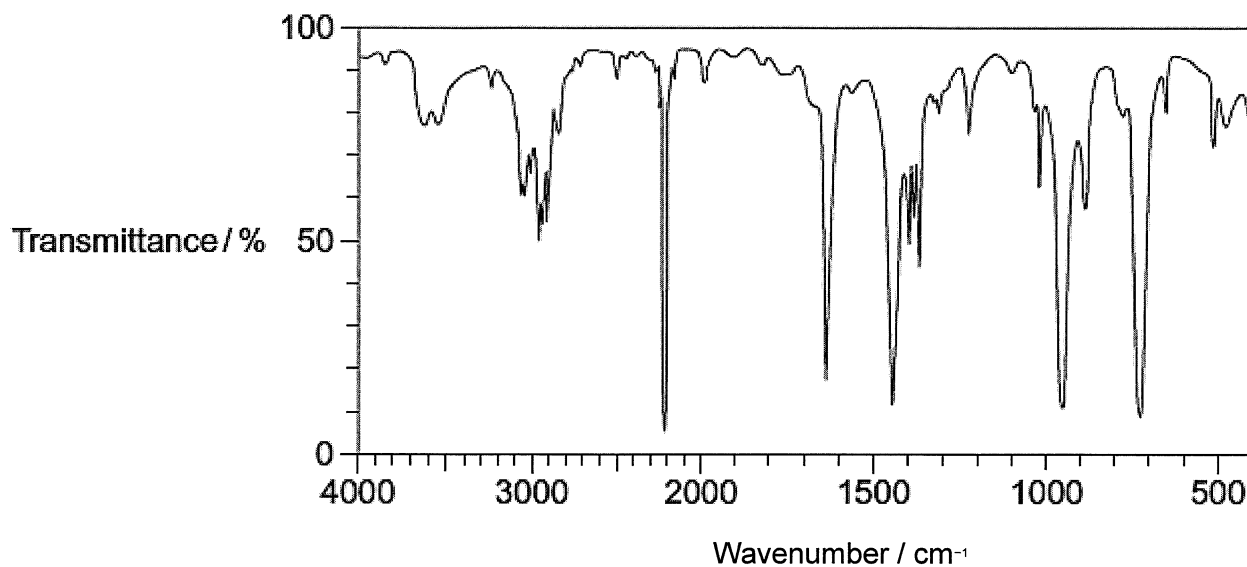
.....
.....
.....

(1)

- (b) Draw the repeating unit of the polyalkene formed by addition polymerisation of (*E*)-but-2-enenitrile.

(1)

(c) Consider the infrared spectrum of (*E*)-but-2-enenitrile.



Identify **two** features of the infrared spectrum that support the fact that this is the infrared spectrum for but-2-enenitrile.

You may find it helpful to refer to **Table 1** on the Data Sheet.

Feature 1

.....

.....

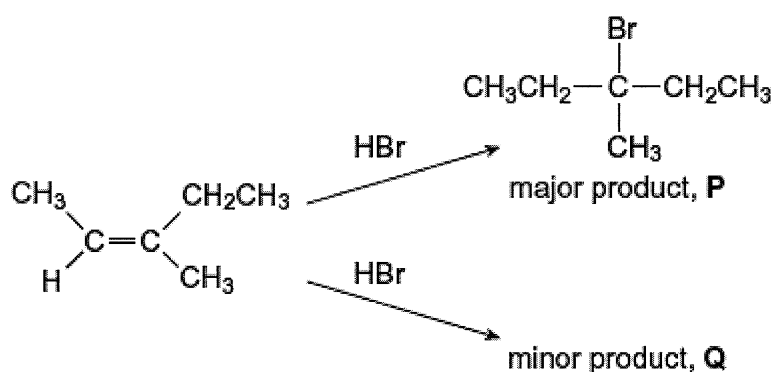
Feature 2

.....

.....

(2)
(Total 5 marks)

7. The alkene (Z)-3-methylpent-2-ene reacts with hydrogen bromide as shown below.



- (a) (i) Name the mechanism for these reactions.

.....

(1)

- (ii) Draw the displayed formula for the minor product **Q** and state the type of structural isomerism shown by **P** and **Q**.

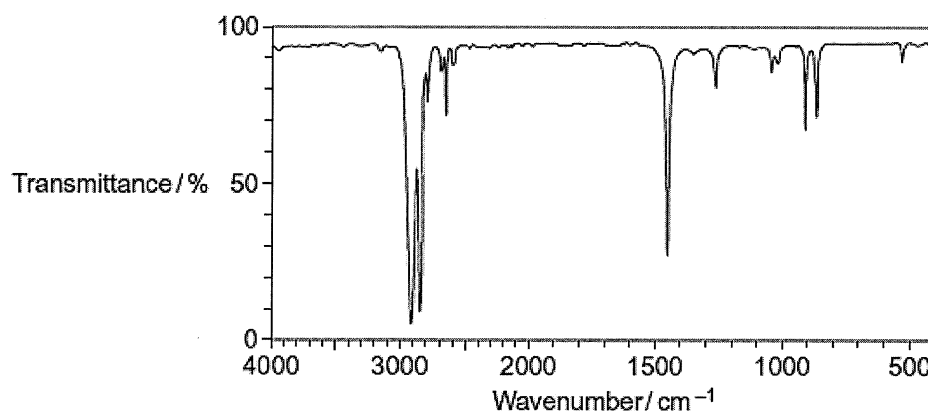
Displayed formula for **Q**

Type of structural isomerism

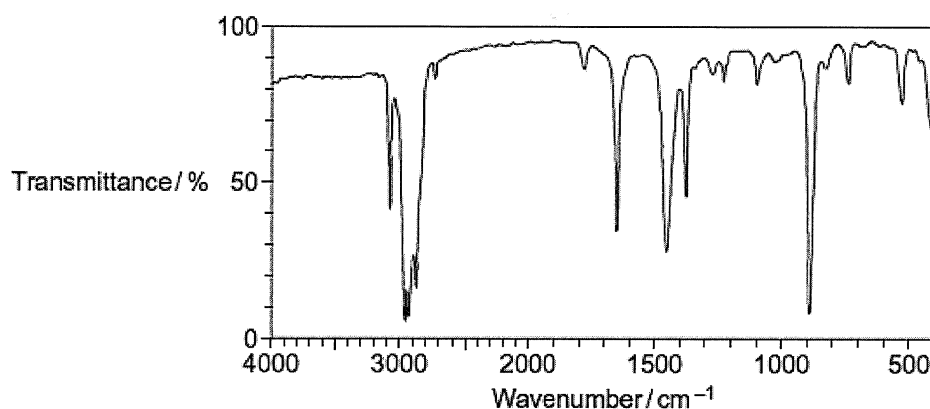
(2)

- (b) The infrared spectra of two compounds **R** and **S** are shown below. **R** and **S** have the molecular formula C_6H_{12} and are structural isomers of 3-methylpent-2-ene. **R** is an unsaturated hydrocarbon and **S** is a saturated hydrocarbon.

Spectrum 1



Spectrum 2



- (i) Identify the infrared Spectrum **1** or **2** that represents compound **R**.
Use information from the infrared spectra to give **one** reason for your answer.
You may find it helpful to refer to **Table 1** on the Data Sheet.

R is represented by Spectrum

Reason

.....

(2)

- (ii) State the type of structural isomerism shown by **R** and **S**.

.....

(1)

- (iii) Name **one** possible compound which could be **S**.

.....

(1)

(Total 7 marks)

Redox, Group 2 and Group 7 Chemistry

Oxidation and reduction
T 1. Work out the oxidation state of an element in a compound or ion from the formula
T 2. Write half-equations identifying the oxidation and reduction processes in redox reactions
T 3. Combine half-equations to give an overall redox equation.
Group 2: The alkaline earth metals
T 1. Explain the trends in atomic radius and first ionisation energy
T 2. Explain the melting point of the elements in terms of their structure and bonding.
T 3. The reactions of the elements Mg–Ba with water.
T 4. The use of magnesium in the extraction of titanium from TiCl_4
T 5. The relative solubilities of the hydroxides of the elements Mg–Ba in water.
T 6. The use of CaO or CaCO_3 to remove SO_2 from flue gases.
T 7. Explain why BaCl_2 solution is used to test for sulfate ions and why it is acidified.
Group 7: The halogens
T 1. Explain the trend in electronegativity
T 2. Explain the trend in the boiling point of the elements in terms of their structure and bonding.
T 3. The trend in oxidising ability of the halogens down the group, including displacement reactions of halide ions in aqueous solution.
T 4. The trend in reducing ability of the halide ions, including the reactions of solid sodium halides with concentrated sulfuric acid.
T 5. The use of acidified silver nitrate solution to identify and distinguish between halide ions.
T 6. The trend in solubility of the silver halides in ammonia.
T 7. The reaction of chlorine with water to form chloride ions and chlorate(I) ions.
T 8. The reaction of chlorine with water to form chloride ions and oxygen.
T 9. Appreciate that society assesses the advantages and disadvantages when deciding if chemicals should be added to water supplies.
T 10. The use of chlorine in water treatment.
T 11. Appreciate that the benefits to health of water treatment by chlorine outweigh its toxic effects.
T 12. The reaction of chlorine with cold, dilute, aqueous NaOH and uses of the solution formed.

Exam booklet reflection:

WWW

EBI

Checked by teacher

Doddle quiz homework:

Alkaline earth metals

Score:

Halogens

Score:

Redox reactions

Score:

AS LEVEL CHEMISTRY

TOPIC 6 – REDOX, GROUP 2 AND GROUP 7 TEST

Answer all questions

Max 50 marks

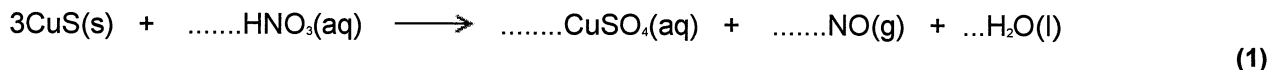
Name	.....	
Mark	...../50	.....%	Grade

SECTION A

1. The price of copper is increasing as supplies of high-grade ores start to run out.
The mineral covellite (CuS), found in low-grade ores, is a possible future source of copper.

(a) When copper is extracted from covellite, a reaction occurs between copper(II) sulfide and nitric acid to form a dilute solution of copper(II) sulfate.

(i) Balance the equation for this reaction.



(ii) Give the oxidation state of nitrogen in each of the following.

HNO₃.....

NO

(2)

(iii) Deduce the redox half-equation for the reduction of the nitrate ion in acidified solution to form nitrogen monoxide and water.

.....

(1)

(iv) Deduce the redox half-equation for the oxidation of the sulfide ion in aqueous solution to form the sulfate ion and H⁺(aq) ions.

.....

(1)

(Total 5 marks)

2. In acidified aqueous solution, nitrate ions, NO₃⁻, react with copper metal forming nitrogen monoxide, NO, and copper(II) ions.

(i) Write a half-equation for the oxidation of copper to copper(II) ions.

.....

(ii) Write a half-equation for the reduction, in an acidified solution, of nitrate ions to nitrogen monoxide.

.....

(iii) Write an overall equation for this reaction.

.....

(3)

(Total 3 marks)

3. (a) Strontium chloride is used in toothpaste for sensitive teeth.
Both strontium carbonate and strontium sulfate are white solids that are insoluble in water.

- (i) Write an equation for the reaction between strontium chloride solution and sodium sulfate solution.
Include state symbols in your equation.

.....

(1)

- (ii) Strontium carbonate reacts with nitric acid to produce a solution of strontium nitrate.
Strontium sulfate does not react with nitric acid.

Describe briefly how you could obtain strontium sulfate from a mixture of strontium carbonate and strontium sulfate.

You are **not** required to describe the purification of the strontium sulfate.

.....

.....

.....

.....

.....

(2)

- (b) A solution of magnesium sulfate is sometimes given as first aid to someone who has swallowed barium chloride.

Explain why drinking magnesium sulfate solution is effective in the treatment of barium poisoning.

.....

.....

(1)

- (c) Medicines for the treatment of nervous disorders often contain calcium bromide.
Silver nitrate, acidified with dilute nitric acid, can be used together with another reagent to test for the presence of bromide ions in a solution of a medicine.

Describe briefly how you would carry out this test and state what you would observe.

.....

.....

.....

.....

.....

(3)

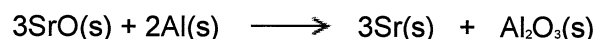
(Total 7 marks)

4. Group 2 metals and their compounds are used commercially in a variety of processes.

- (a) Strontium is extracted from strontium oxide (SrO) by heating a mixture of powdered strontium oxide and powdered aluminium.

Consider these standard enthalpies of formation.

	SrO(s)	Al ₂ O ₃ (s)
$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	– 590	– 1669



Use these data and the equation to calculate the standard enthalpy change for this extraction of strontium.

The use of powdered strontium oxide and powdered aluminium increases the surface area of the reactants.

Suggest **one** reason why this increases the reaction rate.

Suggest **one** major reason why this method of extracting strontium is expensive.

.....

.....

.....

.....

.....

.....

.....

.....

.....

(5)

- (b) Explain why calcium has a higher melting point than strontium.

.....

.....

.....

.....

.....

(2)

- (c) Magnesium is used in fireworks. It reacts rapidly with oxygen, burning with a bright white light. Magnesium reacts slowly with cold water.

Write an equation for the reaction of magnesium with oxygen.

Write an equation for the reaction of magnesium with cold water.

Give a medical use for the magnesium compound formed in the reaction of magnesium with cold water.

.....

.....

.....

.....

.....

.....

.....

.....

(3)
(Total 10 marks)

5. Barium chloride solution was added, dropwise, to magnesium sulfate solution until no more white precipitate was formed. The mixture was filtered.

Give the formulae of the **two** main ions in the filtrate.

.....

.....

(Total 1 mark)

6. A chemical company's records refer to the following acids

hydrochloric acid
hydrobromic acid
hydriodic acid

nitric acid
sulfuric acid

A waste tank was thought to contain a mixture of two of these acids. A chemist performed test-tube reactions on separate samples from the waste tank. The results of these tests are shown below.

Test	Reagent	Observations
A	Barium chloride solution	White precipitate
B	Silver nitrate solution	White precipitate

- (a) Use the result from Test **A** to identify an acid in the company's records which must be **present** in the waste tank.

.....

(1)

- (b) Use the results from Test **A** and Test **B** to identify an acid in the company's records which must be **absent** from the waste tank.

.....

(1)

- (c) The chemist suspected that the waste tank contained hydrochloric acid. State how the precipitate formed in Test **B** could be tested to confirm the presence of hydrochloric acid in the waste tank. State what you would observe.

Test

.....

Observation

.....

(2)

- (d) Suggest one reason why carbonate ions could not be present in the waste tank.

.....

(1)

(Total 5 marks)

7. (a) State and explain the trend in electronegativity down Group VII from fluorine to iodine.

Trend

Explanation

.....

.....

(3)

- (b) State what you would observe when chlorine gas is bubbled into an aqueous solution of potassium iodide. Write an equation for the reaction that occurs.

Observation

Equation

(2)

- (c) Identify **two** sulphur-containing reduction products formed when concentrated sulphuric acid oxidises iodide ions. For each reduction product, write a half-equation to illustrate its formation from sulphuric acid.

Reduction product 1

Half-equation

Reduction product 2

Half-equation

(4)

- (d) Write an equation for the reaction between chlorine gas and dilute aqueous sodium hydroxide. Name the **two** chlorine-containing products of this reaction and give the oxidation state of chlorine in each of these products.

Equation

Name of product 1

Oxidation state of chlorine in product 1

Name of product 2

Oxidation state of chlorine in product 2

(5)

(Total 14 marks)

SECTION B

8. Which one of the following statements concerning halogen chemistry is true?
- A Sodium chloride produces chlorine when treated with concentrated sulphuric acid.
 - B Sodium chloride produces chlorine when treated with bromine.
 - C Sodium bromide produces bromine when treated with concentrated sulphuric acid.
 - D Sodium bromide produces bromine when treated with iodine in aqueous potassium iodide.
- (Total 1 mark)
9. On heating, magnesium reacts vigorously with element X to produce compound Y. An aqueous solution of Y, when treated with aqueous silver nitrate, gives a white precipitate that is readily soluble in dilute aqueous ammonia. What is the minimum mass of X that is needed to react completely with 4.05 g of magnesium?
- A 11.83 g
 - B 5.92 g
 - C 5.33 g
 - D 2.67 g
- (Total 1 mark)
10. The boiling points of the halogens increase down Group VII because
- A covalent bond strengths increase.
 - B bond polarities increase.
 - C the surface areas of the molecules increase.
 - D electronegativities increase.
- (Total 1 mark)

11. Which one of the following is the electron arrangement of the strongest reducing agent?

- A $1s^2 2s^2 2p^5$
- B $1s^2 2s^2 2p^6 3s^2$
- C $1s^2 2s^2 2p^6 3s^2 3p^5$
- D $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

(Total 1 mark)

12. The reaction between sodium iodide and concentrated phosphoric acid produces hydrogen iodide but no iodine. The reaction of sodium iodide with concentrated sulphuric acid produces mainly iodine. The difference in product occurs because, in comparison with sulphuric acid, phosphoric acid is

- A the weaker acid.
- B the stronger oxidising agent.
- C the weaker oxidising agent.
- D the stronger reducing agent.

(Total 1 mark)

