OCR
Oxford Cambridge and RSA

Monday 20 May 2019 – Morning

AS Level Chemistry A

H032/01 Breadth in chemistry

Time allowed: 1 hour 30 minutes

You must have:
- the Data Sheet for Chemistry A (sent with general stationery)

You may use:
- a scientific or graphical calculator

H032/01

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **24** pages.

© OCR 2019 [601/5256/4]
DC (ST/CT) 174260/6
OCR is an exempt Charity

SECTION A

You should spend a maximum of 25 minutes on this section.

Answer **all** the questions.

Write your answer to each question in the box provided.

1 Which statement about the periodic table is **not** correct?

A The elements are arranged in groups with similar chemical properties.

B The elements are arranged in periods with repeating trends in properties.

C The elements are arranged in order of increasing atomic number.

D The elements in the halogen group increase in reactivity down the group.

Your answer ☐ **[1]**

2 Which molecule contains the largest bond angle?

A C_2H_4

B H_2O

C NH_3

D CH_4

Your answer ☐ **[1]**

3 What is the percentage composition by mass of nitrogen in $(NH_4)_2CO_3$?

A 14.58%

B 17.95%

C 29.17%

D 37.50%

Your answer ☐ **[1]**

© OCR 2019

4 Which chemical process is the most sustainable in terms of the atom economy of the organic product?

A $CO_2 + 3H_2 \rightarrow CH_3OH + H_2O$

B $CH_3CH_2OH + NaCl + H_2SO_4 \rightarrow CH_3CH_2Cl + NaHSO_4 + H_2O$

C $CH_3CH_2Br + NaOH \rightarrow CH_3CH_2OH + NaBr$

D $CH_3CH_2CH_2CH_2OH \rightarrow CH_3CH_2CH{=}CH_2 + H_2O$

Your answer ☐ **[1]**

5 $8.0\,dm^3$ of NO is mixed with $6.0\,dm^3$ of O_2 at room temperature and pressure (RTP).
The reaction below takes place until one of the reactants is used up.

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

What is the volume of the mixture at RTP after the reaction has taken place?

A $8.0\,dm^3$

B $10.0\,dm^3$

C $12.0\,dm^3$

D $14.0\,dm^3$

Your answer ☐ **[1]**

6 What is the volume of 0.0100 mol of N_2 at 350 °C and 200 kPa?

A $145\,cm^3$

B $259\,cm^3$

C $145\,dm^3$

D $259\,dm^3$

Your answer ☐ **[1]**

© OCR 2019

7 0.24 g of an element, **X**, is reacted with 0.0100 mol Cl_2 to form a chloride with the formula **X**Cl_2.

What is element **X**?

A carbon

B magnesium

C molybdenum

D titanium

Your answer ☐ **[1]**

8 A phosphate(V) ion has the formula PO_4^{3-}.

What is the formula for copper(I) phosphate(V)?

A $Cu(PO_4)_5$

B Cu_5PO_4

C $Cu(PO_4)_3$

D Cu_3PO_4

Your answer ☐ **[1]**

9 Which reaction shows chlorine only being oxidised?

A $Cl_2 + H_2O \rightarrow HCl + HClO$

B $2ClO_2 + 2NaOH \rightarrow NaClO_2 + NaClO_3 + H_2O$

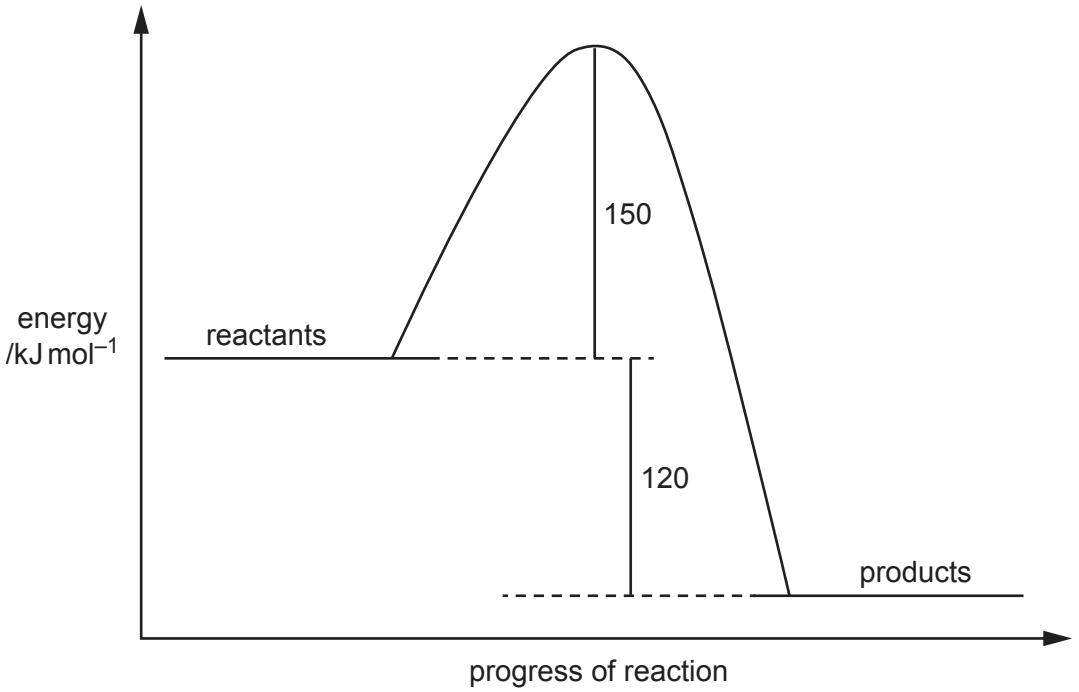
C $4KClO_3 \rightarrow 3KClO_4 + KCl$

D $MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$

Your answer ☐ **[1]**

© OCR 2019

10 A reversible reaction has the enthalpy profile diagram shown below.



Which statement about this reaction is correct?

A The activation energy of the forward reaction is 120 kJ mol^{-1}.

B The activation energy of the reverse reaction is 270 kJ mol^{-1}.

C The enthalpy change of the forward reaction is −30 kJ mol^{-1}.

D The reverse reaction is exothermic.

Your answer ☐ **[1]**

11 Hydrogen and chlorine react as shown below.

$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$ $\Delta H^{\ominus} = -184.6\,kJ\,mol^{-1}$

Which statement about this reaction is correct?

A Less energy is released on bond making than is taken in during bond breaking.

B The enthalpy change for the reverse equation is +184.6 kJ mol^{-1}.

C The enthalpy change of formation of $HCl(g)$ is –184.6 kJ mol^{-1}.

D The temperature decreases during the reaction.

Your answer ☐ **[1]**

© OCR 2019

12 What is the **main** reason for the increase in reaction rate with increasing temperature?

A The activation energy decreases.

B The activation energy increases.

C More molecules have an energy greater than the activation energy.

D The molecules collide more frequently.

Your answer ☐ **[1]**

13 A catalyst is added to a system in equilibrium.

What is the effect on the rates of the forward and reverse reactions?

A There is no effect on the rate in either direction.

B Both rates increase by the same factor.

C The rate in the forward direction increases by a greater factor than the reverse direction.

D The rate in the reverse direction increases by a greater factor than the forward direction.

Your answer ☐ **[1]**

14 What is the best description for the bonding between the carbon atoms in an ethene molecule?

A One σ-bond and one π-bond

B One π-bond

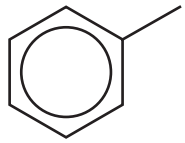
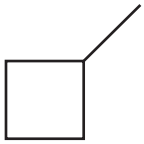
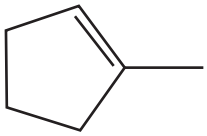
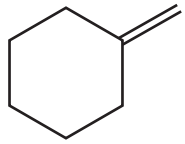
C Two σ-bonds

D Two π-bonds

Your answer ☐ **[1]**

© OCR 2019

15 Which compound is unsaturated, alicyclic and contains an alkyl group?

A	
B	
C	
D	

Your answer ☐ **[1]**

16 Which statement about an electrophile is correct?

A It is an electron pair acceptor.

B It is a proton donor.

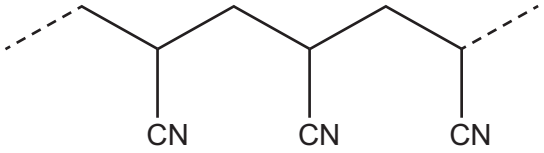
C It is a negative ion.

D It is a species with an unpaired electron.

Your answer ☐ **[1]**

© OCR 2019

17 A section of a polymer is shown below.



Which monomer could form this polymer?

A $CH_3CH(OH)CN$

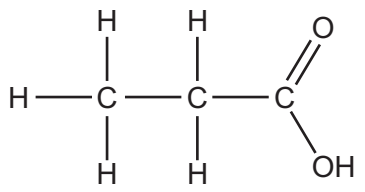
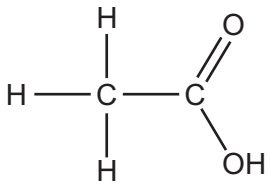
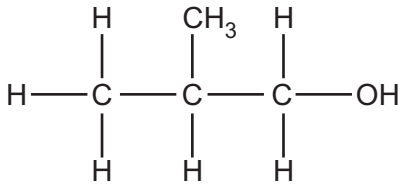
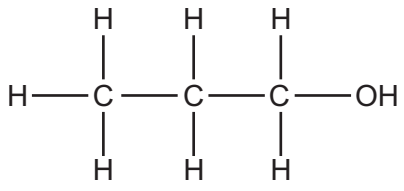
B $HOCH_2CH_2CN$

C $H_2C{=}CHCN$

D NCCH=CHCN

Your answer ☐ **[1]**

18 Which compound is **not** likely to have a fragment ion at $m/z = 43$ in its mass spectrum?

A	
B	
C	
D	

Your answer ☐ **[1]**

© OCR 2019

19 Which statement about infrared radiation is **not** correct?

A The energy from IR radiation causes some covalent bonds to vibrate more.

B Absorption of IR radiation by some atmospheric gases is linked by some scientists to global warming.

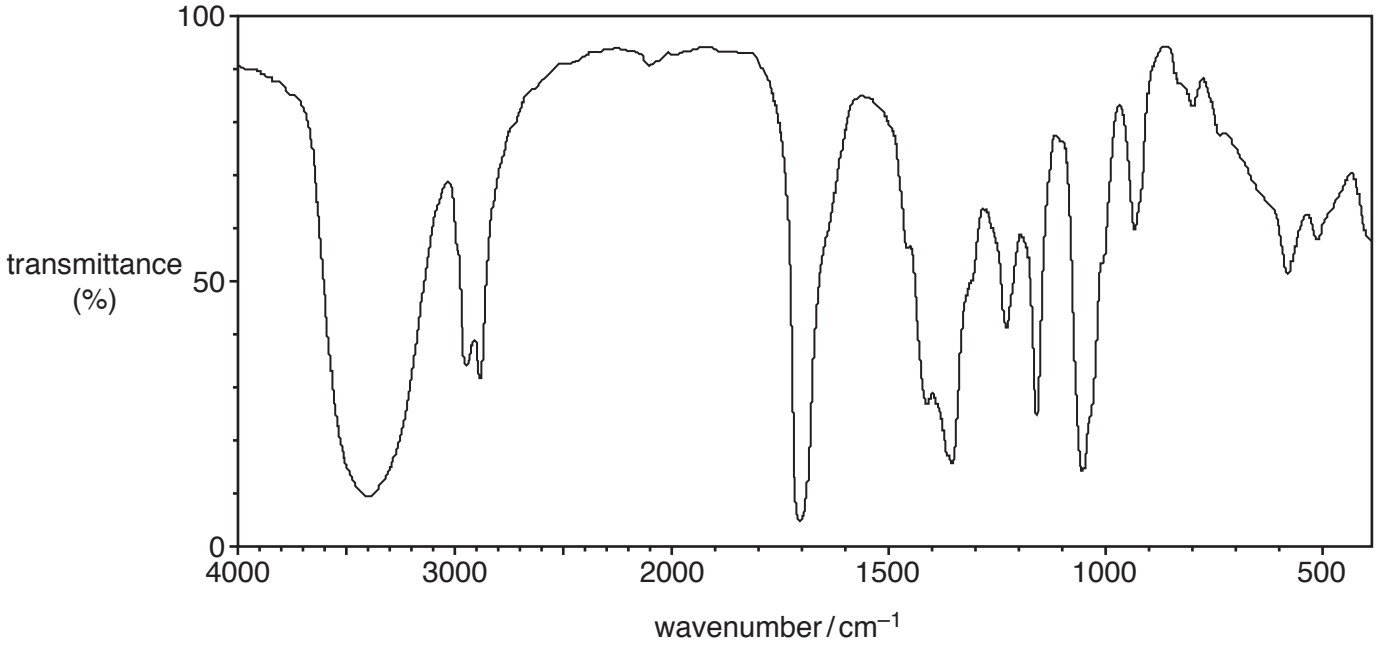
C IR radiation is used to monitor gases causing air pollution.

D The action of IR radiation on CFCs in the upper atmosphere leads to the formation of chlorine radicals.

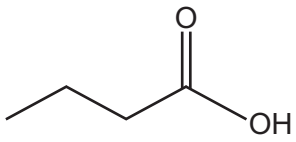
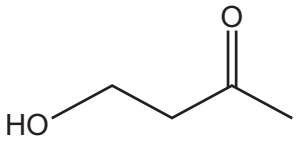
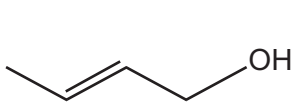
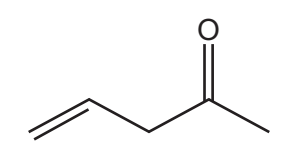
Your answer ☐ **[1]**

© OCR 2019

20 An unknown compound produces the infrared spectrum below.



Which compound could have produced the infrared spectrum?

A	
B	
C	
D	

Your answer ☐ **[1]**

© OCR 2019

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

Turn over for Section B

© OCR 2019

SECTION B

Answer **all** the questions.

21 This question is about atomic structure and the compounds of calcium, nitrogen and oxygen.

(a) Most elements contain different isotopes.

State **two** differences between isotopes of the same element.

.....

.....

..... **[1]**

(b) Complete the table for an atom and an ion of two different elements.

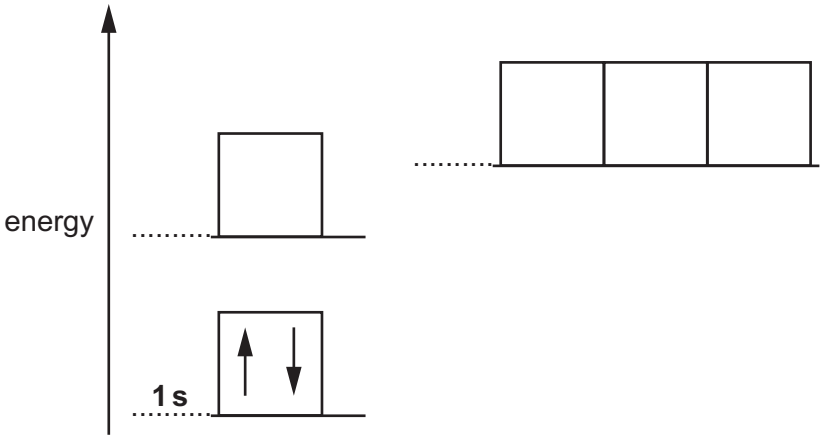
Element	Mass number	Protons	Neutrons	Electrons	Charge
.....	.....	26	28	.....	0
.....	80	.....	.....	36	2−

[2]

(c) Electrons occupy orbitals which are arranged in energy levels.

In the diagram below, each box represents an orbital and each electron is shown as an arrow.

Label the sub-shells and add arrows to show how electrons occupy orbitals in an atom of **oxygen**.



[2]

© OCR 2019

(d) Calcium reacts with nitrogen to form calcium nitride, Ca_3N_2, which is an ionic compound.

(i) Construct a 'dot-and-cross' diagram for Ca_3N_2.

Show outer electrons only and the charges on each ion.

[2]

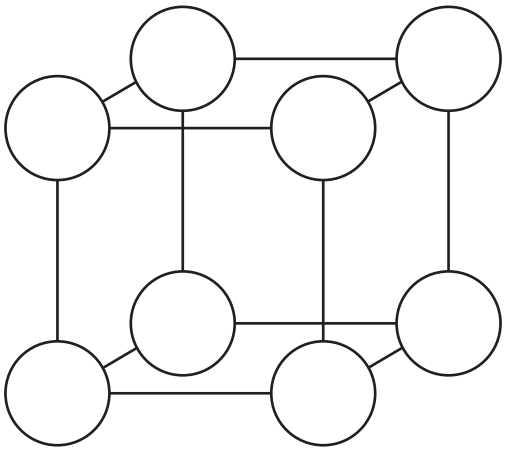
(ii) Calcium nitride reacts with water to form a solution containing two alkaline compounds.

Write an equation for this reaction.

..... **[2]**

(iii) Calcium reacts with oxygen to form a compound which has a giant ionic lattice structure. The diagram shows ions as circles in part of the lattice.

Complete the diagram by showing the symbols of the ions, including charges.



[2]

(iv) Nitrogen forms an oxide with the formula N_2O. A molecule of N_2O is linear and has a nitrogen atom in the centre.

Draw a 'dot-and-cross' diagram for an N_2O molecule.

Show outer electrons only.

[2]

© OCR 2019

22 A student carries out a titration to determine the concentration of some hydrochloric acid.

The student titrates the hydrochloric acid against a standard solution of sodium carbonate, Na_2CO_3. The equation is shown below.

$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$

- The student prepares 0.150 mol dm^{-3} Na_2CO_3 in a 250.0 cm^3 volumetric flask.
- The hydrochloric acid is added to a 50.0 cm^3 burette.
- The student pipettes the $Na_2CO_3(aq)$ using a 25.0 cm^3 pipette.

(a) The student's burette readings are shown in the table.
The rough titre has been omitted.

(i) Complete the table by adding the titres to the table.

Final reading / cm^3	24.60	48.45	34.30
Initial reading / cm^3	0.40	24.60	10.00
Titre / cm^3	.....	.....	.....

[1]

(ii) Calculate the mean titre of HCl, to the nearest 0.05 cm^3, that the student should use for analysing the results.

mean titre = ... cm^3 **[1]**

(b) Calculate the concentration, in mol dm^{-3}, of the hydrochloric acid.

Give your answer to **3** significant figures.

concentration of HCl = ... mol dm^{-3} **[3]**

© OCR 2019

(c) In the titrations, the student measured volumes with a pipette and a burette.

- The pipette had an uncertainty of $\pm 0.04\,cm^3$ in the volume measured.
- The burette had an uncertainty of $\pm 0.05\,cm^3$ in the volume measured.

Determine whether the volume measured by the pipette or the volume measured by the burette has the greater percentage uncertainty.

[2]

© OCR 2019

23 This question is about halogens and halides.

(a) The boiling points of the halogens are shown in the table.

Halogen	Boiling point / K
fluorine	85
chlorine	239
bromine	332
iodine	457
astatine	503

Explain the trend in boiling points of the halogens.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

© OCR 2019

(b) You are supplied with a sample of ammonium bromide.

Describe simple tests that would identify the cation and anion present in ammonium bromide.

Include reagents, expected observations and relevant equations.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[5]**

© OCR 2019

24 This question is about ammonia, NH_3.

(a) In industry, ammonia is made from nitrogen and hydrogen. This is a reversible reaction, as shown in **equilibrium 24.1** below.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\Delta H = -92\,kJ\,mol^{-1}$ **Equilibrium 24.1**

(i) Explain how le Chatelier's principle can be used to predict the conditions of temperature and pressure for a maximum **equilibrium** yield of ammonia.

.....

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

(ii) Using certain conditions, **equilibrium 24.1** has the equilibrium concentrations in the table.

Substance	Equilibrium concentration / mol dm^{-3}
$N_2(g)$	1.25
$H_2(g)$	2.75
$NH_3(g)$	0.862

Calculate the numerical value for K_c for **equilibrium 24.1** under these conditions.

Give your answer to an **appropriate** number of significant figures and in **standard form**.

K_c = ... **[2]**

© OCR 2019

(b) Ammonia is used to make nitric acid. The first stage of the reaction is shown below.

$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$ $\Delta H = -908\,kJ\,mol^{-1}$

Standard enthalpy changes of formation, $\Delta_f H^{\ominus}$, are given in the table.

Substance	$\Delta_f H^{\ominus}$ / kJ mol^{-1}
$NH_3(g)$	−46
$O_2(g)$	0
$H_2O(g)$	−242

(i) State the conditions of temperature and pressure used for standard enthalpy measurements.

Temperature .....

Pressure .....

[1]

(ii) Calculate the standard enthalpy change of formation for NO(g).

Give your answer to a **whole number**.

$\Delta_f H^{\ominus}$ for NO(g) = ... kJ mol^{-1} **[3]**

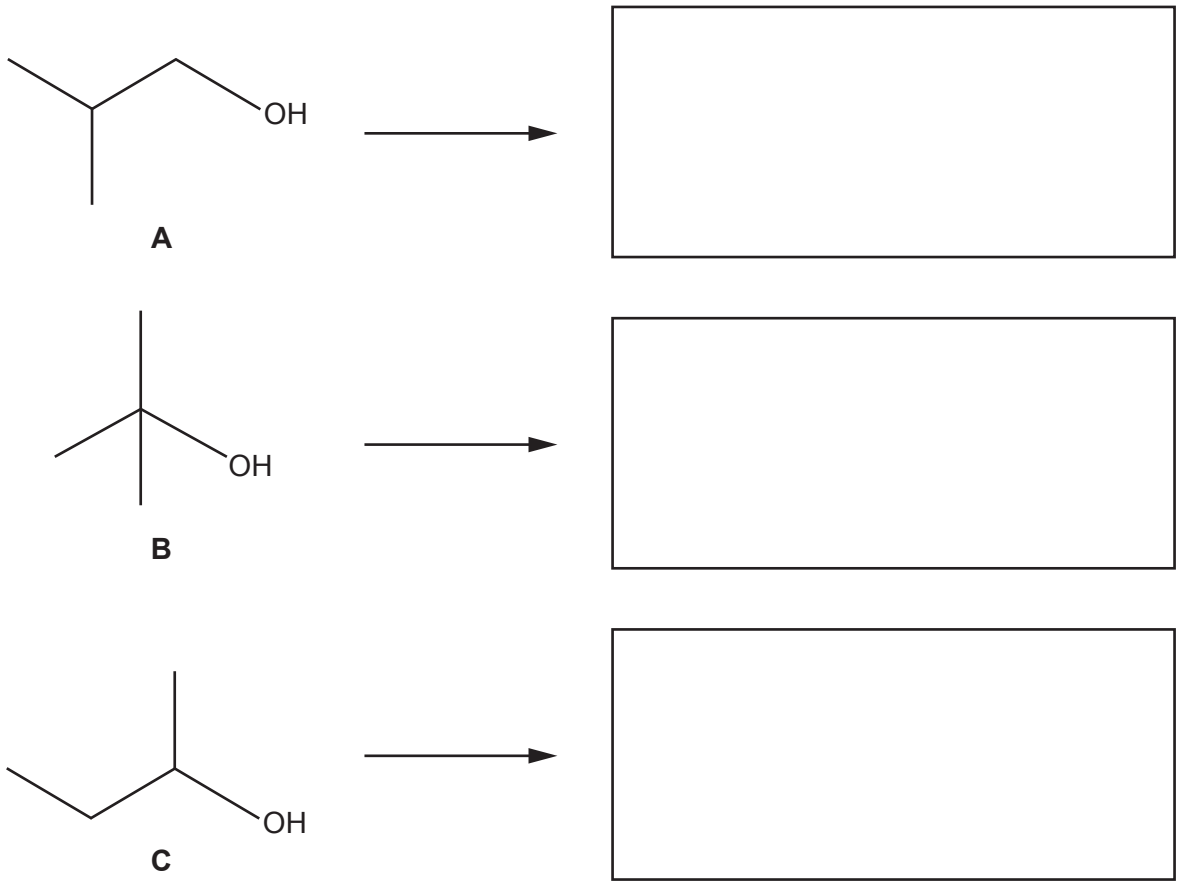
© OCR 2019

25 This question is about alcohols and alkanes.

(a) Three alcohols **A**, **B** and **C** are structural isomers of $C_4H_{10}O$.

Each alcohol is refluxed with acidified dichromate(VI), $H^+/Cr_2O_7^{2-}$.

(i) Draw the structures for the organic products.
If there is no reaction, write '**NONE**'.



[3]

(ii) Write the systematic name for alcohol **C**.

..... **[1]**

(iii) Complete the equation below for the complete combustion of alcohol **A**.

$C_4H_{10}O$ ..... → ..... **[1]**

© OCR 2019

(b) Under suitable conditions, butane, C_4H_{10}, reacts with chlorine by radical substitution.
A mixture of organic compounds is formed, including C_4H_9Cl, and compounds **D** and **E**.

(i) Complete the table below to show the mechanism for the initiation and propagation stages of the reaction of C_4H_{10} with chlorine to form C_4H_9Cl.

In your equations, use molecular formulae and 'dots' (•) with any radicals.

Initiation	Equation ..... Conditions .....
Propagation	..... → .... → .....

[3]

(ii) Organic compound **D** is formed by substitution of **all** the H atoms in butane by Cl atoms.

Write the equation for the formation of compound **D** from butane.

Use molecular formulae.

..... **[1]**

(iii) Organic compound **E** is formed by the substitution of **some** of the H atoms in butane by Cl atoms.

A chemist found that 0.636 g of compound **E** has a volume of 78.0 cm^3.
Under the conditions used, the molar gas volume is 32.5 $dm^3\,mol^{-1}$.

Determine the molecular formula of compound **E**.

molecular formula = ... **[3]**

END OF QUESTION PAPER

© OCR 2019

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

© OCR 2019

© OCR 2019

OCR
Oxford Cambridge and RSA

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact The OCR Copyright Team, The Triangle Building, Shaftesbury Road, Cambridge CB2 8EA.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2019