Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/11**

Paper 1 Multiple Choice **May/June 2014**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

* 4 0 7 3 8 4 7 6 1 6 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
Electronic calculators may be used.

This document consists of **14** printed pages and **2** blank pages.

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Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 *Use of the Data Booklet is relevant to this question.*

Atoms of element X have six unpaired electrons.

What could be element X?

A carbon

B chromium

C iron

D selenium

2 *Use of the Data Booklet is relevant to this question*.

Iodine is a black, shiny, non-metallic solid and a member of Group VII. It sublimes easily on heating to give a purple vapour.

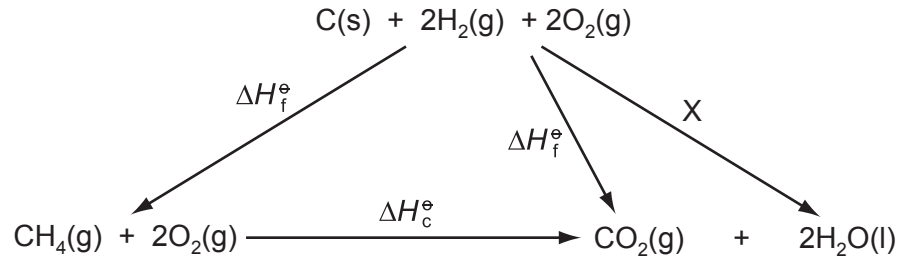
A sample of iodine vapour of mass 6.35 g has a volume of 1.247 dm^3 when maintained at constant temperature and a pressure of 1.00×10^5 Pa.

If iodine vapour acts as an ideal gas, what is the temperature of the iodine vapour?

A 300 K **B** 600 K **C** 300 000 K **D** 600 000 K

3 Enthalpy changes that are difficult to measure directly can often be determined using Hess' Law to construct an enthalpy cycle.

Which enthalpy change is indicated by X in the enthalpy cycle shown?



A $-4 \times$ the enthalpy of combustion of hydrogen

B $+4 \times$ the enthalpy of combustion of hydrogen

C $-2 \times$ the enthalpy of formation of water

D $+2 \times$ the enthalpy of formation of water

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4 The table shows the physical properties of four substances.

Which substance has a giant covalent structure?

	melting point / °C	boiling point / °C	electrical conductivity of solid	electrical conductivity of liquid	electrical conductivity of aqueous solution
A	–119	39	poor	poor	insoluble
B	–115	–85	poor	poor	good
C	993	1695	poor	good	good
D	1610	2230	poor	poor	insoluble

5 A student mixed 25.0 cm^3 of 0.350 mol dm^{-3} sodium hydroxide solution with 25.0 cm^3 of 0.350 mol dm^{-3} hydrochloric acid. The temperature rose by 2.50 °C. Assume that no heat was lost to the surroundings.

The final mixture had a specific heat capacity of 4.20 J cm^{-3} K^{-1}.

What is the molar enthalpy change for the reaction?

A –150 kJ mol^{-1}

B –60.0 kJ mol^{-1}

C –30.0 kJ mol^{-1}

D –0.150 kJ mol^{-1}

6 $AlCl_3$ vapour forms molecules with formula Al_2Cl_6 as it is cooled.

What happens to the bond angles during the change from $AlCl_3$ to Al_2Cl_6?

A Some decrease, some remain the same.

B Some increase, some remain the same.

C They all decrease.

D They all increase.

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7 The Contact process is used in the manufacture of sulfuric acid. The equation for the main reaction is shown below.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -196\,kJ\,mol^{-1}$$

Which statement about this reaction is **incorrect**?

A Increased pressure gives a higher yield of SO_3.

B Increased temperature gives a higher yield of SO_3.

C In the forward reaction the oxidation state of sulfur changes from +4 to +6.

D Vanadium(V) oxide is used as a catalyst.

8 When making sparkler fireworks, a mixture of barium nitrate powder with aluminium powder, water and glue is coated onto wires and allowed to dry. At this stage, the following exothermic reaction may occur.

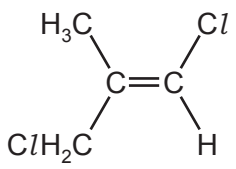
$$16Al + 3Ba(NO_3)_2 + 36H_2O \rightarrow 3Ba(OH)_2 + 16Al(OH)_3 + 6NH_3$$

Which conditions would be best to reduce the rate of this reaction during the drying process, and would also keep the aluminium and barium nitrate unchanged?

	temperature / K	pH
A	298	7
B	298	14
C	398	7
D	398	14

9 Which molecular structure will have the **smallest** overall dipole?

A



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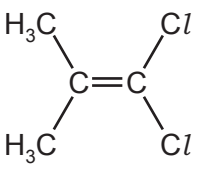

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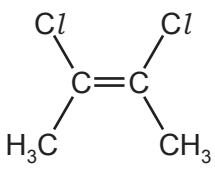

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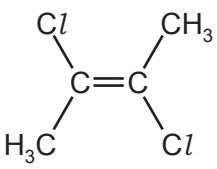

10 The equilibrium constant, K_c, for the reaction $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$, is 60 at 450 °C.

What is the number of moles of hydrogen iodide in equilibrium with 2 mol of hydrogen and 0.3 mol of iodine at 450 °C?

A $\frac{1}{100}$ **B** $\frac{1}{10}$ **C** 6 **D** 36

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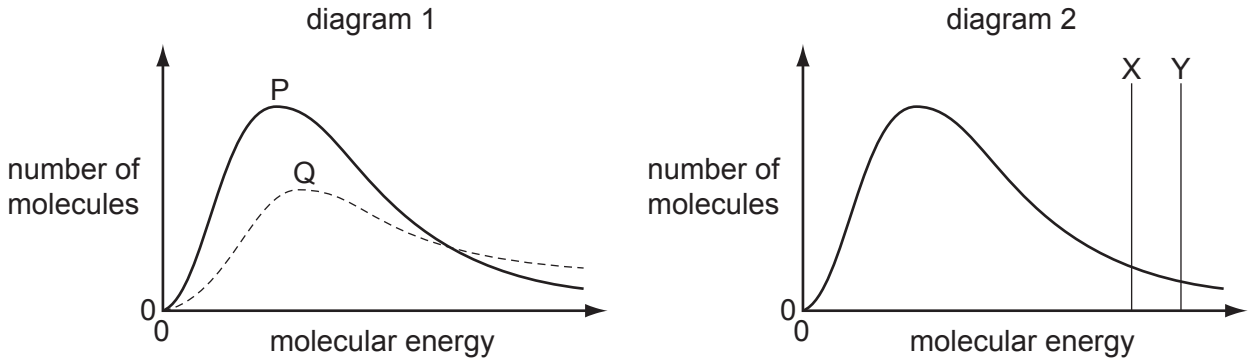
11 Boltzmann distributions are shown in the diagrams.



In diagram 1, one curve, P or Q, corresponds to a temperature higher than that of the other curve.

In diagram 2, one line, X or Y, corresponds to the activation energy in the presence of a catalyst and the other line corresponds to the activation energy of the same reaction in the absence of a catalyst.

Which combination gives the correct curve and line?

	higher temperature	presence of catalyst
A	P	X
B	P	Y
C	Q	X
D	Q	Y

12 Redox reactions occur very frequently in the chemistry of Group VII.

Which statement is correct?

A Chlorine will oxidise bromide ions but not iodide ions.

B Fluorine is the weakest oxidising agent out of F_2, Cl_2, Br_2 and I_2.

C Iodide ions are the weakest reducing agent out of F^-, Cl^-, Br^- and I^-.

D When chlorine reacts with water, chlorine is both oxidised and reduced.

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13 When equal volumes of saturated solutions of barium hydroxide and calcium hydroxide are mixed, a white precipitate, **Y**, forms. The mixture is filtered and carbon dioxide is bubbled through the filtrate, producing a second white precipitate, **Z**.

What are **Y** and **Z**?

	Y	**Z**
A	$Ba(OH)_2$	$Ca(OH)_2$
B	$Ba(OH)_2$	$CaCO_3$
C	$Ca(OH)_2$	$BaCO_3$
D	$Ca(OH)_2$	$Ba(OH)_2$

14 What is the order of increasing melting point of the four chlorides shown?

CCl_4 HCl $MgCl_2$ PCl_5

	lowest melting point →			highest melting point
A	CCl_4	HCl	PCl_5	$MgCl_2$
B	HCl	CCl_4	PCl_5	$MgCl_2$
C	HCl	PCl_5	CCl_4	$MgCl_2$
D	$MgCl_2$	PCl_5	CCl_4	HCl

15 When calcium is burnt in oxygen, what colour is the flame?

A green

B red

C white

D yellow

16 Which description of the bonding and acid / base nature of aluminium oxide is correct?

	bonding	acid / base nature
A	covalent	amphoteric
B	covalent	basic
C	ionic	amphoteric
D	ionic	basic

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17 Group II nitrates undergo thermal decomposition according to the following equation.

$$X(NO_3)_2 \rightarrow XO + 2NO_2 + \tfrac{1}{2}O_2$$

Which Group II nitrate requires the highest temperature to bring about its thermal decomposition?

A barium nitrate

B calcium nitrate

C magnesium nitrate

D strontium nitrate

18 *Use of the Data Booklet is relevant to this question.*

A chemist took 2.00 dm^3 of nitrogen gas, measured under room conditions, and reacted it with a large volume of hydrogen gas, in order to produce ammonia. Only 15.0% of the nitrogen gas reacted to produce ammonia.

What mass of ammonia was formed?

A 0.213 g **B** 0.425 g **C** 1.42 g **D** 2.83 g

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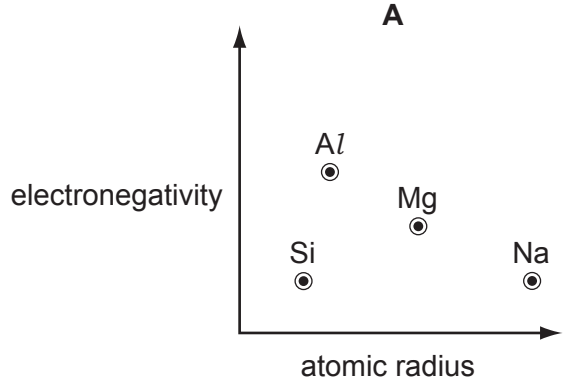
19 *Use of the Data Booklet is relevant to this question*.

Which graph correctly shows relative electronegativity plotted against relative atomic radius for the elements Na, Mg, A*l* and Si?

A



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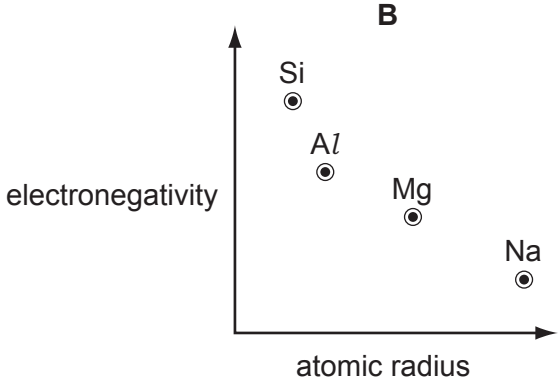

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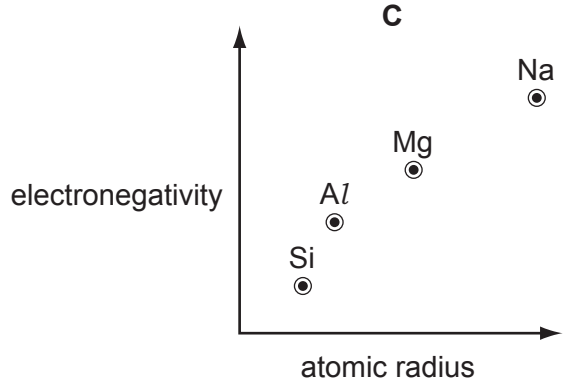

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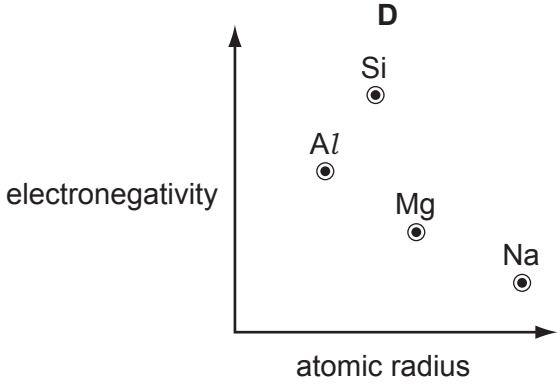

20 Many organic reactions need to be heated before reaction occurs, but some do not require heating.

Which reaction occurs quickly at room temperature?

A $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

B $C_2H_4 + H_2O \rightarrow CH_3CH_2OH$

C $CH_3CH_2OH \rightarrow C_2H_4 + H_2O$

D $CH_3CH_2OH + HBr \rightarrow CH_3CH_2Br + H_2O$

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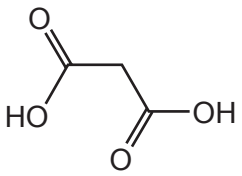
21 Hydroxyethanal, $HOCH_2CHO$, is heated under reflux with an excess of acidified potassium dichromate(VI) until no further oxidation takes place.

What is the skeletal formula of the organic product?

A



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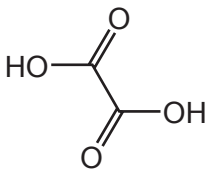

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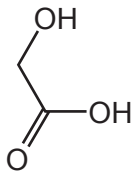

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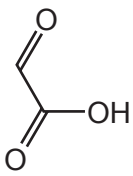
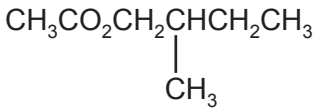
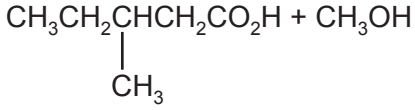
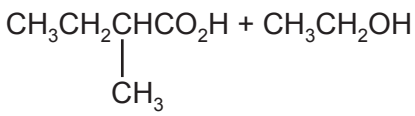


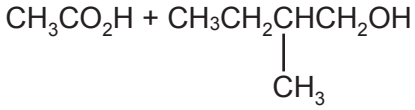
22 An ester with an odour of banana has the following formula.

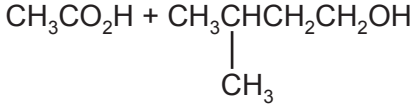


Which pair of reactants, under suitable conditions, will produce this ester?

A 

B 

C 

D 

23 The hydrolysis of 1-chloropropane to produce propan-1-ol is much slower than the corresponding hydrolysis of 1-iodopropane.

Which statement explains this observation?

A Chlorine is more electronegative than iodine.

B The bond strength of the C – I bond is less than that of the C – Cl bond.

C The carbon atom in the C – Cl bond is more $\delta+$ than that in the C – I bond.

D The hydrolysis involves a nucleophilic addition reaction.

24 There are three structural isomers with the formula C_5H_{12}.

Which formulae correctly represent these three structural isomers?

A $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH_2CHCH_3CH_3$ $CH_3CH_3CCH_3CH_3$

B $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH_2(CH)CH_3CH_3$ $C(CH_3)_4$

C $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH(CH_3)CH_2CH_3$ $CH_3C(CH_3)_2CH_3$

D $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH(CH_3)CH_2CH_3$ $CH_3CH_2CH(CH_3)CH_3$

25 $CH_3CH_2COCH_2CH_3$ reacts with hydrogen cyanide to form an organic product called a cyanohydrin.

Which feature applies to the cyanohydrin product?

A It has one chiral centre.

B It is formed by electrophilic addition.

C It is formed via an intermediate which contains the C–OH group.

D Its formation requires the use of cyanide ions as a catalyst.

26 How many moles of oxygen molecules are needed for the complete combustion of one mole of 3-methylpent-2-ene?

A 9 **B** $9\frac{1}{2}$ **C** 18 **D** 19

27 The hydrocarbon $C_{17}H_{36}$ can be cracked.

Which compound is the **least** likely to be produced in this reaction?

A C_3H_8 **B** C_4H_8 **C** C_8H_{16} **D** $C_{16}H_{34}$

28 Compound X has the molecular formula $C_4H_{10}O_2$. X has an unbranched carbon chain and contains two OH groups.

On reaction with an excess of hot, acidified, aqueous manganate(VII) ions, X is converted into a compound of molecular formula $C_4H_6O_4$.

To which two carbon atoms in the chain of X are the two OH groups attached?

A 1st and 2nd

B 1st and 3rd

C 1st and 4th

D 2nd and 3rd

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29 How many geometrical (cis-trans) isomers are there of hex-2,4-diene, $CH_3CH=CHCH=CHCH_3$?

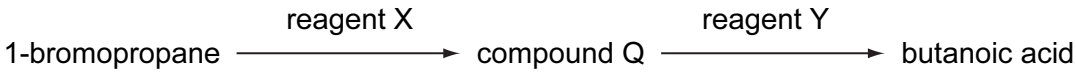
A none; hex-2,4-diene does not show geometric isomerism

B 2

C 3

D 4

30 Butanoic acid can be produced from 1-bromopropane using reagents X and Y as shown below.



What could be reagents X and Y?

	X	Y
A	KCN in ethanol	HCl(aq)
B	KCN in ethanol	NaOH(aq)
C	NH_3 in ethanol	HCl(aq)
D	NaOH(aq)	$H^+ / Cr_2O_7^{2-}$(aq)

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[Turn over

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 *Use of the Data Booklet is relevant to this question.*

When the liquid N_2F_4 is heated, it decomposes into a single product, X.

Which statements are correct?

1 N – F bonds are broken during this decomposition.

2 The enthalpy change when N_2F_4 decomposes into X is approximately +160 kJ mol^{-1}.

3 Molecules of X are non-linear.

32 P and Q are two liquid compounds with similar M_r values. Molecules of P attract each other by hydrogen bonds. Molecules of Q attract each other by van der Waals' forces only.

How do the properties of P and Q differ?

1 P has a higher surface tension than Q.

2 P is less soluble in water than Q.

3 P has a lower melting point than Q.

33 R and S react together.

$$R + S \rightleftharpoons T$$

Which factors affect the rate of the forward reaction?

1 the activation energy of the reaction

2 the enthalpy change of the reaction

3 the equilibrium constant of the reaction

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34 The Brønsted-Lowry theory describes acid and base character.

When concentrated sulfuric acid and concentrated nitric acid are mixed, the following reactions occur.

$$H_2SO_4 + HNO_3 \rightleftharpoons HSO_4^- + H_2NO_3^+$$

$$H_2NO_3^+ \rightleftharpoons H_2O + NO_2^+$$

$$H_2O + H_2SO_4 \rightleftharpoons HSO_4^- + H_3O^+$$

Which species are bases in these reactions?

1 HSO_4^-

2 HNO_3

3 NO_2^+

35 Pollutant oxide **Y**, which contains non-metallic element **X**, is formed in a car engine.

Further oxidation of **Y** to **Z** occurs in the atmosphere. In this further oxidation, 1 mol of **Y** reacts with 0.5 mol of gaseous oxygen molecules.

X could be either nitrogen or sulfur.

Which statements about **X**, **Y** and **Z** can be correct?

1 The oxidation number of **X** increases by two from **Y** to **Z**.

2 **Y** has an unpaired electron in its molecule.

3 **Y** is a polar molecule.

36 A test-tube of HI gas and a test-tube of HBr gas are placed together in an environment at temperature, T.

Which combinations of observations are possible depending on the temperature, T?

1 A brown vapour appears in one of the test-tubes. No change is apparent in the other test-tube.

2 A brown vapour appears in one of the test-tubes. A purple vapour appears in the other test-tube.

3 No change is apparent in either test-tube.

37 Which pairs of reagents will take part in a redox reaction?

1 CH_3COCH_3 + Tollens' reagent

2 CH_3CH_2CHO + Fehling's reagent

3 $CH_3CH{=}CH_2 + Br_2$

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

38 The molecule responsible for the pineapple flavour used in sweets is $CH_3CH_2CH_2CO_2CH_2CH_3$.

Which statements about this molecule are correct?

1 The name of this compound is ethyl butanoate.

2 This compound is a structural isomer of hexanoic acid.

3 When this compound is heated with aqueous sodium hydroxide, the products are butan-1-ol and sodium ethanoate.

39 The compound pentan-1,4-diol has two OH groups per molecule and can be oxidised.

Which statements about pentan-1,4-diol or its oxidation products are correct?

1 When one mole of pentan-1,4-diol reacts with an excess of sodium metal, one mole of hydrogen molecules is produced.

2 At least one of the possible oxidation products of pentan-1,4-diol will react with 2,4-dinitrophenylhydrazine reagent.

3 Dehydration of pentan-1,4-diol could produce a compound with empirical formula C_5H_8.

40 *Use of the Data Booklet is relevant to this question.*

In an organic synthesis, a 62% yield of product is achieved.

Which conversions are consistent with this information?

1 74.00 g of butan-2-ol $\rightarrow$ 44.64 g of butanone

2 74.00 g of butan-1-ol $\rightarrow$ 54.56 g of butanoic acid

3 74.00 g of 2-methylpropan-1-ol $\rightarrow$ 54.56 g of 2-methylpropanoic acid

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