Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **February/March 2016**

1 hour

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

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.

Section A

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

Use of the Data Booklet may be appropriate for some questions.

1 Which compound contains two different elements with identical oxidation states?

A HC*l*O **B** $Mg(OH)_2$ **C** Na_2SO_4 **D** $NH_4C\mathit{l}$

2 For the element sulfur, which pair of ionisation energies has the largest difference between them?

A third and fourth ionisation energies

B fourth and fifth ionisation energies

C fifth and sixth ionisation energies

D sixth and seventh ionisation energies

3 Which ion has both more electrons than protons and more protons than neutrons?
[H = $^{1}_{1}H$; D = $^{2}_{1}H$; O = $^{16}_{8}O$]

A D^- **B** H_3O^+ **C** OD^- **D** OH^-

4 Which species contains the smallest number of electrons?

A B^{3+} **B** Be^{2+} **C** H^- **D** He^+

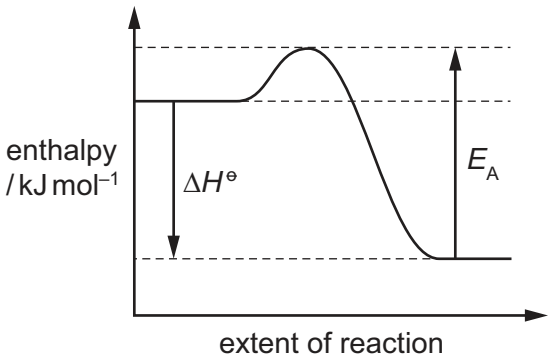
5 Nitric oxide, NO, and bromine vapour react together according to the following equation.

$$2NO(g) + Br_2(g) \rightarrow 2NOBr(g) \qquad \Delta H^{\ominus} = -23\,kJ\,mol^{-1}$$

The reaction has an activation energy of $+5.4\,kJ\,mol^{-1}$.

What is the correct reaction pathway diagram for this reaction?

A



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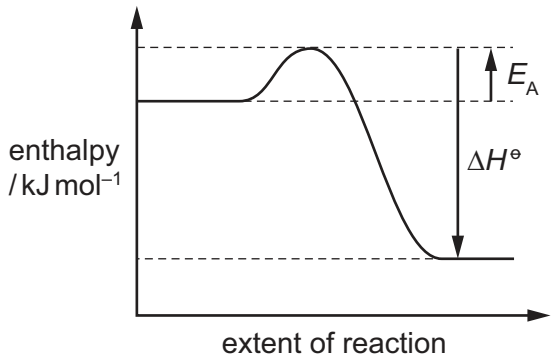

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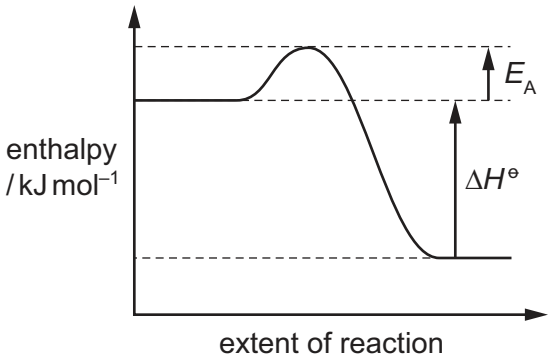

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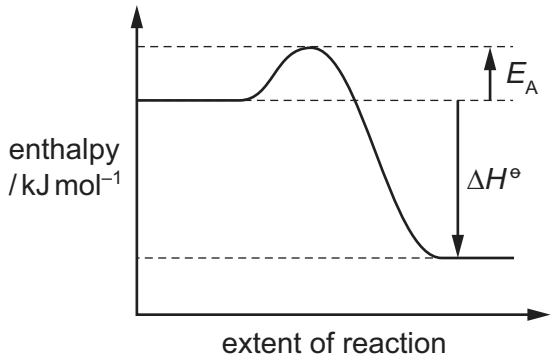


6 Which series shows molecules in order of increasing bond angle?

A $CH_4 \rightarrow BF_3 \rightarrow NH_3$

B $H_2O \rightarrow CO_2 \rightarrow BF_3$

C $NH_3 \rightarrow CH_4 \rightarrow CO_2$

D $NH_3 \rightarrow CH_4 \rightarrow H_2O$

7 What is the volume of steam produced when 1.00 g of ice is heated to 323 °C at a pressure of 101 kPa?

A $0.27\,dm^3$ **B** $1.3\,dm^3$ **C** $2.7\,dm^3$ **D** $48\,dm^3$

8 Solid carbon dioxide, CO_2, is similar to solid iodine, I_2, in its structure and properties. Carbon is in Group 14. Silica, SiO_2, is a Group 14 compound.

Which statement about solid CO_2 and solid SiO_2 is correct?

A Both solids exist in a lattice structure.

B Both solids have a simple molecular structure.

C Both solids have atoms joined by single covalent bonds.

D Both solids change spontaneously to gas at s.t.p.

9 An article in a science magazine contains the following statement.

'It is lighter than a feather, stronger than steel, yet incredibly flexible and more conductive than copper.'

Which form of carbon is being described?

A buckminsterfullerene

B diamond

C graphene

D graphite

10 Which equation has an enthalpy change of reaction which corresponds to the standard enthalpy change of atomisation of chlorine?

A $\frac{1}{2}Cl_2(g) \rightarrow Cl(g)$

B $\frac{1}{2}Cl_2(l) \rightarrow Cl(g)$

C $Cl_2(g) \rightarrow 2Cl(g)$

D $Cl_2(l) \rightarrow 2Cl(g)$

11 In an experiment, 2.00 mol of hydrogen and 3.00 mol of iodine were heated together in a sealed container and allowed to reach equilibrium at a fixed temperature. The container had a fixed volume of 1.00 dm^3. At equilibrium, there were 2.40 mol of iodine present in the mixture.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

What is the value of the equilibrium constant, K_c?

A 0.107 **B** 0.357 **C** 0.429 **D** 2.33

12 Consecutive elements **X**, **Y** and **Z** are in Period 3 of the Periodic Table. Element **Y** has the highest first ionisation energy and the lowest melting point of these three elements.

What are the identities of **X**, **Y** and **Z**?

A sodium, magnesium, aluminium

B magnesium, aluminium, silicon

C aluminium, silicon, phosphorus

D silicon, phosphorus, sulfur

13 When dealing with a spillage of metallic sodium it is important that no toxic or flammable products are formed.

Which material should be used if there is a spillage of metallic sodium?

A dilute hydrochloric acid

B ethanol

C sand

D water spray

14 Chlorine gas is widely used to treat contaminated water.

Which species present in water when chlorine gas has been added is responsible for killing bacteria?

A $Cl O_2^-$ **B** Cl^- **C** HCl **D** OCl^-

15 Which row of the table is correct?

	shape		bonds present	
	ammonia molecule	ammonium ion	ammonia molecule	ammonium ion
A	pyramidal	regular tetrahedral	σ	σ
B	pyramidal	regular tetrahedral	σ	π
C	regular tetrahedral	pyramidal	σ	σ
D	regular tetrahedral	pyramidal	π	σ

16 Hydrogen chloride gas and hydrogen iodide gas have different thermal stabilities. The difference is due to a difference in the energies of some of the covalent bonds that are involved in the decomposition.

Which row identifies the more stable of the two compounds, and gives the correct explanation?

	identity of the more thermally stable compound	explanation for the difference in stability
A	hydrogen chloride	the C*l*–C*l* bond is stronger than the I–I bond
B	hydrogen chloride	the H–C*l* bond is stronger than the H–I bond
C	hydrogen iodide	the C*l*–C*l* bond is stronger than the I–I bond
D	hydrogen iodide	the H–C*l* bond is stronger than the H–I bond

17 Ammonium sulfate, $(NH_4)_2SO_4$, and ammonium nitrate, NH_4NO_3, are used as fertilisers.

These salts have different percentages by mass of nitrogen. They have the same effect as each other on the pH of neutral soil.

Which row is correct?

	higher percentage of nitrogen by mass	effect on pH of soil
A	ammonium nitrate	decrease
B	ammonium nitrate	increase
C	ammonium sulfate	decrease
D	ammonium sulfate	increase

18 River water in a chalky agricultural area contains Ca^{2+}, Mg^{2+}, CO_3^{2-}, HCO_3^-, Cl^- and NO_3^- ions. In a water treatment plant, such water is treated by adding a calculated quantity of calcium hydroxide.

What will be precipitated from the river water following the addition of calcium hydroxide?

A $CaCl_2$ **B** $CaCO_3$ **C** $Ca(NO_3)_2$ **D** $Mg(NO_3)_2$

19 After black and white photographic film has been developed, unreacted silver bromide is removed by reaction with sodium thiosulfate.

$$AgBr + 2Na_2S_2O_3 \rightarrow 4Na^+ + Br^- + [Ag(S_2O_3)_2]^{3-}$$

What is the function of the thiosulfate ion?

A to make the silver ions soluble

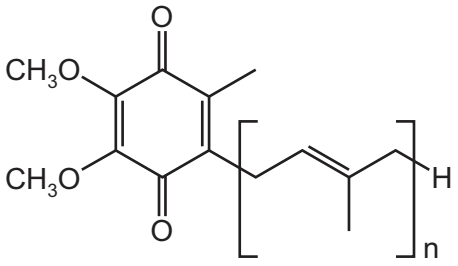
B to oxidise the silver ions

C to reduce the bromine

D to reduce the silver ions

20 People who take statin drugs to control their blood cholesterol may also take 'coenzyme Q_{10}'.

The diagram shows a simplified structure of one form of this coenzyme.

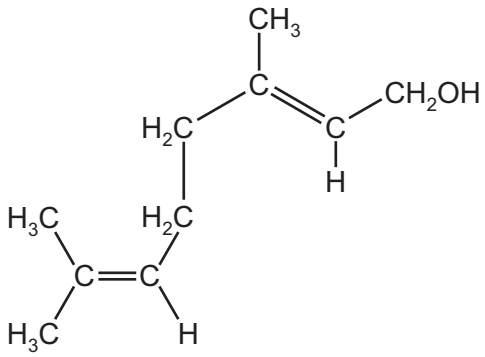


coenzyme Q_{10}

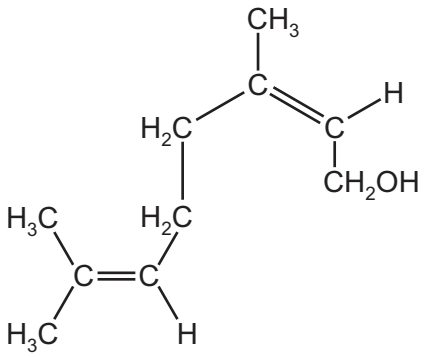
Which row describes this structure correctly?

	the coenzyme is	number of π bonds in one molecule
A	an aldehyde	$n + 2$
B	an aldehyde	$n + 4$
C	a ketone	$n + 2$
D	a ketone	$n + 4$

21 Geraniol and nerol are compounds found in some flower fragrances. They are isomers of each other.



geraniol



nerol

Which type of isomerism is shown here?

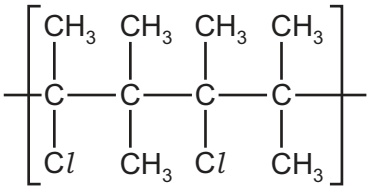
A chain

B geometrical (cis-trans)

C optical

D positional

22 A section showing two repeat units of an addition polymer is shown.



What is the identity of the monomer that produced this polymer?

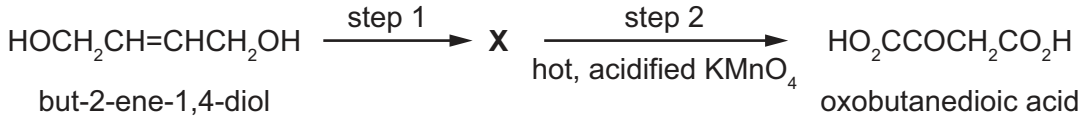
A 2-chloro-3-methylbutane

B 2-chloro-3-methylbut-2-ene

C 2-chloropent-2-ene

D 2,4-dichloro-3,3,4,5-tetramethylhexane

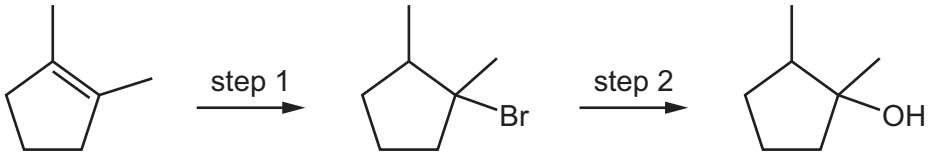
23 But-2-ene-1,4-diol is converted in two steps through an intermediate **X** into oxobutanedioic acid.



What could be the reagent for step 1 and what is the intermediate **X**?

	reagent for step 1	**X**
A	cold, acidified $KMnO_4$	$HOCH_2CH_2CH(OH)CH_2OH$
B	hot, acidified $K_2Cr_2O_7$	$HO_2CCH=CHCO_2H$
C	steam and concentrated H_2SO_4	$HOCH_2CH(OH)CH_2CH_2OH$
D	warm, acidified $K_2Cr_2O_7$	$OHCCH(OH)CH_2CHO$

24 Hydrogen bromide can be added to T to give compound U. Compound U can be hydrolysed to compound V.



Four students, W, X, Y and Z, made the following statements.

W All the atoms in a molecule of compound T lie in the same plane.

X Compound V contains only one chiral centre.

Y Step 1 is an electrophilic addition reaction.

Z Step 2 is a nucleophilic substitution reaction.

Which two students are correct?

A W and Y **B** W and Z **C** X and Y **D** Y and Z

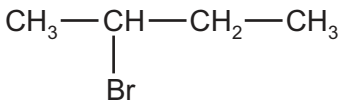
25 Structural isomerism and stereoisomerism should be considered in answering this question.

Compound J is reacted with KOH dissolved in ethanol. Three isomeric alkenes with molecular formula C_4H_8 are formed.

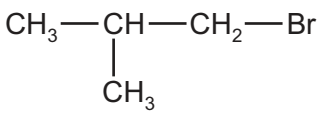
What is J?

A $CH_3—CH_2—CH_2—CH_2—Br$

B



C



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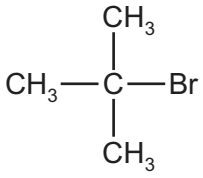
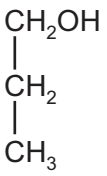
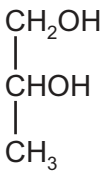
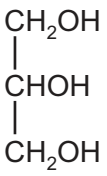
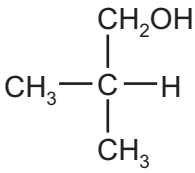
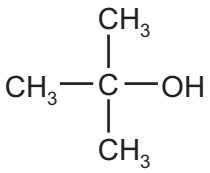
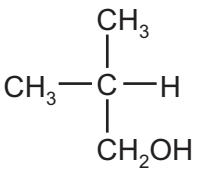
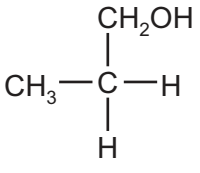
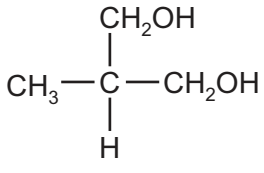
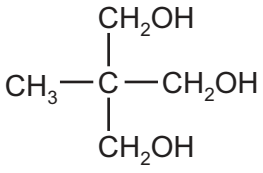
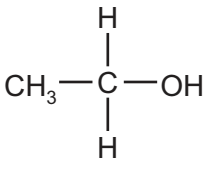
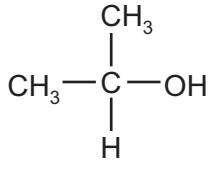
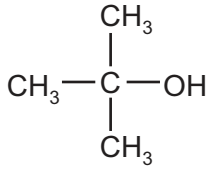
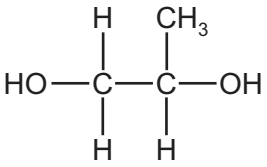


26 Which row correctly shows a primary, a secondary and a tertiary alcohol?

	primary	secondary	tertiary
A			
B			
C			
D			

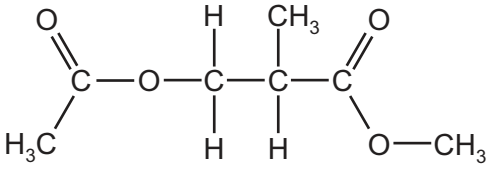
27 The fragrance compounds of perfumes are often dissolved in solvent **Y**, which has a molecular formula $C_7H_{12}O_4$. It is made by reacting propane-1,2-diol with ethanoic acid in the presence of an acid catalyst.



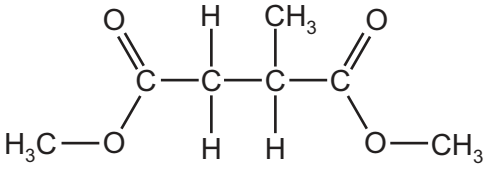
propane-1,2-diol

What is the structure of solvent **Y**?

A



B



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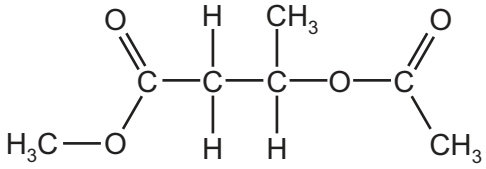

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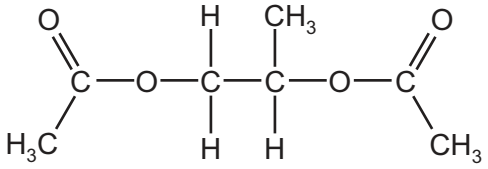


28 Which mixture could be used to produce propyl methanoate?

A $CH_3CH_2CO_2H$ and CH_3OH

B $CH_3CH_2CH_2CH_2OH$ and HCO_2H

C $CH_3CH_2CH_2OH$ and HCO_2H

D $CH_3CH_2CH_2CO_2H$ and CH_3OH

29 Which statement about poly(chloroethene) is correct?

A The polymer can be cracked to produce chlorinated alkenes.

B The polymer has harmless combustion products.

C The polymer is readily biodegradable when buried.

D The repeat unit of the polymer has an M_r of 97.

[Turn over

30 Which row of the table is correct?

	increasing number of carbon atoms ⟶			
A	ethyl methanoate	methyl propanoate	pentyl pentanoate	propyl butanoate
B	ethyl methanoate	methyl propanoate	propyl butanoate	pentyl pentanoate
C	methyl propanoate	propyl butanoate	ethyl methanoate	pentyl pentanoate
D	propyl butanoate	ethyl methanoate	pentyl pentanoate	methyl propanoate

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.

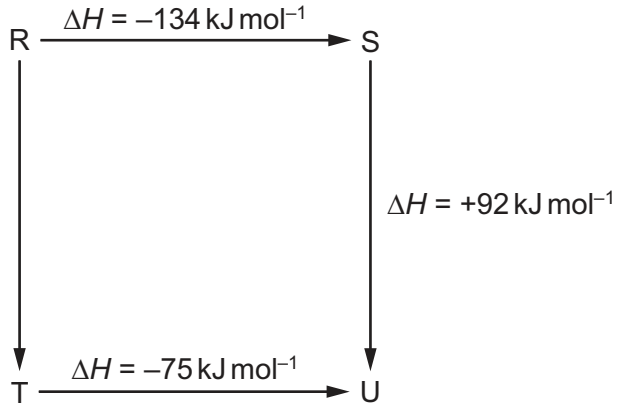
31 Which molecules have an overall dipole moment?

1 carbon monoxide, CO

2 phosphine, PH_3

3 carbon dioxide, CO_2

32 The diagram illustrates the enthalpy changes of a set of reactions



Which statements are correct?

1 The enthalpy change for the transformation U → R is +42 kJ mol^{-1}.

2 The enthalpy change for the transformation T → S is endothermic.

3 The enthalpy change for the transformation R → T is –33 kJ mol^{-1}.

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.

33 Which statements about reversible reactions are correct?

1 An increase in concentration of a reactant always increases the concentration of the product.

2 An increase in temperature always increases the rate at which the equilibrium is established.

3 An increase in temperature always increases the concentration of the product at equilibrium.

34 A chemist puts a sample of dilute aqueous hydrochloric acid into beaker 1. She adds a sample of zinc and measures the rate of production of hydrogen gas.

She then puts a different sample of dilute aqueous hydrochloric acid into beaker 2. She adds a different sample of zinc and measures the rate of production of hydrogen gas.

The rate of the reaction in beaker 2 is greater than the rate of the reaction in beaker 1.

Which factors **could** help to explain this observation?

1 The reaction in beaker 1 has a higher activation energy than the reaction in beaker 2.

2 The zinc in beaker 1 is in larger pieces than the zinc in beaker 2.

3 The acid in beaker 1 is at a lower concentration than the acid in beaker 2.

35 In some rice-growing parts of the world, farmers use a combination of paddy fields and a fish farm. Rice paddy fields are flooded for much of the growing cycle and water running off the fields flows through pens where fish are raised. Nitrogen-based fertilisers are generally very soluble in water.

Which problems could result from farmers applying excess nitrogen-based fertilisers to their paddy fields?

1 decreased fish production in the fish pens

2 decreased levels of oxygen in the water

3 increased growth of algae in the fish pens

36 A sample containing 0.40 mol of calcium nitrate was decomposed by heating in a roaring Bunsen burner flame until there was no further decomposition.

What are the products of this reaction?

1 0.40 mol of calcium oxide

2 0.40 mol of nitrogen, $N_2(g)$

3 0.40 mol of oxygen, $O_2(g)$

37 Which reagents, when used in an excess, can be used to make sodium lactate, $CH_3CH(OH)CO_2Na$, from lactic acid, $CH_3CH(OH)CO_2H$?

1 Na

2 $NaHCO_3$

3 NaOH

38 Chlorine atoms in the upper atmosphere cause the breakdown of ozone.

$$Cl + O_3 \rightarrow O_2 + ClO$$

$$ClO + O \rightarrow Cl + O_2$$

Which statements are correct when referring to these chlorine atoms?

1 The chlorine atoms act as catalysts.

2 The chlorine atoms are free radicals.

3 The chlorine atoms are formed by heterolytic fission of a covalent bond in chlorofluorocarbons.

39 An unknown organic compound **Z** reacts with sodium to give a combustible gas as one product. **Z** does **not** give a yellow precipitate with alkaline aqueous iodine.

What is a possible identity of **Z**?

1 ethanoic acid

2 pentan-3-ol

3 propan-1-ol

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.

40 Compound **X** has the molecular formula $C_3H_6O_3$.

Heating **X** under reflux with acidified $K_2Cr_2O_7$ forms HO_2CCOCO_2H.

Reacting **X** with $NaBH_4$ forms $HOCH_2CH(OH)CH_2OH$.

What is a possible structural formula for **X**?

1 $HOCH_2CH_2CO_2H$

2 $HOCH_2CH(OH)CHO$

3 $HOCH_2COCH_2OH$