

CHEMISTRY

9701/11

Paper 1 Multiple Choice

October/November 2017

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.

This document consists of **15** printed pages and **1** blank page.



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.

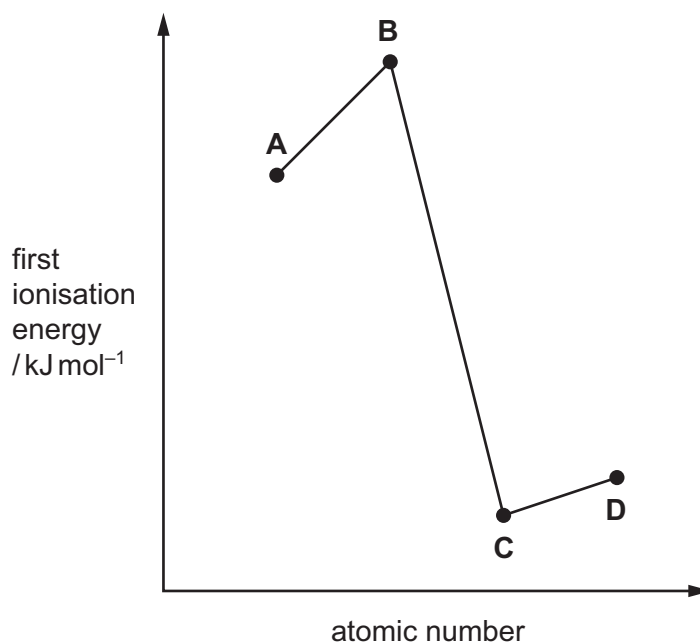
- 1 Which formula represents the empirical formula of a compound?

A $\text{C}_2\text{H}_4\text{O}$ **B** $\text{C}_2\text{H}_4\text{O}_2$ **C** C_6H_{12} **D** H_2O_2

- 2 The relative first ionisation energies of four elements with consecutive atomic numbers below 20 are shown on the graph.

One of the elements reacts with hydrogen to form a covalent compound with formula HX .

Which element could be X?



- 3 In which structure are three atoms bonded together in a straight line?

A poly(ethene), $-(\text{CH}_2\text{CH}_2)_n-$
B propane, C_3H_8
C silicon tetrachloride, SiCl_4
D sulfur hexafluoride, SF_6

- 4 In the sodium chloride lattice the number of chloride ions that surround each sodium ion is called the *co-ordination number* of the sodium ions.

What are the co-ordination numbers of the sodium ions and the chloride ions in the sodium chloride lattice?

	sodium ions	chloride ions
A	4	6
B	6	4
C	6	6
D	8	6

- 5 A fluorescent light tube has an internal volume of 400 cm^3 and an internal pressure of 200 kPa.

It is filled with 0.03 moles of an ideal gas.

What is the temperature of the gas inside the fluorescent light tube?

- A** $3.21 \times 10^{-1}\text{ K}$
B $3.21 \times 10^2\text{ K}$
C $3.21 \times 10^5\text{ K}$
D $3.21 \times 10^8\text{ K}$

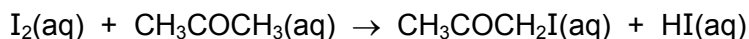
- 6 One of the reactions in a lead / acid cell is shown.



Which statement about this reaction is correct?

- A** Lead is both oxidised and reduced.
B Lead is neither oxidised nor reduced.
C Lead is oxidised only.
D Lead is reduced only.

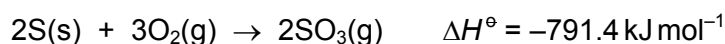
- 7 Iodine and propanone react according to the following equation.



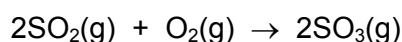
If the concentration of propanone is increased, keeping the total reaction volume constant, the rate of the reaction also increases.

What could be the reason for this?

- A** A greater proportion of collisions is successful at the higher concentration.
 - B** The particles are further apart at the higher concentration.
 - C** The particles have more energy at the higher concentration.
 - D** There are more collisions between reactant particles per second at the higher concentration.
- 8 Sulfur can be oxidised in two ways.

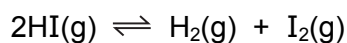


Sulfur trioxide can be made from sulfur dioxide and oxygen.



What is the standard enthalpy change for this reaction?

- A** $-1384.4 \text{ kJ mol}^{-1}$
 - B** $-989.8 \text{ kJ mol}^{-1}$
 - C** $-494.9 \text{ kJ mol}^{-1}$
 - D** $-198.4 \text{ kJ mol}^{-1}$
- 9 Hydrogen iodide dissociates into hydrogen and iodine.

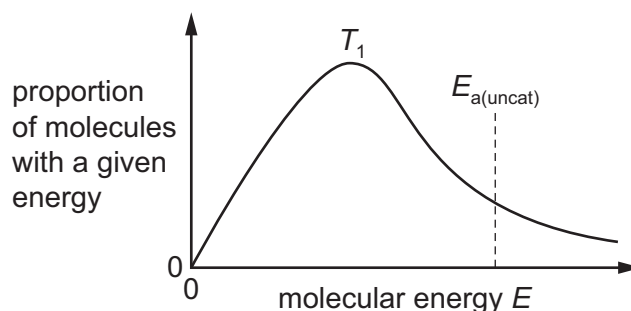


In an experiment, b mol of hydrogen iodide were put into a sealed vessel at pressure p . At equilibrium, x mol of the hydrogen iodide had dissociated.

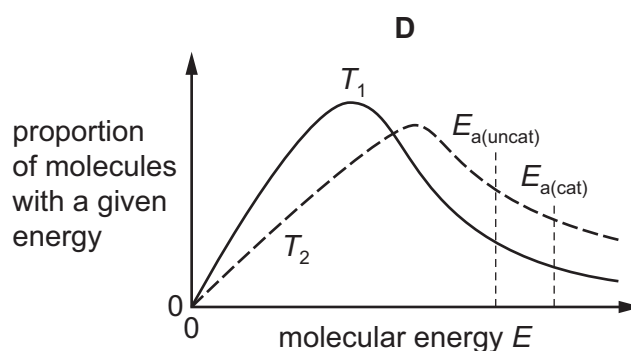
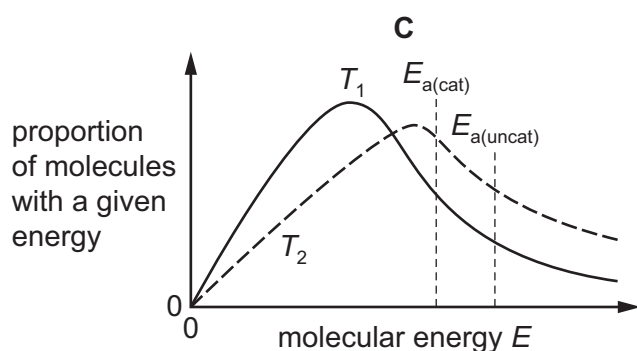
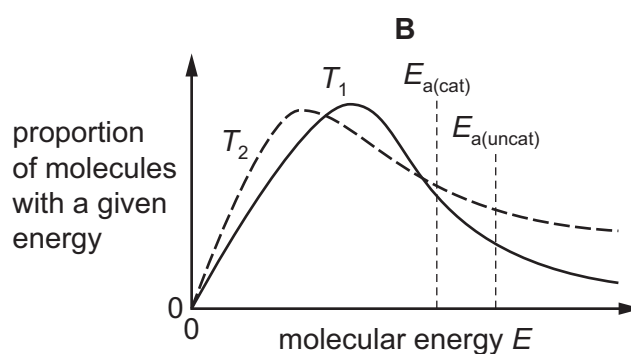
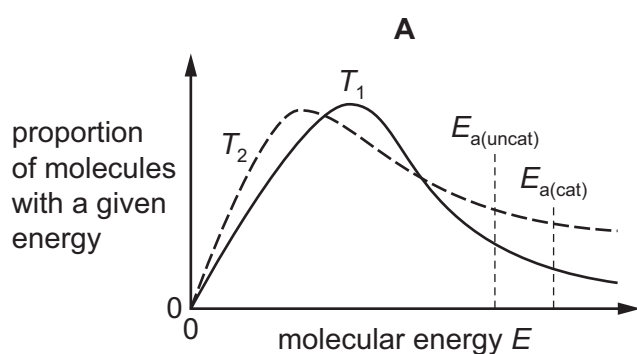
Which expression for K_p is correct?

- A** $\frac{x^2}{(b-x)^2}$
- B** $\frac{x^2 p^2}{(b-x)^2}$
- C** $\frac{x^2 p^2}{4b(b-x)}$
- D** $\frac{x^2}{4(b-x)^2}$

- 10 The diagram shows the distribution of molecular energies in a sample of gas at a temperature T_1 . The activation energy for an uncatalysed reaction of this gas, $E_{a(\text{uncat})}$, is shown.



Which diagram correctly shows the new distribution and new activation energy, $E_{a(\text{cat})}$, when the temperature is increased to T_2 , and a catalyst is used that increases the rate of the reaction?



- 11 200 g of water are at 25 °C.

The water is heated to 75 °C by burning 2 g of ethanol.

What is the amount of energy transferred to the water?

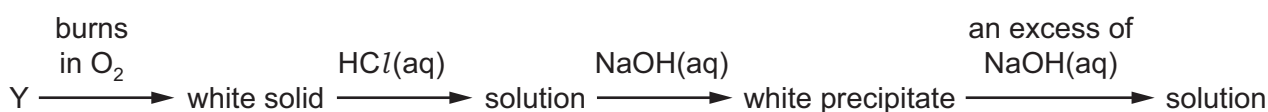
- A** 0.418 kJ **B** 10.4 kJ **C** 41.8 kJ **D** 62.7 kJ

12 The elements *Cl*, *Mg*, *Si* and *S* are all in Period 3.

What is the correct sequence of the melting points of these elements, from lowest to highest?

	lowest melting point		→	highest melting point	
A	<i>Cl</i>	<i>S</i>		<i>Mg</i>	<i>Si</i>
B	<i>Cl</i>	<i>S</i>		<i>Si</i>	<i>Mg</i>
C	<i>Mg</i>	<i>Si</i>		<i>S</i>	<i>Cl</i>
D	<i>Si</i>	<i>Mg</i>		<i>S</i>	<i>Cl</i>

13 An element *Y* reacts according to the following sequence.



What could be element *Y*?

- A** *Al* **B** *Ca* **C** *Mg* **D** *P*

14 Which compound would most usually be added to soil to reduce its acidity?

- A** aluminium hydroxide
B calcium hydroxide
C magnesium hydroxide
D sodium hydroxide

15 The mineral dolomite is a mixture of magnesium carbonate and calcium carbonate.

An aqueous reagent, *X*, was added to a small sample of dolomite. Effervescence was seen and a white solid, *Y*, was formed.

What could be the correct identity of reagent *X* and solid *Y*?

	reagent <i>X</i>	solid <i>Y</i>
A	hydrochloric acid	calcium chloride
B	hydrochloric acid	magnesium chloride
C	sulfuric acid	calcium sulfate
D	sulfuric acid	magnesium sulfate

16 Which fertiliser contains the greatest percentage of nitrogen by mass?

- A ammonium nitrate, NH_4NO_3
- B ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$
- C diammonium hydrogen phosphate, $(\text{NH}_4)_2\text{HPO}_4$
- D urea, $\text{CO}(\text{NH}_2)_2$

17 71.0g of chlorine, Cl_2 , react with an excess of sodium hydroxide solution at a particular temperature. The reaction produces exactly 35.5g of product X.

What is product X?

- A H_2O
- B NaCl
- C NaClO
- D NaClO_3

18 Compound Q is a white crystalline solid which dissolves easily in water. When concentrated sulfuric acid is added to a dry sample of Q steamy white fumes are formed which, when passed through aqueous silver nitrate solution, form a white precipitate. This precipitate is soluble in dilute ammonia solution.

What could be the identity of compound Q?

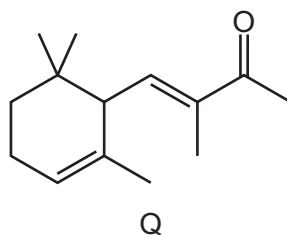
- A AgCl
- B NaBr
- C NaCl
- D PbBr_2

19 The strengths of the covalent bonds within halogen molecules, and the van der Waals' forces between halogen molecules, vary going down Group 17 from chlorine to bromine to iodine.

Which row shows these correctly?

	strength of covalent bonds	strength of van der Waals' forces
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

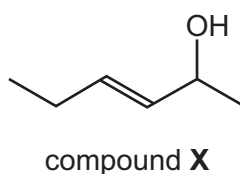
20 The structural formula of compound Q is shown.



How many stereoisomers exist with this structural formula?

- A** 1 **B** 2 **C** 4 **D** 8

21 What is the name of compound X?



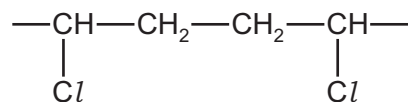
- A** *trans*-2-hydroxyhex-3-ene
B *trans*-2-hydroxyhexene
C *trans*-5-hydroxyhex-3-ene
D *trans*-5-hydroxyhexene

22 Many, but not all, organic reactions need to be heated before a reaction occurs.

Which reaction occurs quickly at room temperature, 20 °C?

- A** $\text{C}_2\text{H}_4 + \text{Br}_2 \rightarrow \text{C}_2\text{H}_4\text{Br}_2$
B $\text{C}_2\text{H}_4 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{OH}$
C $\text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{C}_2\text{H}_4 + \text{H}_2\text{O}$
D $\text{CH}_3\text{CH}_2\text{OH} + \text{HBr} \rightarrow \text{CH}_3\text{CH}_2\text{Br} + \text{H}_2\text{O}$

23 A section of an addition polymer chain is shown.



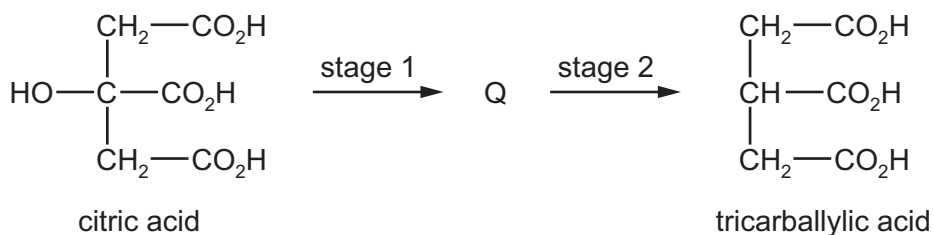
Which monomer could be used to make this polymer?

- A $\text{CH}_2\text{CHCH}_2\text{Cl}$
- B CH_2CHCl
- C CH_3CHCHCl
- D $\text{CHClCHCH}_2\text{CH}_2\text{Cl}$

24 Which organic reaction is an example of nucleophilic substitution?

- A $\text{CH}_3\text{CH}_2\text{Br} + \text{NaOH} \rightarrow \text{CH}_2\text{CH}_2 + \text{H}_2\text{O} + \text{NaBr}$
- B $\text{CH}_3\text{CH}_2\text{Br} + \text{NaOH} \rightarrow \text{CH}_3\text{CH}_2\text{OH} + \text{NaBr}$
- C $\text{CH}_2\text{CH}_2 + \text{HCl} \rightarrow \text{C}_2\text{H}_5\text{Cl}$
- D $\text{C}_2\text{H}_6 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{HCl}$

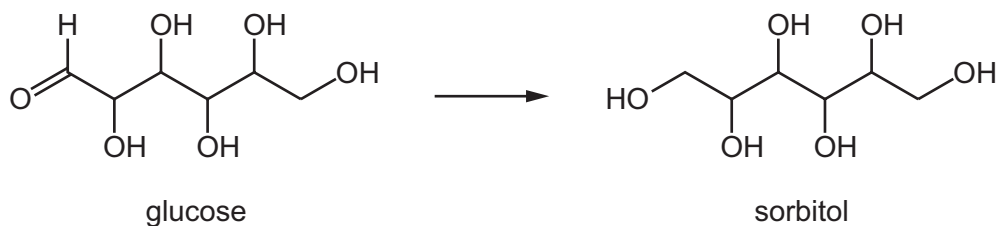
25 Citric acid can be converted into tricarballic acid in two stages. An intermediate, Q, is formed.



Which reagents are needed for each stage?

	stage 1	stage 2
A	concentrated H_2SO_4	$\text{H}_2(\text{g})$ and Ni
B	concentrated H_2SO_4	LiAlH_4
C	LiAlH_4	$\text{H}_2\text{SO}_4(\text{aq})$
D	$\text{NaOH}(\text{aq})$	$\text{H}_2(\text{g})$ and Ni

- 26 Glucose can be used to prepare sorbitol, a compound used as a sugar substitute.



Which reagent may be used for this conversion?

- A acidified potassium dichromate(VI)
 - B sodium borohydride
 - C sodium hydroxide
 - D Tollens' reagent
- 27 3-methylbutanone is treated with alkaline aqueous iodine. The mixture of products is then acidified.
- Which compound is present in the final mixture of products?
- A 3-methylbutanoic acid
 - B butanoic acid
 - C methylpropanoic acid
 - D propanoic acid
- 28 At room temperature, propanoic acid was reacted to produce sodium propanoate. No gas was produced during the reaction.

What could the propanoic acid have reacted with?

- A $\text{NaHCO}_3(\text{aq})$
- B $\text{NaOH}(\text{aq})$
- C $\text{Na}_2\text{CO}_3(\text{aq})$
- D $\text{Na}_2\text{SO}_4(\text{aq})$

- 29** Ethene is reacted with steam in the presence of concentrated H_3PO_4 . The product of this reaction is added to acidified potassium dichromate(VI) and heated under reflux for one hour. The final organic product is collected and labelled X.

But-2-ene is treated with hot, concentrated, acidified potassium manganate(VII). The final organic product is collected and labelled Y.

Which statement is correct?

- A** One molecule of X has more carbon atoms than one molecule of Y.
 - B** One molecule of Y has more carbon atoms than one molecule of X.
 - C** X and Y have different functional groups.
 - D** X is the same compound as Y.
- 30** A sample of the ester $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}_3$ is hydrolysed. The product mixture is then treated with hot, acidified KMnO_4 .

What are the final carbon-containing products?

- A** $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$ only
- B** $\text{CH}_3\text{CO}_2\text{H} + \text{CH}_3\text{CH}_2\text{CO}_2\text{H}$
- C** $\text{CH}_3\text{CO}_2\text{H} + \text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$
- D** $\text{CH}_3\text{CH}_2\text{OH} + \text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$

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.

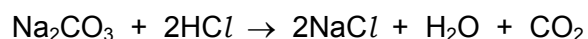
Use of the Data Booklet may be appropriate for some questions.

31 The definitions of many chemical terms can be illustrated by chemical equations.

Which terms can be illustrated by an equation that includes the formation of a positive ion?

- 1** first ionisation energy
- 2** heterolytic fission of a covalent bond
- 3** enthalpy change of atomisation

32 A student makes sodium chloride by reacting together 0.025 mol of sodium carbonate with an excess of 0.2 mol dm⁻³ hydrochloric acid.



Which statements about the quantities of substance are correct?

- 1** 600 cm³ of carbon dioxide are produced at room temperature and pressure.
- 2** 250 cm³ of the hydrochloric acid are needed to exactly neutralise the sodium carbonate.
- 3** 1.46 g of sodium chloride are produced.

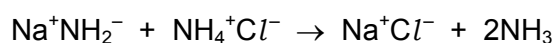
- 33** One way of recovering tin from old printed circuit boards is to dissolve it in a mixture of concentrated hydrochloric acid and concentrated nitric acid. The tin dissolves because it reacts with the mixture of these concentrated acids.



Which statements about this reaction are correct?

- 1 Nitrogen is present in three different oxidation states in the reactants and products.
- 2 The oxidation state of tin increases from 0 to +4.
- 3 The oxidation state of chlorine remains the same.

- 34** The following reaction takes place in a suitable solvent.



Which statements explain why this reaction should be classified as a Brønsted-Lowry acid-base reaction?

- 1 The ammonium ion acts as a proton donor.
- 2 Na^+Cl^- is a salt.
- 3 Ammonia is a nucleophile.

- 35** Which statements about the elements barium and calcium and their compounds are correct?

- 1 Barium nitrate decomposes at a higher temperature than calcium nitrate.
- 2 Barium hydroxide is more soluble in water than is calcium hydroxide.
- 3 Calcium is more reactive with water than is barium.

- 36** Which statements explain why nitrogen gas is unreactive?

- 1 Nitrogen atoms are highly electronegative.
- 2 Nitrogen molecules are non-polar.
- 3 The triple bond between nitrogen atoms is very strong.

- 37** In which molecules do all the carbon atoms lie in the same plane?

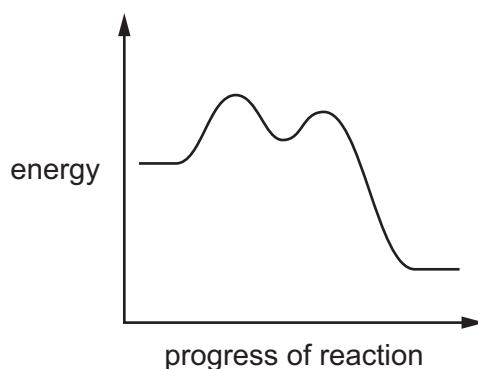
- 1 2,3-dimethylbut-2-ene
- 2 propane
- 3 cyclohexane

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 A reaction pathway diagram is shown.

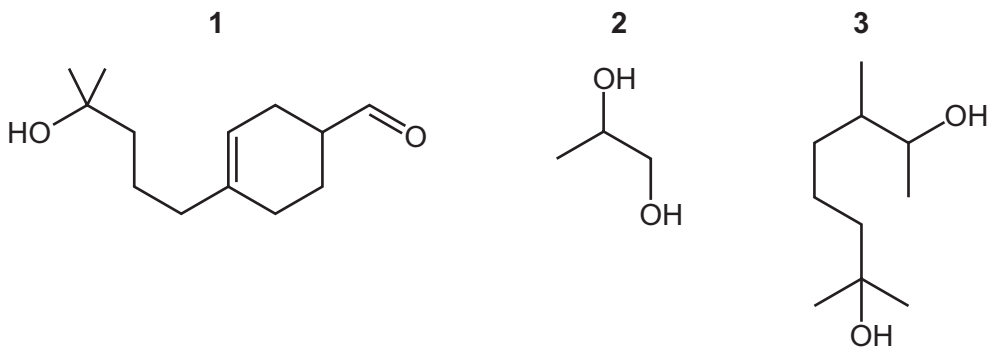


Which reactions would have this reaction pathway diagram?

- 1** $(\text{CH}_3)_3\text{CBr} + \text{NaOH} \rightarrow (\text{CH}_3)_3\text{COH} + \text{NaBr}$
- 2** $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br} + \text{NaOH} \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + \text{NaBr}$
- 3** $(\text{CH}_3)_3\text{CCH}_2\text{CH}_2\text{Cl} + 2\text{NH}_3 \rightarrow (\text{CH}_3)_3\text{CCH}_2\text{CH}_2\text{NH}_2 + \text{NH}_4\text{Cl}$

39 The compounds below are used to make perfumes.

Which compounds will produce a yellow precipitate with alkaline aqueous iodine?



- 40** The reaction of ethanal, CH_3CHO , with HCN to form 2-hydroxypropanenitrile is catalysed by NaCN .

What are features of the intermediate of this reaction?

- 1** It is chiral.
- 2** It has a single negative charge on one of its atoms.
- 3** It is a nucleophile.

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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.

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

1 In which pair do the atoms contain the same number of neutrons?

- A** ^{11}B and ^{12}C
B ^7Li and ^9Be
C ^{24}Mg and ^{28}Si
D ^{14}N and ^{16}O

2 Two hydrocarbons have the formulae C_WH_X and C_YH_Z . W, X, Y and Z represent different whole numbers.

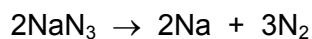
$$\frac{W}{X} = \frac{Y}{Z}$$

Which row is correct when comparing the two hydrocarbons?

	empirical formula	molecular formula	relative molecular mass
A	different	same	different
B	different	same	same
C	same	different	different
D	same	different	same

3 The airbags in cars contain sodium azide, NaN_3 , and an excess of potassium nitrate, KNO_3 .

In a car accident, the reactions shown occur, producing nitrogen. This causes the airbag to inflate rapidly.



How many moles of nitrogen gas are produced **in total** when 1 mol of sodium azide, NaN_3 , decomposes in an airbag?

- A** 1.5 **B** 1.6 **C** 3.2 **D** 4.0

- 4 Ethane burns in oxygen to produce carbon dioxide and water vapour.

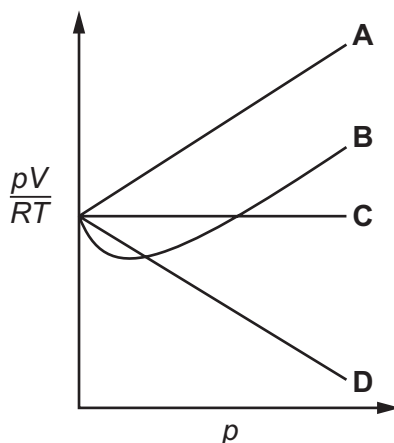
Which bond angles are present in the molecules of ethane and its combustion products?

	ethane	combustion products
A	90°	104.5° and 180°
B	90°	109.5° and 120°
C	109.5°	104.5° and 180°
D	109.5°	109.5° and 180°

- 5 A sample of an ideal gas is contained at a constant temperature of 300 K in a gas syringe.

The pressure is increased and a graph of $\frac{pV}{RT}$ against pressure is plotted.

Which graph correctly represents the results?



- 6 In calculating the enthalpy change, ΔH , of an experiment involving solutions, the mass of the solution, m , specific heat capacity of the solution, c , and the temperature change, ΔT , are needed.

$$\Delta T = T_{\text{final}} - T_{\text{initial}}$$

Which expression for ΔH is correct?

- A** $\Delta H = \frac{mc}{\Delta T}$ **B** $\Delta H = \frac{-mc}{\Delta T}$ **C** $\Delta H = mc\Delta T$ **D** $\Delta H = -mc\Delta T$

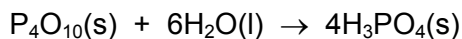
- 7 The following data are needed for this question.

$$\Delta H_f^\ominus (\text{P}_4\text{O}_{10}(\text{s})) = -3012 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\ominus (\text{H}_2\text{O}(\text{l})) = -286 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\ominus (\text{H}_3\text{PO}_4(\text{s})) = -1279 \text{ kJ mol}^{-1}$$

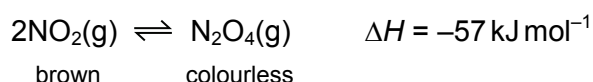
What is $\Delta H^\ominus$ for the reaction shown?



- A $-9844 \text{ kJ mol}^{-1}$
 B -388 kJ mol^{-1}
 C -97 kJ mol^{-1}
 D $+2019 \text{ kJ mol}^{-1}$
- 8 Which statement is **always** correct for an oxidation reaction?
- A It involves the gain of oxygen by an element.
 B For one reactant to be oxidised a different reactant must be reduced.
 C The element or ion being oxidised will gain electrons.
 D The oxidation number of the element being oxidised will increase.
- 9 Nitrogen dioxide, NO_2 , is a brown gas.

Dinitrogen tetroxide, N_2O_4 , is a colourless gas.

An equilibrium is established between NO_2 and N_2O_4 in a closed vessel.



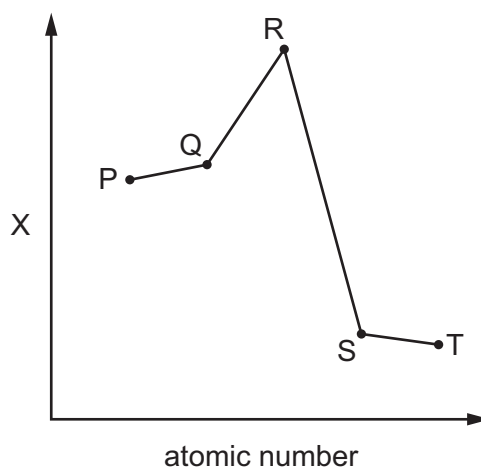
Which row describes the effects of changing conditions on the colour of an equilibrium mixture of NO_2 and N_2O_4 ?

	increasing the pressure	increasing the temperature
A	colour becomes darker	colour becomes darker
B	colour becomes darker	colour becomes lighter
C	colour becomes lighter	colour becomes darker
D	colour becomes lighter	colour becomes lighter

- 10 A large excess of marble chips was reacted with 25 cm^3 of 1.0 mol dm^{-3} hydrochloric acid at 40°C .

How will the result be different when the reaction is repeated with 60 cm^3 of 0.5 mol dm^{-3} hydrochloric acid at 40°C ?

- A The reaction is faster and less of the products are made.
 B The reaction is faster and more of the products are made.
 C The reaction is slower and less of the products are made.
 D The reaction is slower and more of the products are made.
- 11 Which change alters the activation energy of a given reaction?
- A adding a suitable catalyst
 B changing the particle size of the reactants
 C changing the pressure at which the reaction is carried out
 D changing the temperature at which the reaction is carried out
- 12 The relative magnitude of the property X of five elements is shown. P, Q, R, S and T are all in Period 3 and have consecutive atomic numbers.



Which row shows a correct pairing of property X and element R?

	property X	element R
A	electrical conductivity	Al
B	electronegativity	Si
C	melting point	Al
D	second ionisation energy	Si

- 13 Element Z has a giant structure.

The chloride of Z reacts with water to give a solution with a pH less than 5.

Which row shows two elements which could be Z?

- A aluminium, magnesium
- B aluminium, silicon
- C phosphorus, magnesium
- D phosphorus, silicon

- 14 Radium is an element below barium in Group 2 of the Periodic Table.

Which equation shows what happens when solid radium nitrate, $\text{Ra}(\text{NO}_3)_2$, is heated strongly?

- A $\text{Ra}(\text{NO}_3)_2(\text{s}) \rightarrow \text{RaO}(\text{s}) + \text{N}_2\text{O}(\text{g}) + 2\text{O}_2(\text{g})$
- B $2\text{Ra}(\text{NO}_3)_2(\text{s}) \rightarrow 2\text{RaO}(\text{s}) + 2\text{N}_2(\text{g}) + 5\text{O}_2(\text{g})$
- C $2\text{Ra}(\text{NO}_3)_2(\text{s}) \rightarrow 2\text{RaO}(\text{s}) + 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$
- D $4\text{Ra}(\text{NO}_3)_2(\text{s}) \rightarrow 2\text{Ra}_2\text{O}(\text{s}) + 8\text{NO}_2(\text{g}) + 3\text{O}_2(\text{g})$

- 15 Exactly 3.705 kg of substance Y are needed to neutralise 100 moles of $\text{HCl}(\text{aq})$.

What could be substance Y?

- A Ca
- B CaO
- C $\text{Ca}(\text{OH})_2$
- D CaCO_3

- 16 In an experiment, 0.125 mol of chlorine gas, Cl_2 , is reacted with an excess of cold, aqueous sodium hydroxide. One of the products is a compound of sodium, oxygen and chlorine.

Which mass of this product is formed?

- A 9.31 g
- B 13.3 g
- C 18.6 g
- D 26.6 g

- 17 Sodium bromide reacts with concentrated sulfuric acid.

Which observation will be made?

- A A coloured vapour is produced.
- B A purple solid is formed.
- C A strong smell of H_2S is detected.
- D Yellow sulfur is formed.

- 18 The reaction of nitrogen and oxygen to produce oxides of nitrogen happens at high temperatures in car engines or lightning strikes during thunderstorms.

What is the main reason for these reactions requiring such high temperatures?

- A the lack of reactivity of nitrogen, due to the half-filled 2p subshell in the nitrogen atom
- B the lack of reactivity of nitrogen, due to the strength of the bond in N_2
- C the lack of reactivity of oxygen, due to electron-electron repulsion in one of its 2p orbitals
- D the lack of reactivity of oxygen, due to the strength of the bond in O_2

- 19 X is a mixture of two compounds of Group 2 elements.

X undergoes thermal decomposition to produce a white solid and only two gaseous products. One of the gaseous products relights a glowing splint.

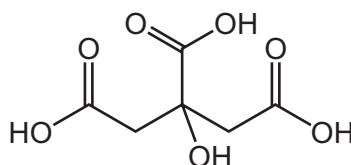
What could be the components of mixture X?

- A $MgCl_2$ and $CaCO_3$
- B $MgCO_3$ and $Ca(NO_3)_2$
- C $Mg(NO_3)_2$ and $Ca(NO_3)_2$
- D MgO and CaO

- 20 Which compound does **not** exhibit stereoisomerism?

- A $CH_3CHClCH_2CHO$
- B $CH_3CHCHCH_3$
- C $CH_2ClCH_2CCl_2H$
- D $CHClCHCl$

- 21 The diagram shows the skeletal formula of citric acid.

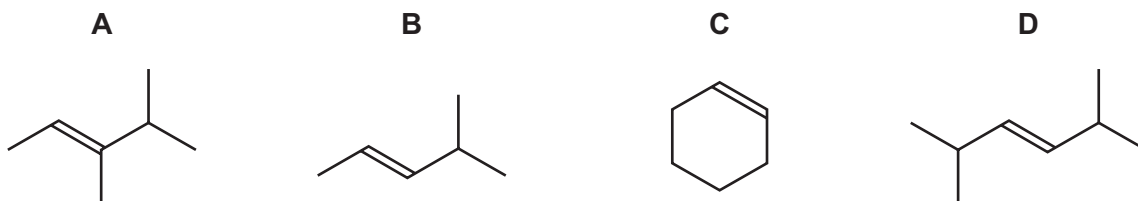


citric acid

What is the molecular formula of citric acid?

- A $C_6H_8O_7$
- B $C_6H_4O_7$
- C $C_8H_8O_7$
- D $C_{10}H_8O_7$

- 22 Which compound would produce two different carboxylic acids when treated with hot, concentrated, acidified manganate(VII) ions?



- 23 Which types of bond are broken and formed in the addition polymerisation of alkenes?

	type of bond broken	type of bond formed
A	π only	σ only
B	π only	σ and π
C	σ and π	σ only
D	σ and π	σ and π

- 24 2,3-dimethylpent-2-ene, $(\text{CH}_3)_2\text{C}=\text{C}(\text{CH}_3)\text{CH}_2\text{CH}_3$, is treated with cold, dilute KMnO_4 . The product of this reaction is treated with an excess of concentrated H_2SO_4 at 180°C , giving a mixture of isomeric hydrocarbons with molecular formula C_7H_{12} .

What is the name of one of the isomeric hydrocarbons?

- A** 2,3-dimethylpenta-1,2-diene
B cis-2,3-dimethylpenta-1,3-diene
C 2,3-dimethylpenta-1,4-diene
D 3,4-dimethylpenta-1,3-diene
- 25 Equal volumes of aqueous silver nitrate were added to separate small volumes of bromoethane and iodoethane in two test-tubes. The test-tubes were shaken.

Which row about the observations made for **bromoethane** is correct?

	colour of precipitate	rate of reaction
A	cream	faster than for iodoethane
B	cream	slower than for iodoethane
C	yellow	faster than for iodoethane
D	yellow	slower than for iodoethane

26 Many, but not all, organic reactions need to be heated before a reaction occurs.

Which reaction occurs quickly at room temperature (20 °C)?

- A** $\text{CH}_3\text{OH} + \text{PCl}_5 \rightarrow \text{CH}_3\text{Cl} + \text{POCl}_3 + \text{HCl}$
B $\text{CH}_3\text{CH}_2\text{Br} + \text{KCN} \rightarrow \text{CH}_3\text{CH}_2\text{CN} + \text{KBr}$
C $\text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{C}_2\text{H}_4 + \text{H}_2\text{O}$
D $\text{CH}_3\text{CH}_2\text{CN} + 2\text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{CO}_2\text{H} + \text{NH}_3$

27 When compound X is warmed with dilute, acidified potassium dichromate(VI) there is no colour change. X does not give an orange precipitate with 2,4-dinitrophenylhydrazine reagent.

What could X be?

- A** butan-2-ol
B ethanal
C methylpropan-2-ol
D propanone

28 What are the **only** structures formed when butan-2-ol is heated with concentrated H_2SO_4 ?

A	$\begin{array}{c} \text{CH}_3\text{CH}_2 \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C}=\text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad \text{H} \end{array}$ $\begin{array}{c} \text{CH}_3 \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C}=\text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad \text{CH}_3 \end{array}$
B	$\begin{array}{c} \text{CH}_3 \quad \text{CH}_3 \\ \diagdown \quad \diagup \\ \text{C}=\text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad \text{H} \end{array}$ $\begin{array}{c} \text{CH}_3 \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C}=\text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad \text{CH}_3 \end{array}$ $\begin{array}{c} \text{H} \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C}=\text{C} \\ \diagup \quad \diagdown \\ \text{CH}_3\text{CH}_2 \quad \text{H} \end{array}$
C	$\begin{array}{c} \text{H} \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C}=\text{C} \\ \diagup \quad \diagdown \\ \text{CH}_3\text{CH}_2 \quad \text{H} \end{array}$ $\begin{array}{c} \text{H} \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C}=\text{C} \\ \diagup \quad \diagdown \\ \text{CH}_3 \quad \text{CH}_3 \end{array}$
D	$\begin{array}{c} \text{CH}_3 \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C}=\text{C} \\ \diagup \quad \diagdown \\ \text{CH}_3 \quad \text{H} \end{array}$ $\begin{array}{c} \text{CH}_3\text{CH}_2 \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C}=\text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad \text{H} \end{array}$ $\begin{array}{c} \text{H} \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C}=\text{C} \\ \diagup \quad \diagdown \\ \text{CH}_3 \quad \text{CH}_3 \end{array}$

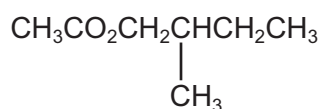
29 Compound G

- has a chiral centre,
- gives a positive result with alkaline aqueous iodine,
- does not give a silver mirror with Tollens' reagent.

What could compound G be?

- A** 1-hydroxybutan-2-one
B 2-hydroxybutanal
C 3-hydroxybutanal
D 3-hydroxybutan-2-one

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



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

- A** $\begin{array}{c} \text{CH}_3\text{CH}_2\text{CHCH}_2\text{CO}_2\text{H} \\ | \\ \text{CH}_3 \end{array} + \text{CH}_3\text{OH}$
B $\begin{array}{c} \text{CH}_3\text{CH}_2\text{CHCO}_2\text{H} \\ | \\ \text{CH}_3 \end{array} + \text{CH}_3\text{CH}_2\text{OH}$
C $\text{CH}_3\text{CO}_2\text{H} + \begin{array}{c} \text{CH}_3\text{CH}_2\text{CHCH}_2\text{OH} \\ | \\ \text{CH}_3 \end{array}$
D $\text{CH}_3\text{CO}_2\text{H} + \begin{array}{c} \text{CH}_3\text{CHCH}_2\text{CH}_2\text{OH} \\ | \\ \text{CH}_3 \end{array}$

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.

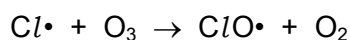
Use of the Data Booklet may be appropriate for some questions.

- 31** In 2011 an international group of scientists agreed to add two new elements to the Periodic Table. Both elements had been made artificially and are called flerovium, *Fl*, and livermorium, *Lv*.

	<i>Fl</i>	<i>Lv</i>
proton number	114	116
nucleon number	289	292

From the information about atoms in the table, which statements are correct?

- 1** One atom of *Lv* has one more neutron than one atom of *Fl*.
 - 2** One Fl^{2-} ion has the same number of electrons as one atom of *Lv*.
 - 3** One Lv^+ ion has the same number of electrons as one Fl^- ion.
- 32** The chlorine oxide free radical, $ClO\cdot$, is produced by the reaction between chlorine atoms and ozone.



Which features are present in the chlorine oxide free radical?

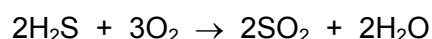
- 1** an odd number of electrons
- 2** a single covalent bond
- 3** a dative covalent bond from oxygen to chlorine

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** Hydrogen sulfide can be oxidised to form sulfur dioxide.



Which statements are correct?

- 1** The oxidation number of sulfur increases by 6.
- 2** The oxidation number of oxygen increases by 2.
- 3** The oxidation number of hydrogen decreases.

- 34** Methanoic acid, HCO_2H , and hydrocyanic acid, HCN , can both behave as acids.

A solution of methanoic acid has a lower pH than a solution of hydrocyanic acid of the same concentration.

Which statements explain this?

- 1** HCO_2H molecules dissociate more fully than HCN molecules do.
- 2** Each HCO_2H molecule has two hydrogen atoms; each HCN molecule only has one.
- 3** Methanoic acid is a weaker acid than hydrocyanic acid.

- 35** Which statements correctly describe a trend on going down Group 2?

- 1** Reactivity of the elements increases.
- 2** First ionisation energy of the elements decreases.
- 3** The hydroxides become more soluble in water.

- 36** Modern cars are fitted with catalytic converters to reduce atmospheric pollution caused by unwanted reactions during the combustion of the fuel.

Which statements are correct?

- 1** Carbon monoxide is oxidised to carbon dioxide in a catalytic converter.
- 2** Catalytic converters have a very large surface area.
- 3** Nitrogen dioxide is reduced to nitrogen monoxide in a catalytic converter.

37 Which statements are correct for an S_N2 mechanism?

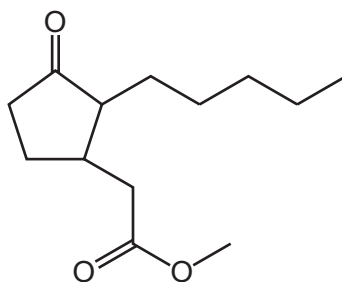
- 1 One bond is being broken at the same time as another bond is being formed.
- 2 The formation of the intermediate involves the collision of two molecules or ions.
- 3 A carbon atom in the transition state is bonded, either fully or partially, to five atoms.

38 Bromoethane is heated under reflux with concentrated aqueous NaOH.

Which statements are correct?

- 1 The major product is a primary alcohol.
- 2 The major reaction is hydrolysis by an S_N2 mechanism.
- 3 The major product would be the same if the NaOH is dissolved in ethanol.

39 Compound M is an important ingredient in perfume.



compound M

M reacts with HCN.

Which statements about this reaction are correct?

- 1 A small amount of NaOH will speed up the reaction.
- 2 The reaction is initiated by the transfer of a proton to one of the C=O groups.
- 3 Both of the C=O groups react with HCN.

40 Carboxylic acids can be converted into their salts by a number of reactions at room temperature.

Which reactions would produce sodium butanoate and a gas?

- 1 sodium carbonate + butanoic acid
- 2 sodium + butanoic acid
- 3 sodium hydroxide + butanoic acid

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CHEMISTRY

9701/13

Paper 1 Multiple Choice

October/November 2017

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.

This document consists of **15** printed pages and **1** blank page.

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.

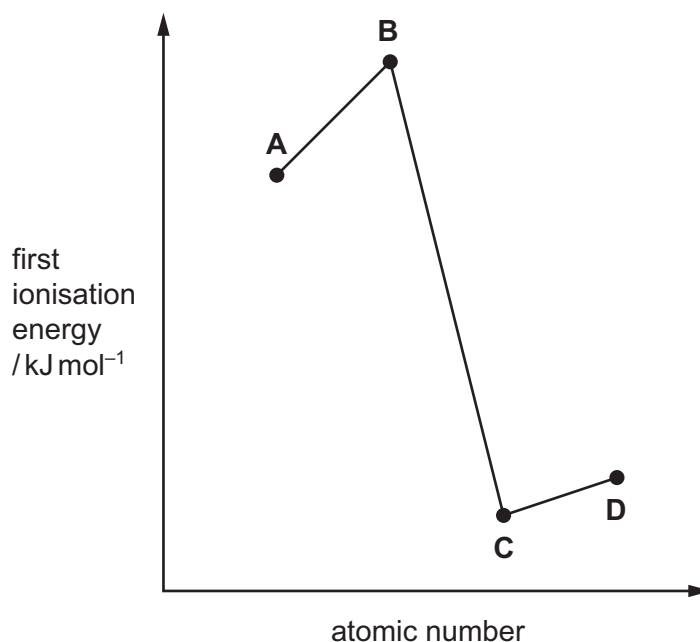
- 1 Which formula represents the empirical formula of a compound?

A $\text{C}_2\text{H}_4\text{O}$ **B** $\text{C}_2\text{H}_4\text{O}_2$ **C** C_6H_{12} **D** H_2O_2

- 2 The relative first ionisation energies of four elements with consecutive atomic numbers below 20 are shown on the graph.

One of the elements reacts with hydrogen to form a covalent compound with formula HX .

Which element could be X?



- 3 In which structure are three atoms bonded together in a straight line?

A poly(ethene), $-(\text{CH}_2\text{CH}_2)_n-$
B propane, C_3H_8
C silicon tetrachloride, SiCl_4
D sulfur hexafluoride, SF_6

- 4 In the sodium chloride lattice the number of chloride ions that surround each sodium ion is called the *co-ordination number* of the sodium ions.

What are the co-ordination numbers of the sodium ions and the chloride ions in the sodium chloride lattice?

	sodium ions	chloride ions
A	4	6
B	6	4
C	6	6
D	8	6

- 5 A fluorescent light tube has an internal volume of 400 cm^3 and an internal pressure of 200 kPa.

It is filled with 0.03 moles of an ideal gas.

What is the temperature of the gas inside the fluorescent light tube?

- A** $3.21 \times 10^{-1}\text{ K}$
B $3.21 \times 10^2\text{ K}$
C $3.21 \times 10^5\text{ K}$
D $3.21 \times 10^8\text{ K}$

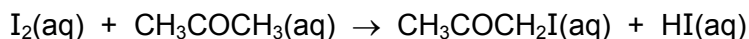
- 6 One of the reactions in a lead / acid cell is shown.



Which statement about this reaction is correct?

- A** Lead is both oxidised and reduced.
B Lead is neither oxidised nor reduced.
C Lead is oxidised only.
D Lead is reduced only.

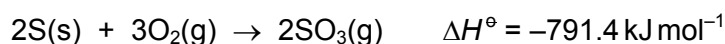
- 7 Iodine and propanone react according to the following equation.



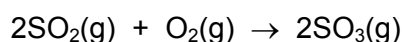
If the concentration of propanone is increased, keeping the total reaction volume constant, the rate of the reaction also increases.

What could be the reason for this?

- A** A greater proportion of collisions is successful at the higher concentration.
 - B** The particles are further apart at the higher concentration.
 - C** The particles have more energy at the higher concentration.
 - D** There are more collisions between reactant particles per second at the higher concentration.
- 8 Sulfur can be oxidised in two ways.

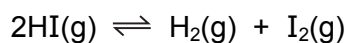


Sulfur trioxide can be made from sulfur dioxide and oxygen.



What is the standard enthalpy change for this reaction?

- A** $-1384.4 \text{ kJ mol}^{-1}$
 - B** $-989.8 \text{ kJ mol}^{-1}$
 - C** $-494.9 \text{ kJ mol}^{-1}$
 - D** $-198.4 \text{ kJ mol}^{-1}$
- 9 Hydrogen iodide dissociates into hydrogen and iodine.

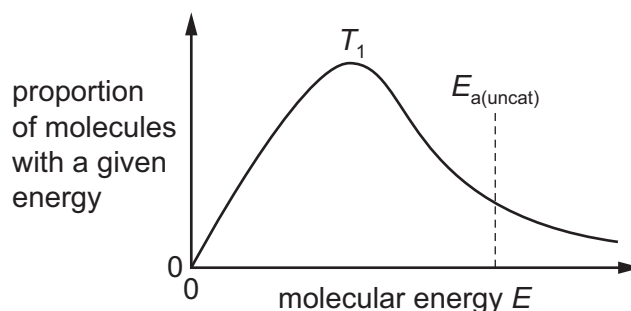


In an experiment, b mol of hydrogen iodide were put into a sealed vessel at pressure p . At equilibrium, x mol of the hydrogen iodide had dissociated.

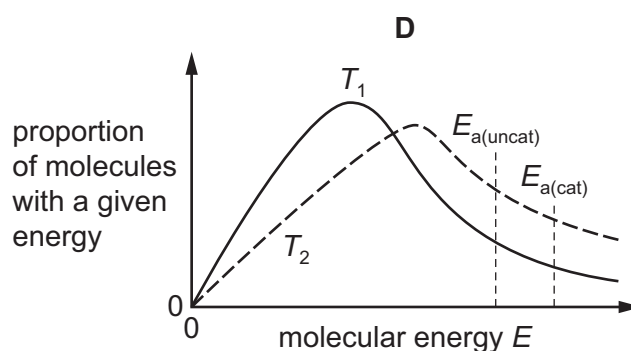
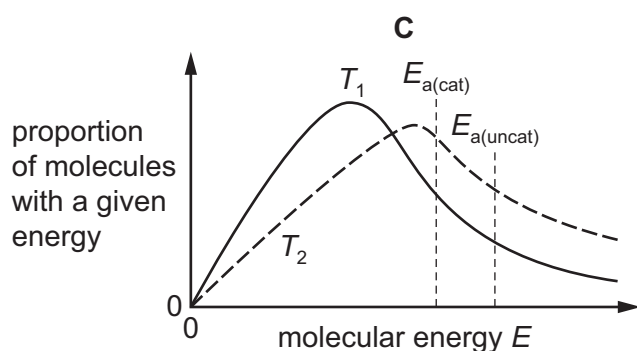
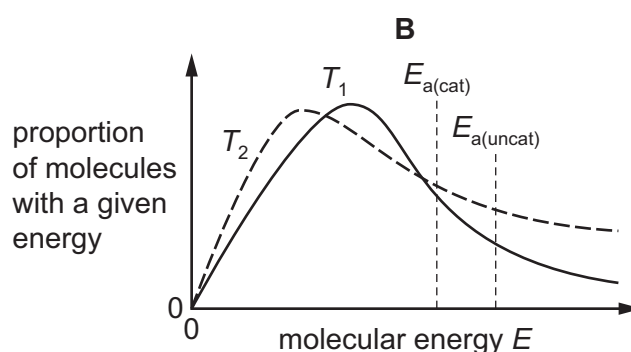
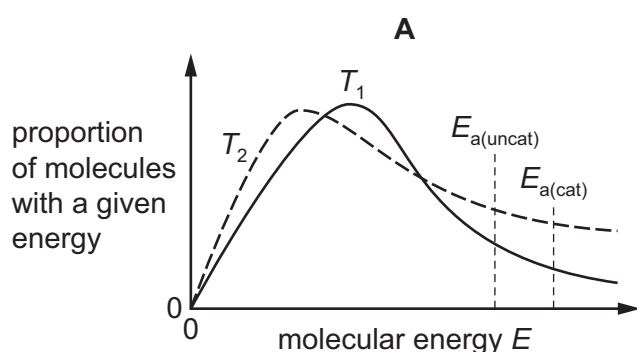
Which expression for K_p is correct?

- A** $\frac{x^2}{(b-x)^2}$
- B** $\frac{x^2 p^2}{(b-x)^2}$
- C** $\frac{x^2 p^2}{4b(b-x)}$
- D** $\frac{x^2}{4(b-x)^2}$

- 10 The diagram shows the distribution of molecular energies in a sample of gas at a temperature T_1 . The activation energy for an uncatalysed reaction of this gas, $E_{a(\text{uncat})}$, is shown.



Which diagram correctly shows the new distribution and new activation energy, $E_{a(\text{cat})}$, when the temperature is increased to T_2 , and a catalyst is used that increases the rate of the reaction?



- 11 200 g of water are at 25 °C.

The water is heated to 75 °C by burning 2 g of ethanol.

What is the amount of energy transferred to the water?

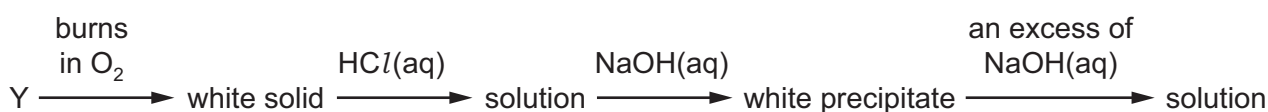
- A** 0.418 kJ **B** 10.4 kJ **C** 41.8 kJ **D** 62.7 kJ

12 The elements Cl, Mg, Si and S are all in Period 3.

What is the correct sequence of the melting points of these elements, from lowest to highest?

	lowest melting point		→	highest melting point	
A	Cl	S	Mg	Si	
B	Cl	S	Si	Mg	
C	Mg	Si	S	Cl	
D	Si	Mg	S	Cl	

13 An element Y reacts according to the following sequence.



What could be element Y?

- A** Al **B** Ca **C** Mg **D** P

14 Which compound would most usually be added to soil to reduce its acidity?

- A** aluminium hydroxide
B calcium hydroxide
C magnesium hydroxide
D sodium hydroxide

15 The mineral dolomite is a mixture of magnesium carbonate and calcium carbonate.

An aqueous reagent, X, was added to a small sample of dolomite. Effervescence was seen and a white solid, Y, was formed.

What could be the correct identity of reagent X and solid Y?

	reagent X	solid Y
A	hydrochloric acid	calcium chloride
B	hydrochloric acid	magnesium chloride
C	sulfuric acid	calcium sulfate
D	sulfuric acid	magnesium sulfate

16 Which fertiliser contains the greatest percentage of nitrogen by mass?

- A ammonium nitrate, NH_4NO_3
- B ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$
- C diammonium hydrogen phosphate, $(\text{NH}_4)_2\text{HPO}_4$
- D urea, $\text{CO}(\text{NH}_2)_2$

17 71.0g of chlorine, Cl_2 , react with an excess of sodium hydroxide solution at a particular temperature. The reaction produces exactly 35.5g of product X.

What is product X?

- A H_2O
- B NaCl
- C NaClO
- D NaClO_3

18 Compound Q is a white crystalline solid which dissolves easily in water. When concentrated sulfuric acid is added to a dry sample of Q steamy white fumes are formed which, when passed through aqueous silver nitrate solution, form a white precipitate. This precipitate is soluble in dilute ammonia solution.

What could be the identity of compound Q?

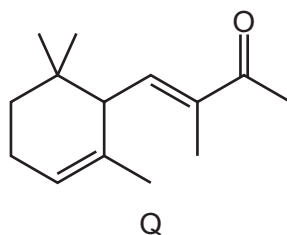
- A AgCl
- B NaBr
- C NaCl
- D PbBr_2

19 The strengths of the covalent bonds within halogen molecules, and the van der Waals' forces between halogen molecules, vary going down Group 17 from chlorine to bromine to iodine.

Which row shows these correctly?

	strength of covalent bonds	strength of van der Waals' forces
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

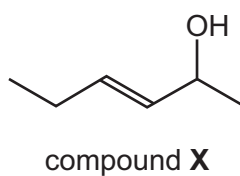
20 The structural formula of compound Q is shown.



How many stereoisomers exist with this structural formula?

- A** 1 **B** 2 **C** 4 **D** 8

21 What is the name of compound X?



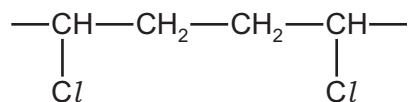
- A** *trans*-2-hydroxyhex-3-ene
B *trans*-2-hydroxyhexene
C *trans*-5-hydroxyhex-3-ene
D *trans*-5-hydroxyhexene

22 Many, but not all, organic reactions need to be heated before a reaction occurs.

Which reaction occurs quickly at room temperature, 20 °C?

- A** $\text{C}_2\text{H}_4 + \text{Br}_2 \rightarrow \text{C}_2\text{H}_4\text{Br}_2$
B $\text{C}_2\text{H}_4 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{OH}$
C $\text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{C}_2\text{H}_4 + \text{H}_2\text{O}$
D $\text{CH}_3\text{CH}_2\text{OH} + \text{HBr} \rightarrow \text{CH}_3\text{CH}_2\text{Br} + \text{H}_2\text{O}$

23 A section of an addition polymer chain is shown.



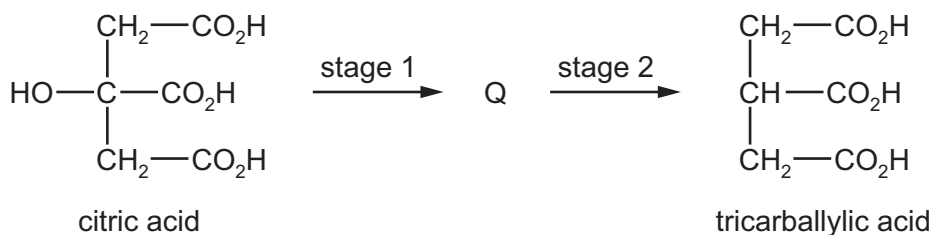
Which monomer could be used to make this polymer?

- A $\text{CH}_2\text{CHCH}_2\text{Cl}$
- B CH_2CHCl
- C CH_3CHCHCl
- D $\text{CHClCHCH}_2\text{CH}_2\text{Cl}$

24 Which organic reaction is an example of nucleophilic substitution?

- A $\text{CH}_3\text{CH}_2\text{Br} + \text{NaOH} \rightarrow \text{CH}_2\text{CH}_2 + \text{H}_2\text{O} + \text{NaBr}$
- B $\text{CH}_3\text{CH}_2\text{Br} + \text{NaOH} \rightarrow \text{CH}_3\text{CH}_2\text{OH} + \text{NaBr}$
- C $\text{CH}_2\text{CH}_2 + \text{HCl} \rightarrow \text{C}_2\text{H}_5\text{Cl}$
- D $\text{C}_2\text{H}_6 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{HCl}$

25 Citric acid can be converted into tricarballic acid in two stages. An intermediate, Q, is formed.



Which reagents are needed for each stage?

	stage 1	stage 2
A	concentrated H_2SO_4	$\text{H}_2(\text{g})$ and Ni
B	concentrated H_2SO_4	LiAlH_4
C	LiAlH_4	$\text{H}_2\text{SO}_4(\text{aq})$
D	$\text{NaOH}(\text{aq})$	$\text{H}_2(\text{g})$ and Ni



- A** acidified potassium dichromate(VI)
B sodium borohydride
C sodium hydroxide
D Tollens' reagent

- Which compound is present in the final mixture of products?

- A** 3-methylbutanoic acid
B butanoic acid
C methylpropanoic acid
D propanoic acid

- What could the propanoic acid have reacted with?

- A** $\text{NaHCO}_3(\text{aq})$ **B** $\text{NaOH}(\text{aq})$ **C** $\text{Na}_2\text{CO}_3(\text{aq})$ **D** $\text{Na}_2\text{SO}_4(\text{aq})$

- 29** Ethene is reacted with steam in the presence of concentrated H_3PO_4 . The product of this reaction is added to acidified potassium dichromate(VI) and heated under reflux for one hour. The final organic product is collected and labelled X.

But-2-ene is treated with hot, concentrated, acidified potassium manganate(VII). The final organic product is collected and labelled Y.

Which statement is correct?

- A** One molecule of X has more carbon atoms than one molecule of Y.
 - B** One molecule of Y has more carbon atoms than one molecule of X.
 - C** X and Y have different functional groups.
 - D** X is the same compound as Y.
- 30** A sample of the ester $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}_3$ is hydrolysed. The product mixture is then treated with hot, acidified KMnO_4 .

What are the final carbon-containing products?

- A** $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$ only
- B** $\text{CH}_3\text{CO}_2\text{H} + \text{CH}_3\text{CH}_2\text{CO}_2\text{H}$
- C** $\text{CH}_3\text{CO}_2\text{H} + \text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$
- D** $\text{CH}_3\text{CH}_2\text{OH} + \text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$

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.

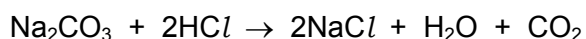
Use of the Data Booklet may be appropriate for some questions.

31 The definitions of many chemical terms can be illustrated by chemical equations.

Which terms can be illustrated by an equation that includes the formation of a positive ion?

- 1** first ionisation energy
- 2** heterolytic fission of a covalent bond
- 3** enthalpy change of atomisation

32 A student makes sodium chloride by reacting together 0.025 mol of sodium carbonate with an excess of 0.2 mol dm⁻³ hydrochloric acid.



Which statements about the quantities of substance are correct?

- 1** 600 cm³ of carbon dioxide are produced at room temperature and pressure.
- 2** 250 cm³ of the hydrochloric acid are needed to exactly neutralise the sodium carbonate.
- 3** 1.46 g of sodium chloride are produced.

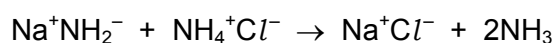
- 33 One way of recovering tin from old printed circuit boards is to dissolve it in a mixture of concentrated hydrochloric acid and concentrated nitric acid. The tin dissolves because it reacts with the mixture of these concentrated acids.



Which statements about this reaction are correct?

- 1 Nitrogen is present in three different oxidation states in the reactants and products.
- 2 The oxidation state of tin increases from 0 to +4.
- 3 The oxidation state of chlorine remains the same.

- 34 The following reaction takes place in a suitable solvent.



Which statements explain why this reaction should be classified as a Brønsted-Lowry acid-base reaction?

- 1 The ammonium ion acts as a proton donor.
- 2 Na^+Cl^- is a salt.
- 3 Ammonia is a nucleophile.

- 35 Which statements about the elements barium and calcium and their compounds are correct?

- 1 Barium nitrate decomposes at a higher temperature than calcium nitrate.
- 2 Barium hydroxide is more soluble in water than is calcium hydroxide.
- 3 Calcium is more reactive with water than is barium.

- 36 Which statements explain why nitrogen gas is unreactive?

- 1 Nitrogen atoms are highly electronegative.
- 2 Nitrogen molecules are non-polar.
- 3 The triple bond between nitrogen atoms is very strong.

- 37 In which molecules do all the carbon atoms lie in the same plane?

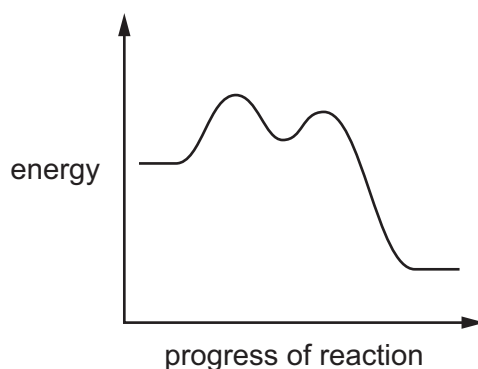
- 1 2,3-dimethylbut-2-ene
- 2 propane
- 3 cyclohexane

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 A reaction pathway diagram is shown.

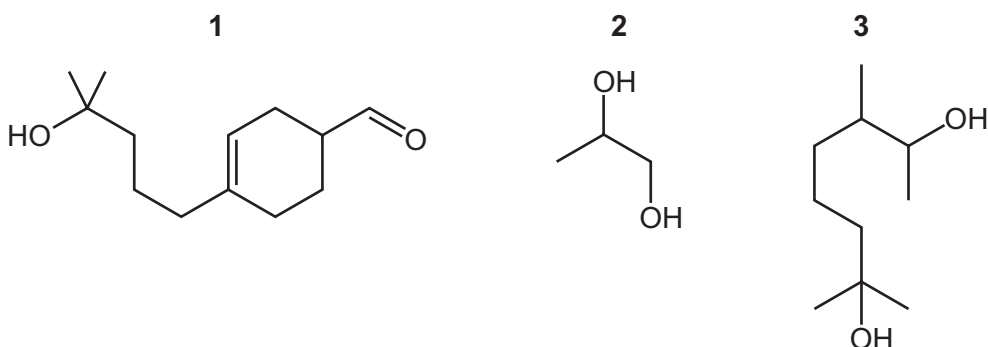


Which reactions would have this reaction pathway diagram?

- 1** $(\text{CH}_3)_3\text{CBr} + \text{NaOH} \rightarrow (\text{CH}_3)_3\text{COH} + \text{NaBr}$
- 2** $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br} + \text{NaOH} \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + \text{NaBr}$
- 3** $(\text{CH}_3)_3\text{CCH}_2\text{CH}_2\text{Cl} + 2\text{NH}_3 \rightarrow (\text{CH}_3)_3\text{CCH}_2\text{CH}_2\text{NH}_2 + \text{NH}_4\text{Cl}$

39 The compounds below are used to make perfumes.

Which compounds will produce a yellow precipitate with alkaline aqueous iodine?



- 40** The reaction of ethanal, CH_3CHO , with HCN to form 2-hydroxypropanenitrile is catalysed by NaCN .

What are features of the intermediate of this reaction?

- 1** It is chiral.
- 2** It has a single negative charge on one of its atoms.
- 3** It is a nucleophile.

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