



Cambridge International AS & A Level

CHEMISTRY

9701/13

Paper 1 Multiple Choice

October/November 2020

1 hour

You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data booklet

INSTRUCTIONS

- 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 multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
- Any rough working should be done on this question paper.

This document has **16** pages. Blank pages are indicated.



Section A

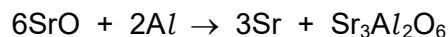
For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider to be correct.

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

1 Which statement is correct?

- A** Cl has a relative isotopic mass of 35.5.
- B** Cl_2 has a relative molecular mass of 70.
- C** ICl has a relative molecular mass of 162.4.
- D** NaCl has a relative molecular mass of 58.5.

2 Strontium metal can be extracted from strontium oxide, SrO , by reduction with aluminium. One of the possible reactions is shown.



What is the maximum mass of strontium metal that can be produced from the reduction of 100 g of strontium oxide using this reaction?

- A** 41.3 g **B** 42.3 g **C** 84.6 g **D** 169.2 g

3 A single ^{32}P nucleus can be produced when a single ^{32}S nucleus joins with particle X. In the process a proton is emitted.

What is particle X?

- A** a deuteron, $^2_1\text{H}^+$
- B** an electron
- C** a neutron
- D** a proton

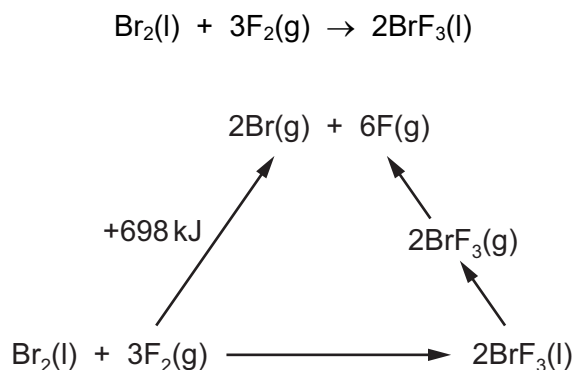
4 In which of the following, when in liquid form, are there only intermolecular forces based on temporary dipoles between the particles?

- A** bromine
- B** ethanol
- C** hydrogen chloride
- D** water

- 5 Copper has a high melting point.

What is the reason for the high melting point of copper?

- A** strong attractive forces between copper atoms only
B strong attractive forces between copper ions and delocalised electrons
C strong attractive forces between copper ions only
D strong attractive forces between copper atoms and delocalised electrons
- 6 Which pair of standard enthalpy changes are numerically equal?
- A** atomisation of $\text{CH}_4(\text{g})$ and formation of $\text{CH}_4(\text{g})$
B combustion of $\text{CH}_3\text{OH}(\text{l})$ and combustion of graphite + 2(combustion of $\text{H}_2(\text{g})$)
C combustion of graphite and formation of $\text{CO}_2(\text{g})$
D neutralisation of $\text{HCl}(\text{aq})$ with $\text{NaOH}(\text{aq})$ and formation of $\text{H}_2\text{O}(\text{l})$
- 7 An energy cycle is drawn for the following reaction.



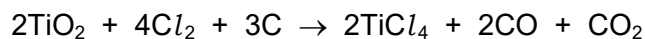
The standard enthalpy of formation of $\text{BrF}_3(\text{l}) = -301 \text{ kJ mol}^{-1}$.

The enthalpy change of $\text{BrF}_3(\text{l})$ to $\text{BrF}_3(\text{g})$ is $+44 \text{ kJ mol}^{-1}$.

What is the average bond energy of the Br–F bond in BrF_3 ?

- A** 152 kJ mol^{-1} **B** 202 kJ mol^{-1} **C** 304 kJ mol^{-1} **D** 404 kJ mol^{-1}
- 8 In which reaction does the greatest change in the oxidation number of sulfur occur?
- A** $\text{S}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{SO}_2(\text{g})$
B $\text{SO}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightleftharpoons \text{SO}_3(\text{g})$
C $\text{SO}_3(\text{g}) + \text{H}_2\text{SO}_4(\text{l}) \rightarrow \text{H}_2\text{S}_2\text{O}_7(\text{l})$
D $\text{H}_2\text{S}_2\text{O}_7(\text{l}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2\text{H}_2\text{SO}_4(\text{l})$

- 9 The first stage in the chloride process for the manufacture of titanium consists of the following reaction.



What is reduced in this reaction?

- A carbon
 - B chlorine
 - C oxygen
 - D titanium
- 10 In aqueous solution, sulfuric acid dissociates as shown.

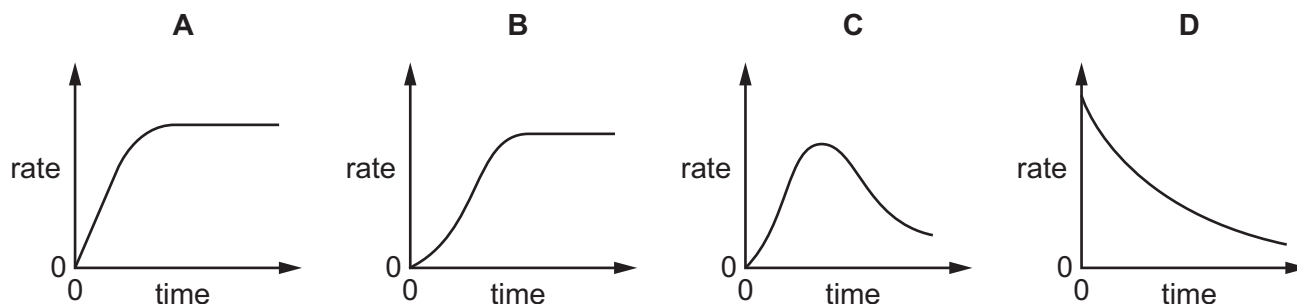


Analysis of a 2.00 mol dm^{-3} solution of H_2SO_4 found the HSO_4^- concentration to be $1.988 \text{ mol dm}^{-3}$.

What is K_c ?

- A $1.381 \times 10^5 \text{ dm}^3 \text{ mol}^{-1}$
 - B $82.34 \text{ dm}^3 \text{ mol}^{-1}$
 - C $1.214 \times 10^{-2} \text{ mol dm}^{-3}$
 - D $7.244 \times 10^{-5} \text{ mol dm}^{-3}$
- 11 An autocatalytic reaction is a reaction in which one of the products catalyses the reaction.

Which curve would be obtained if the rate of an autocatalytic reaction is plotted against time?



12 X and Y are two elements in Period 3 of the Periodic Table. They combine to form compound Z.

X forms a soluble acidic oxide. The oxidation number of X in this oxide is +4.

Y forms an amphoteric oxide.

What is the formula of compound Z?

- A** AlP **B** Al_2S_3 **C** Si_2P_5 **D** SiS_2

13 This question is about two elements in Group 2, Q and R.

Three of the statements shown are correct for metal Q.

The one remaining statement is correct for metal R.

Which statement applies to R?

- A** A saturated solution of the hydroxide of this metal has the higher pH value.
B This metal has a carbonate that is used in agriculture to reduce the acidity of soil.
C This metal has the greater atomic radius.
D This metal reacts more quickly with cold water.

14 The electronic arrangement for atoms of four elements is given.

Which element is the strongest oxidising agent?

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

15 A student mixes pairs of chemicals together in separate test-tubes.

- excess calcium (s) + water (l)
- barium chloride (aq) + strontium hydroxide (aq)
- calcium carbonate (s) + excess hydrochloric acid (aq)
- magnesium sulfate (aq) + barium nitrate (aq)

How many of the mixtures produce a white, solid product?

- A** 0 **B** 1 **C** 2 **D** 3

16 With which compound does concentrated sulfuric acid react **both** as a strong acid **and** as an oxidising agent?

- A** magnesium carbonate
- B** potassium chloride
- C** sodium bromide
- D** sulfur trioxide

17 Ammonia can undergo an acid–base reaction with hydrogen chloride to form ammonium chloride.

Which statement is correct?

- A** The ammonium ion is basic.
- B** The hydrogen atom from HCl donates a lone pair of electrons to the nitrogen atom.
- C** The H–N–H bond angle in ammonia is the same as the H–N–H bond angle in the ammonium ion.
- D** The H–N–H bond angle in the ammonium ion is the same as the H–C–H bond angle in methane.

18 What are the trends in the stated properties as Group 2 is descended from magnesium to barium?

	decomposition temperature of the carbonate	first ionisation energy
A	decreases	increases
B	decreases	decreases
C	increases	increases
D	increases	decreases

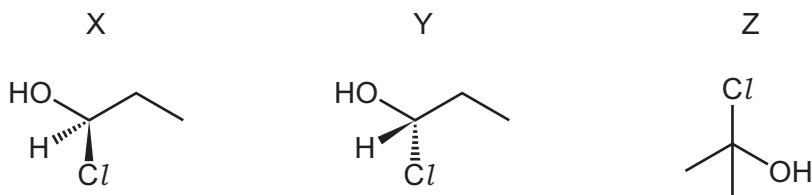
19 Sulfur dioxide, SO_2 , reacts with calcium hydroxide in aqueous solution.

What is the main product that is first formed?

- A** $\text{Ca}(\text{HSO}_4)_2$
- B** CaS
- C** CaSO_3
- D** CaSO_4

- 20 Structural and stereoisomerism should be considered when answering this question.

Compounds X, Y and Z are shown.



How many other isomers of C_3H_7ClO are there that are alcohols?

- A** 2 **B** 3 **C** 4 **D** 5
- 21 Two students each make a statement about 2-methylbut-1-ene.
- Student 1 states that 2-methylbut-1-ene has geometrical isomers.
- Student 2 states that 2-methylbut-1-ene reacts with HBr in an addition reaction to give 1-bromo-2-methylbutane as the main product.
- Which students are correct?
- A** both 1 and 2
B 1 only
C 2 only
D neither 1 nor 2
- 22 Which statement is correct when referring to the complete combustion of PVC?
- A** A gas is made which contributes to global warming.
B Carbon dioxide and water are the only products.
C If water is used to clean the exhaust gases, the water becomes alkaline.
D There is no need to treat the exhaust gases as the products are non-hazardous.
- 23 Iodoethane, CH_3CH_2I , reacts with aqueous silver nitrate at $50^\circ C$. A precipitate forms during this reaction.

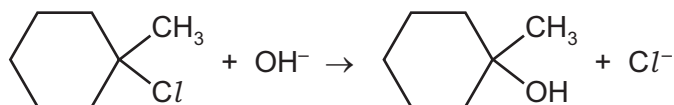
Which row of the table is correct about this reaction?

	type of organic reaction	colour of precipitate
A	electrophilic substitution	cream
B	electrophilic substitution	yellow
C	nucleophilic substitution	cream
D	nucleophilic substitution	yellow

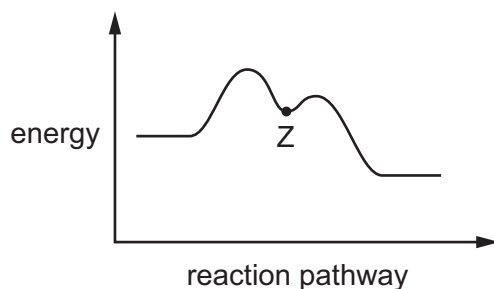
- 24** A student converts 1-iodopropane, $\text{C}_3\text{H}_7\text{I}$, into butanoic acid, $\text{C}_3\text{H}_7\text{CO}_2\text{H}$, by a two-stage chemical synthesis.

In the **first** of the two stages, which reagent is reacted with 1-iodopropane?

- A** aqueous sodium hydroxide
 - B** ethanolic ammonia
 - C** ethanolic potassium cyanide
 - D** ethanolic sodium hydroxide
- 25** 1-chloro-1-methylcyclohexane is hydrolysed by heating with NaOH(aq) .



The reaction pathway is shown.



One carbon atom in 1-chloro-1-methylcyclohexane is bonded to three other carbon atoms.

What is the charge on this carbon atom at point Z?

- A** 1–
 - B** $\delta-$
 - C** $\delta+$
 - D** 1+
- 26** An alcohol with the molecular formula $\text{C}_5\text{H}_{12}\text{O}$ decolourises warm acidified potassium manganate(VII). The alcohol also gives a yellow precipitate with alkaline aqueous iodine.

What could be the identity of the alcohol?

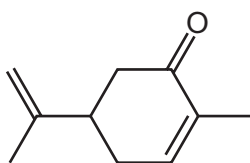
- A** 2-methylbutan-2-ol
- B** 3-methylbutan-2-ol
- C** pentan-1-ol
- D** pentan-3-ol

27 Which pair of test results would prove that a substance, X, is a ketone?

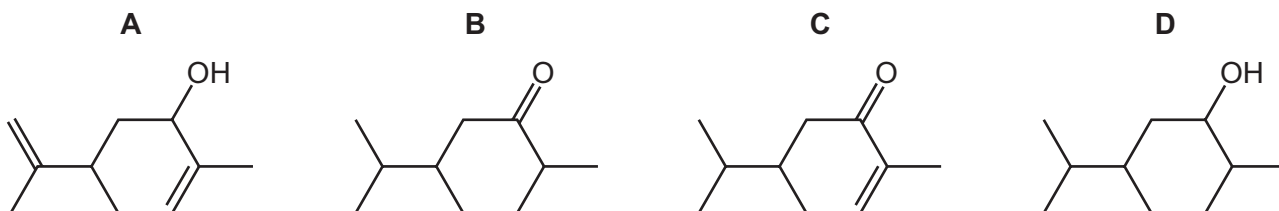
- A X has no reaction with Tollens' reagent. X reacts with alkaline aqueous iodine.
- B X is reduced by lithium aluminium hydride. X is oxidised by acidified dichromate(VI).
- C X reacts with 2,4-DNPH reagent. X has no reaction with Fehling's reagent.
- D X reacts with hydrogen cyanide. X is reduced by lithium aluminium hydride.

28 Carvone is found in spearmint oil.

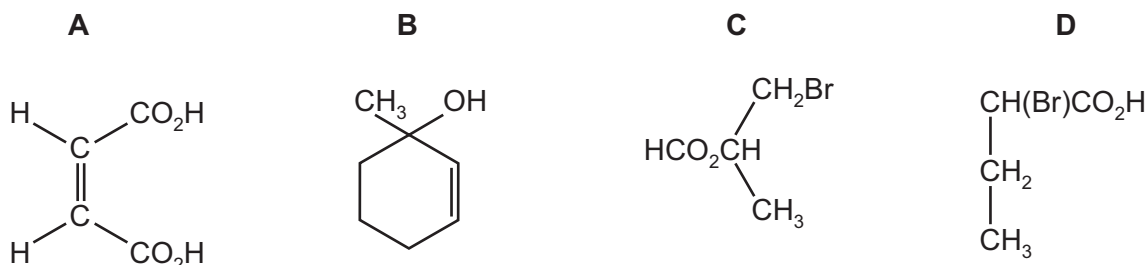
carvone



Which product is formed when carvone is reacted with NaBH_4 ?

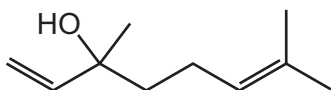


29 Which compound is chiral and reacts with Na_2CO_3 to give CO_2 ?



30 The skeletal formula of compound X is shown.

compound X



What is the molecular formula of compound X?

- A $\text{C}_{10}\text{H}_{18}\text{O}$
- B $\text{C}_{10}\text{H}_{20}\text{O}$
- C $\text{C}_{11}\text{H}_{22}\text{O}$
- D $\text{C}_{11}\text{H}_{24}\text{O}$

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 Nitrogen forms a number of oxides. Their enthalpies of formation are given.

$$\Delta H_f^\circ[\text{NO(g)}] = +90 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\circ[\text{N}_2\text{O(g)}] = +82 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\circ[\text{NO}_2\text{(g)}] = +33 \text{ kJ mol}^{-1}$$

Which statements are correct?

- 1** If $\text{N}_2\text{O(g)}$ is oxidised by $\text{O}_2\text{(g)}$ to $\text{NO}_2\text{(g)}$, 16 kJ is released per mole of N_2O .
- 2** The decomposition of $\text{N}_2\text{O(g)}$ to $\text{N}_2\text{(g)}$ and $\text{O}_2\text{(g)}$ is exothermic.
- 3** The reaction between NO and oxygen is exothermic.

32 Which statements are correct?

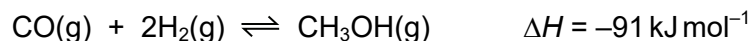
- 1** enthalpy of combustion of H_2 = enthalpy of formation of H_2O
- 2** enthalpy of formation of H_2 = $-(\text{enthalpy of atomisation of } \text{H}_2)$
- 3** enthalpy of solution of HCl = enthalpy of hydration of H^+ + enthalpy of hydration of Cl^-

33 The units of K_c for an equilibrium reaction are $\text{mol}^{-1} \text{ dm}^3$.

What could be the equation for the equilibrium?

- 1** $\text{A(aq)} + \text{B(aq)} \rightleftharpoons \text{C(s)} + \text{D(aq)}$
- 2** $\text{P(aq)} + \text{Q(aq)} \rightleftharpoons \text{R(aq)}$
- 3** $\text{W(aq)} + 2\text{X(aq)} \rightleftharpoons \text{Y(aq)} + \text{Z(aq)}$

34 Methanol, CH_3OH , can be produced industrially by reacting CO with H_2 .



The process can be carried out at $4 \times 10^3 \text{ kPa}$ and 1150 K .

Which statements about this reaction are correct?

- 1 Increasing the temperature will increase the rate of reaction because more effective collisions will occur.
- 2 Lowering the temperature will reduce the rate of reaction because the forward reaction is exothermic.
- 3 Increasing the pressure will reduce the rate of reaction because there are a larger number of moles on the left-hand side of the equation.

35 Which rows correctly show the relative electrical conductivities of the sets of three Period 3 elements?

	greatest conductivity	→	least conductivity
1	sodium	silicon	chlorine
2	aluminium	magnesium	phosphorus
3	sulfur	silicon	phosphorus

36 Three test-tubes, X, Y and Z, each contain water.

- A small amount of NaCl is added to test-tube X.
- A small amount of SiCl_4 is added to test-tube Y.
- A small amount of AlCl_3 is added to test-tube Z.

After a short time, two drops of universal indicator solution are added to each test-tube.

Which statements can be correct?

- 1 The pH in test-tube X is 7.
- 2 The pH in test-tube Y is 2.
- 3 The pH in test-tube Z is 2.

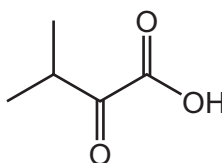
The responses **A** to **D** should be selected on the basis of

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.

37 The structure of compound R is shown.

compound R



Which statements about compound R are correct?

- 1** It has an M_r of 116.
- 2** It contains two groups that show strong absorptions between 1640 and 1740 cm^{-1} in its infrared spectrum.
- 3** Its only infrared absorption between 2500 and 3000 cm^{-1} is sharp and strong.

38 During the bromination of methane, the free radical $\text{CH}_3\cdot$ is generated. A possible termination step of this reaction is the formation of C_2H_6 by the combination of two free radicals.

What could be produced in a termination step during the bromination of **propane**?

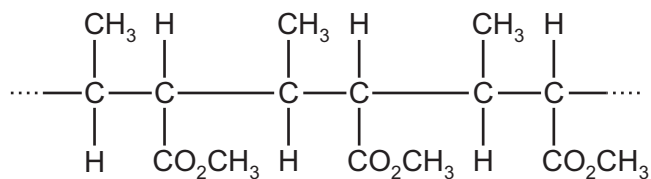
- 1** $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$
- 2** $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}(\text{CH}_3)_2$
- 3** $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_3)_2$

39 Three reactions of primary alcohols are listed.

Which reactions give water as one of the products?

- 1 reaction with ethanoic acid
- 2 reaction with concentrated HBr
- 3 passing the alcohol vapour over heated Al_2O_3

40 The diagram shows part of the structure of polymer X.



Which reagents react with polymer X?

- 1 aqueous sulfuric acid
- 2 aqueous sodium hydroxide
- 3 sodium

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