Cambridge Assessment International Education

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.

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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 Which statement is correct?

A C*l* has a relative isotopic mass of 35.5.

B Cl_2 has a relative molecular mass of 70.

C IC*l* has a relative molecular mass of 162.4.

D NaC*l* 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.

$$6SrO + 2Al \rightarrow 3Sr + Sr_3Al_2O_6$$

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, $^{2}_{1}H^{+}$

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

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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 $CH_4(g)$ and formation of $CH_4(g)$

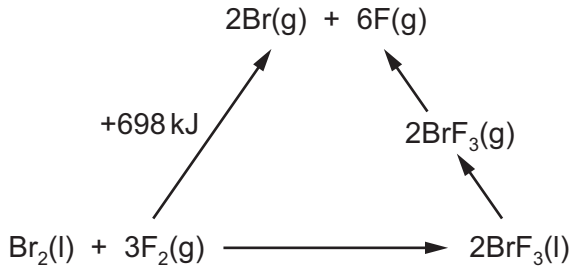
B combustion of $CH_3OH(l)$ and combustion of graphite + 2(combustion of $H_2(g)$)

C combustion of graphite and formation of $CO_2(g)$

D neutralisation of $HCl(aq)$ with NaOH(aq) and formation of $H_2O(l)$

7 An energy cycle is drawn for the following reaction.

$$Br_2(l) + 3F_2(g) \rightarrow 2BrF_3(l)$$



The standard enthalpy of formation of $BrF_3(l)$ = –301 kJ mol^{-1}.

The enthalpy change of $BrF_3(l)$ to $BrF_3(g)$ is +44 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 $S(s) + O_2(g) \rightarrow SO_2(g)$

B $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$

C $SO_3(g) + H_2SO_4(l) \rightarrow H_2S_2O_7(l)$

D $H_2S_2O_7(l) + H_2O(l) \rightarrow 2H_2SO_4(l)$

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

$$2TiO_2 + 4Cl_2 + 3C \rightarrow 2TiCl_4 + 2CO + CO_2$$

What is reduced in this reaction?

A carbon

B chlorine

C oxygen

D titanium

10 In aqueous solution, sulfuric acid dissociates as shown.

$H_2SO_4 \rightarrow HSO_4^- + H^+$ This reaction goes to completion.

$HSO_4^- \rightleftharpoons SO_4^{2-} + H^+$ This reaction reaches equilibrium with constant K_c.

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

What is K_c?

A $1.381 \times 10^5\,dm^3\,mol^{-1}$

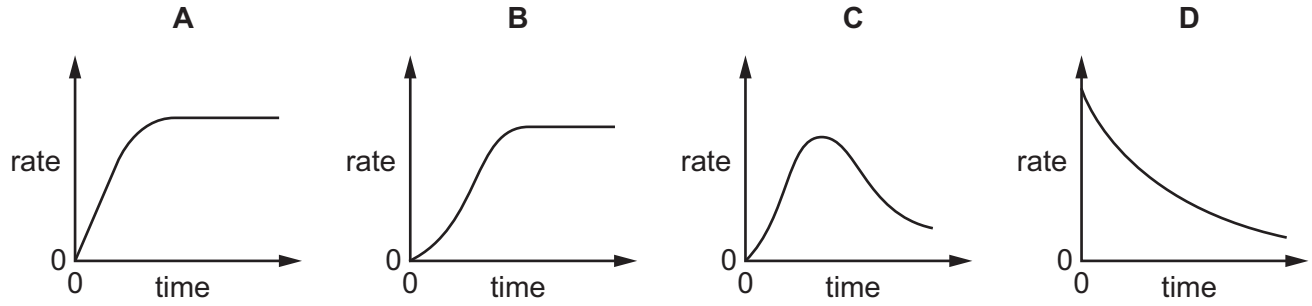
B $82.34\,dm^3\,mol^{-1}$

C $1.214 \times 10^{-2}\,mol\,dm^{-3}$

D $7.244 \times 10^{-5}\,mol\,dm^{-3}$

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 $Al P$ **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

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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 HC*l* 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.

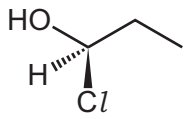
What is the main product that is first formed?

A $Ca(HSO_4)_2$ **B** CaS **C** $CaSO_3$ **D** $CaSO_4$

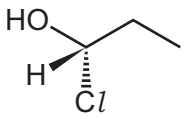
20 Structural and stereoisomerism should be considered when answering this question.

Compounds X, Y and Z are shown.

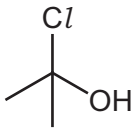
X



Y



Z



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 °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

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24 A student converts 1-iodopropane, C_3H_7I, into butanoic acid, $C_3H_7CO_2H$, by a two-stage chemical synthesis.

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

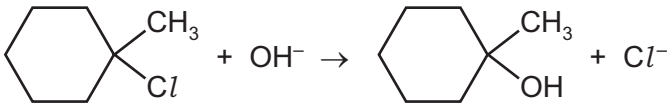
A aqueous sodium hydroxide

B ethanolic ammonia

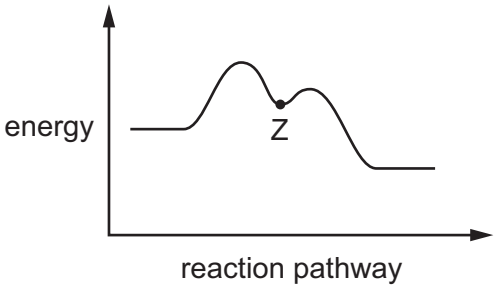
C ethanolic potassium cyanide

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** δ– **C** δ+ **D** 1+

26 An alcohol with the molecular formula $C_5H_{12}O$ 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

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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.

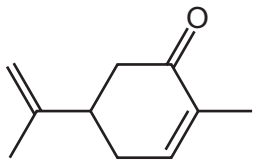
B X is reduced by lithium aluminium hydride. X is oxidised by acidified dichromate(VI).

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.

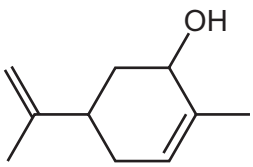
28 Carvone is found in spearmint oil.

carvone

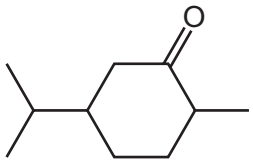


Which product is formed when carvone is reacted with $NaBH_4$?

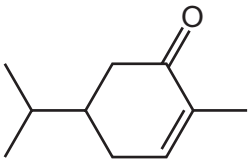
A



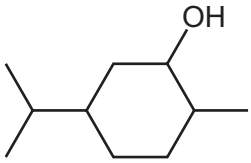
B



C

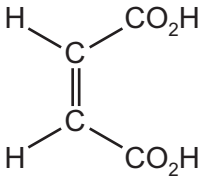


D

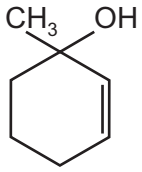


29 Which compound is chiral and reacts with Na_2CO_3 to give CO_2?

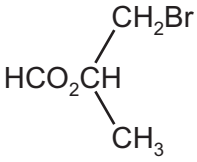
A



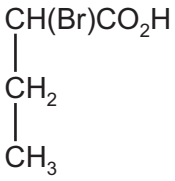
B



C

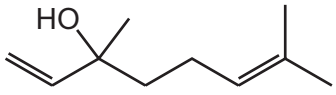


D



30 The skeletal formula of compound X is shown.

compound X



What is the molecular formula of compound X?

A $C_{10}H_{18}O$ **B** $C_{10}H_{20}O$ **C** $C_{11}H_{22}O$ **D** $C_{11}H_{24}O$

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.

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

$\Delta H_f^{\ominus}[N_2O(g)] = +82\,kJ\,mol^{-1}$

$\Delta H_f^{\ominus}[NO_2(g)] = +33\,kJ\,mol^{-1}$

Which statements are correct?

1 If $N_2O(g)$ is oxidised by $O_2(g)$ to $NO_2(g)$, 16 kJ is released per mole of N_2O.

2 The decomposition of $N_2O(g)$ to $N_2(g)$ and $O_2(g)$ 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 = –(enthalpy of atomisation of 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 $mol^{-1}\,dm^3$.

What could be the equation for the equilibrium?

1 $A(aq) + B(aq) \rightleftharpoons C(s) + D(aq)$

2 $P(aq) + Q(aq) \rightleftharpoons R(aq)$

3 $W(aq) + 2X(aq) \rightleftharpoons Y(aq) + Z(aq)$

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

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \qquad \Delta H = -91\,kJ\,mol^{-1}$$

The process can be carried out at 4×10^3 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.

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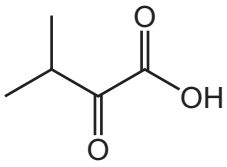
The responses **A** to **D** should be selected on the basis of

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 CH_3• 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 $CH_3CH_2CH(CH_3)CH_2CH_3$

2 $CH_3CH(CH_3)CH(CH_3)_2$

3 $CH_3CH_2CH_2CH(CH_3)_2$

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39 Three reactions of primary alcohols are listed.

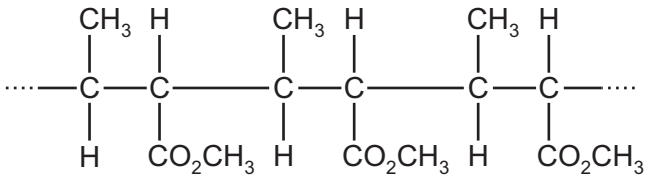
Which reactions give water as one of the products?

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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