Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/12**

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 What is the average oxidation number of sulfur in each compound?

	$Ca(HSO_3)_2$	$Na_2S_2O_3$
A	4	2
B	4	4
C	6	2
D	6	4

2 An ore of manganese contains 4% by mass of MnO_2 and no other manganese compound.

Which mass of manganese would be obtained from 1 tonne of this ore?

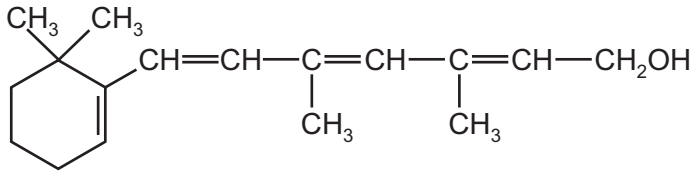
A 25.3 kg **B** 40.0 kg **C** 63.3 kg **D** 632 kg

3 Which atomic orbitals are occupied in an atom of phosphorus?

A 1p 2s 2p **B** 2s 2p 2d **C** 2s 2p 3s **D** 2p 3s 3d

4 The structure of compound A is shown.

compound A



Some of the carbon atoms in compound A have a tetrahedral arrangement of bonds.

Some of the carbon atoms in compound A have a trigonal planar arrangement of bonds.

How many carbon atoms are there of each type?

	tetrahedral	trigonal planar
A	5	12
B	8	8
C	9	6
D	9	8

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5 A white powder is known to be a mixture of magnesium oxide and aluminium oxide.

100 cm^3 of 2 mol dm^{-3} NaOH(aq) is just enough to dissolve the aluminium oxide in *x* grams of the mixture.

The reaction is shown.

$$Al_2O_3 + 2OH^- + 3H_2O \rightarrow 2Al(OH)_4^-$$

800 cm^3 of 2 mol dm^{-3} HCl(aq) is just enough to dissolve **all** of the oxide in *x* grams of the mixture.

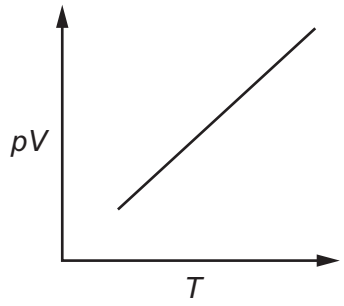
The reactions are shown.

$$Al_2O_3 + 6H^+ \rightarrow 2Al^{3+} + 3H_2O$$
$$MgO + 2H^+ \rightarrow Mg^{2+} + H_2O$$

How many moles of each oxide are present in *x* grams of the mixture?

	aluminium oxide	magnesium oxide
A	0.05	0.25
B	0.05	0.50
C	0.10	0.25
D	0.10	0.50

6 A graph of *pV* against *T* is shown for a fixed mass of gas. (*p* = pressure, *V* = volume and *T* = temperature in K.)



Which gas gives this graph over the widest range of temperatures and pressures?

A hydrogen, H_2

B hydrogen chloride, HCl

C hydrogen fluoride, HF

D oxygen, O_2

7 A weather balloon is filled with 12.0 kg helium. The weather balloon reaches a height of 20 km, the pressure inside the balloon is 6000 Pa and the temperature is 216 K.

What is the volume of the weather balloon at this height, correct to three significant figures?

A 897 dm^3 **B** 1790 dm^3 **C** 897 000 dm^3 **D** 1 790 000 dm^3

8 Which pair of enthalpy changes will **always** share the same sign (i.e. both are always exothermic **or** both are always endothermic)?

A enthalpy change of atomisation and enthalpy change of neutralisation

B enthalpy change of atomisation and enthalpy change of solution

C enthalpy change of combustion and enthalpy change of hydration

D enthalpy change of solution and enthalpy change of hydration

9 Chlorine dioxide, ClO_2, reacts with sodium hydroxide in the reaction shown.

$$2ClO_2 + 2OH^- \rightarrow ClO_2^- + ClO_3^- + H_2O$$

Which statement correctly describes this redox reaction?

A Chlorine atoms are oxidised and oxygen atoms are reduced.

B Chlorine atoms are reduced and oxygen atoms are oxidised.

C Some chlorine atoms are oxidised and some chlorine atoms are reduced.

D Some oxygen atoms are oxidised and some oxygen atoms are reduced.

10 Sulfur dioxide and oxygen react to form sulfur trioxide. The reaction is reversible.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad K_p = 2.96 \times 10^{-9}\ Pa^{-1} \text{ at } 700\,°C$$

The reaction is allowed to reach equilibrium at 700 °C. The partial pressure of $O_2(g)$ is 375 kPa and the partial pressure of $SO_3(g)$ is 20.3 kPa.

What is the partial pressure of $SO_2(g)$?

A 19.3 kPa **B** 609 kPa **C** 18 300 kPa **D** 609 000 kPa

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11 Ammonia is made by the Haber process. The reactants are nitrogen and hydrogen.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H \text{ is negative}$$

What will increase the rate of the forward reaction?

A adding argon to the mixture but keeping the total volume constant

B decreasing the temperature

C increasing the total pressure by reducing the total volume at constant temperature

D removing ammonia as it is made but keeping the total volume of the mixture the same

12 Element X, in Period 3, has the following properties.

- Its oxide has a giant structure.
- It forms covalent bonds with chlorine.
- Its oxide will neutralise HC*l*(aq).

What is element X?

A Mg **B** A*l* **C** Si **D** P

13 Which row could refer to barium metal and barium hydroxide?

	colour seen when the metal is burnt in O_2	pH of a saturated solution of the hydroxide
A	green flame	8
B	green flame	13
C	white flame	8
D	white flame	13

14 $AgNO_3(aq)$ is added to a solution of a halide ion, $X^-(aq)$, and aqueous ammonia is then added.

The ionic equations for the two reactions that occur are shown.

$$Ag^+(aq) + X^-(aq) \rightleftharpoons AgX(s) \qquad \text{equilibrium 1}$$

$$Ag^+(aq) + 2NH_3(aq) \rightleftharpoons Ag(NH_3)_2^+(aq) \qquad \text{equilibrium 2}$$

Which statement is correct?

A The position of equilibrium 1 lies to the left when $X^- = I^-$.

B Increasing the concentration of ammonia causes the position of equilibrium 1 to move to the left.

C K_c for equilibrium 2 is larger when $X^- = Cl^-$ than when $X^- = I^-$.

D Equilibrium 2 is a redox reaction.

15 Water and ammonia take part in a reaction that produces the ammonium ion.

Which statement about this reaction is correct?

A The ammonia molecule and the ammonium ion do not have dipole moments.

B The bond angle changes from 109.5° in the ammonia molecule to 107° in the ammonium ion.

C The reaction is a redox reaction.

D The water is acting as an acid.

16 Due to their similar ionic radii, the reactions of lithium and magnesium and their corresponding compounds are very similar.

Which statement about the reactions of lithium or its compounds can be predicted from this statement?

A Lithium burns very slowly in oxygen.

B Lithium carbonate decomposes on heating in a blue Bunsen burner flame, forming lithium oxide and carbon dioxide.

C Lithium nitrate decomposes on heating, forming lithium nitrite, $LiNO_2$, and oxygen.

D Lithium reacts very violently with cold water, producing hydrogen.

17 Which statement about Group 17 elements and their compounds is correct?

A Chlorine reacts with cold concentrated sodium hydroxide to form $NaCl$ and $NaClO_3$.

B HCl is more thermally stable than HBr because chlorine is less electronegative than bromine.

C Iodide ions are oxidised to iodine by concentrated sulfuric acid.

D Silver iodide is soluble in dilute aqueous ammonia.

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18 Which substance, when warmed with aqueous ammonium chloride, would produce an alkaline gas?

A CH_3CO_2H **B** CH_3CH_2OH **C** $CH_3CO_2CH_3$ **D** CH_3CH_2ONa

19 Compound X is the oxide of a Period 3 element. Compound X reacts with water to give an acidic solution.

A solution is prepared by reacting 0.100 g of compound X with an excess of water. This solution is neutralised by exactly 25.0 cm^3 of 0.100 mol dm^{-3} sodium hydroxide solution.

What could be the identity of compound X?

A Al_2O_3 **B** MgO **C** P_4O_{10} **D** SO_3

20 The unsaturated hydrocarbon octa-1,3,5,7-tetraene, C_8H_{10}, can display geometric isomerism.

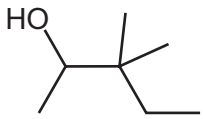
octa-1,3,5,7-tetraene

$CH_2=CHCH=CHCH=CHCH=CH_2$

How many isomers exist?

A 2 **B** 3 **C** 4 **D** 8

21 What is the correct name for the compound shown?



A 1,2,2-trimethylbutan-3-ol

B 2-ethyl-2-methylbutan-2-ol

C 3,3-dimethylpentan-2-ol

D 4-hydroxy-3,3-dimethylpentane

22 A polymer has the following repeat unit. It is made from two different monomers.

$$\left(CH_2-CHCl-CH_2-CH=CH-CH_2\right)$$

Which pair of monomers could be used to make this polymer?

A $CH_2=CHCl$ and $CH_2=CH_2$

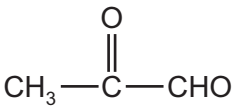
B $CH_2=CHCl$ and $CH_2=CH–CH=CH_2$

C $CH_3–CH_2Cl$ and $CH_3–CH=CH–CH_3$

D $CH_3–CH=CH–CH_3$ and $CH_2=CHCl$

23 Compound X contains two functional groups.

compound X



Which reagent will react with **only one** of the functional groups?

A acidified potassium dichromate(VI)

B 2,4-DNPH reagent

C hydrogen cyanide

D $NaBH_4$

24 Ethanol can be converted into ethene in a single reaction.

Ethanol can be converted into bromoethane in a single reaction.

Under standard laboratory conditions, is a catalyst used in these reactions?

	ethanol to ethene	ethanol to bromoethane
A	yes	yes
B	yes	no
C	no	yes
D	no	no

25 Diols in which both hydroxy groups are bonded to the same carbon atom can spontaneously eliminate a molecule of water to produce a carbonyl compound.

Which compound, after complete hydrolysis, gives a silver mirror with Tollens' reagent?

A 1,1-dibromobutane

B 1,2-dibromobutane

C 1,3-dibromobutane

D 2,2-dibromobutane

26 Which alcohol will give a yellow precipitate when warmed with alkaline aqueous iodine?

A $(CH_3)_2CHCH_2OH$

B $(CH_3)_3COH$

C $CH_3CH_2C(OH)(CH_3)_2$

D $CH_3CH(OH)CH_2CH_3$

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27 How many structural isomers are there of molecular formula $C_5H_{10}O$ that give a red precipitate with Fehling's solution?

A 1 **B** 2 **C** 3 **D** 4

28 Which statement about the use of alkane fuels in internal combustion engines is correct?

A C_8H_{18} is used as fuel in internal combustion engines and reacts with oxygen and nitrogen from the air.

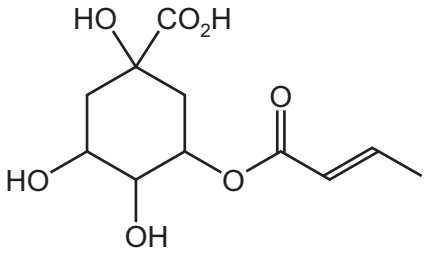
B In limited oxygen, CO is produced which oxidises SO_2 to SO_3 in the atmosphere.

C The catalytic converter removes polluting gases including NO_2 and CO_2.

D Unburnt hydrocarbons and NO_2 can react in sunlight to produce photochemical smog.

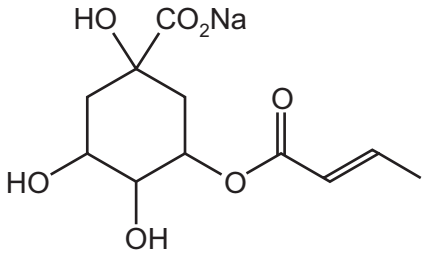
29 Compound Z is shown.

compound Z

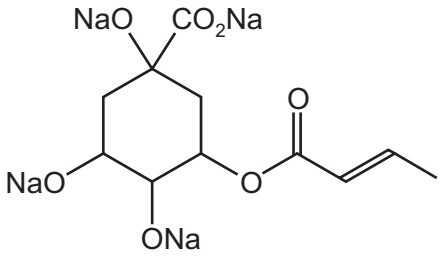


What is produced in good yield when compound Z is treated with an excess of sodium carbonate solution at room temperature?

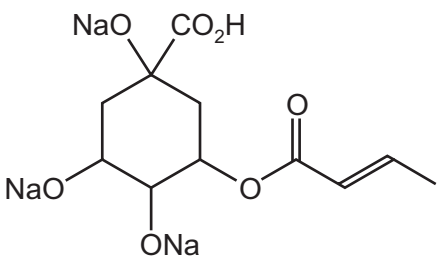
A



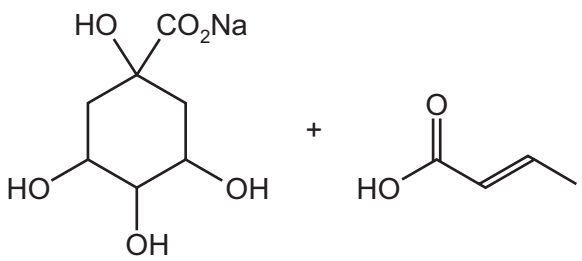
B



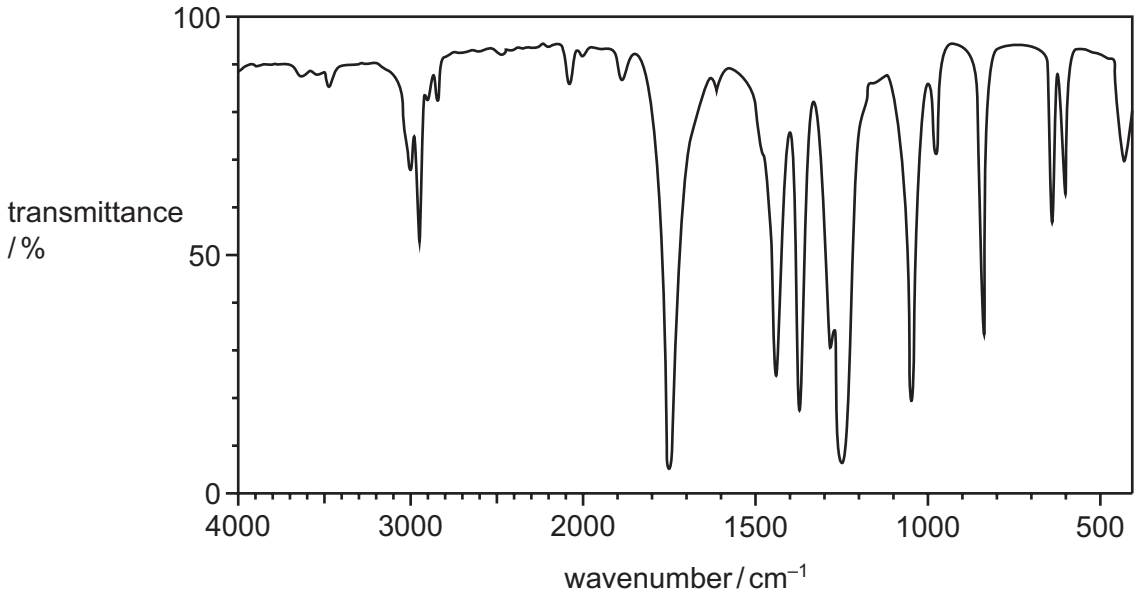
C



D



30 The infra-red spectrum shown was obtained from compound G.



What could be compound G?

A CH_3COCH_2OH

B $CH_3CH_2CO_2H$

C $CH_3CO_2CH_3$

D $CH_3CHCHCH_3$

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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 symbol for a phosphorus ion is $^{33}_{15}P^{3-}$.

The symbol for a potassium ion is $^{37}_{19}K^{+}$.

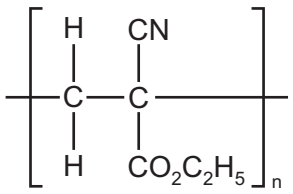
What do these two ions have in common?

1 the same number of electrons

2 the same number of neutrons

3 the same number of protons

32 The repeat unit of a polymer is shown.



Which types of intermolecular forces exist in the solid polymer?

1 temporary dipole – induced dipole interactions

2 permanent dipole – permanent dipole interactions

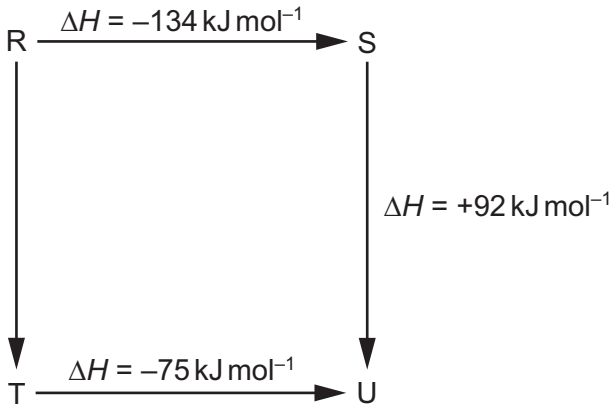
3 hydrogen bonds

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 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}.

34 Which statements about a reaction that has reached dynamic equilibrium are correct?

1 The rate of the forward reaction equals the rate of the reverse reaction.

2 There is no overall change in the concentrations of reactants and products.

3 There is no change in the measurable properties of the system.

35 Group 2 elements and their compounds show trends in their physical and chemical properties. Barium is above radium in Group 2 of the Periodic Table.

Which statements are likely to be correct?

1 Barium hydroxide is less soluble than radium hydroxide.

2 Barium reacts less vigorously with water than radium does.

3 Barium sulfate is more soluble than radium sulfate.

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36 Which statements are correct?

1 The empirical formula of silicon(IV) oxide is SiO_2.

2 The molecular formula of phosphorus(V) oxide is P_2O_5.

3 Silicon(IV) oxide and phosphorus(V) oxide are both simple molecular compounds.

37 Which reagents could be used, under suitable conditions, to oxidise $CH_3CH_2CH_2OH$ to CH_3CH_2CHO?

1 acidified potassium manganate(VII)

2 acidified potassium dichromate(VI)

3 Tollens' reagent

38 Which free radicals can be generated during a free-radical substitution reaction between chlorine and ethane?

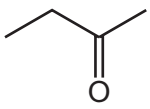
1 CH_3•

2 $CH_2Cl CH_2$•

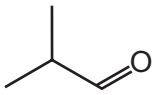
3 CH_3CCl_2•

39 Which substances have molecular formula C_4H_8O?

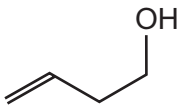
1



2



3



40 Which reactions produce pentanoic acid?

1 $CH_3CH_2CH_2CH(OH)CH_3 + H^+ / MnO_4^-(aq)$

2 $CH_3OCO(CH_2)_3CH_3 + HCl(aq)$

3 $CH_3(CH_2)_3CN + H_2SO_4(aq)$

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