Cambridge Assessment International Education

Cambridge Pre-U

CHEMISTRY **9791/01**

Paper 1 Multiple Choice **For examination from 2020**

SPECIMEN PAPER **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 specimen paper has been updated for assessments from 2020. The specimen questions and mark schemes remain the same. The layout and wording of the front covers have been updated to reflect the new Cambridge International branding and to make instructions clearer for candidates.

This syllabus is regulated for use in England, Wales and Northern Ireland as a Cambridge International Level 3 Pre-U Certificate.

This document has **14** pages. Blank pages are indicated.

1 The first seven successive ionisation energies of an element are 1010, 1900, 2900, 5000, 6300, 21 300 and 25 400 $kJ\,mol^{-1}$ respectively. In which group of the Periodic Table is this element found?

A 1 **B** 13 **C** 15 **D** 17

2 How does a catalyst function?

A by providing the same reaction pathway and increasing the average energy of the molecules

B by providing an alternative reaction pathway and increasing the average energy of the molecules

C by providing the same reaction pathway with a lower activation energy

D by providing an alternative reaction pathway with a lower activation energy

3 The $[Cu(H_2O)_6]^{2+}(aq)$ ion is blue whereas the $[CuCl_4]^{2-}(aq)$ ion is yellow.

Which row best explains the difference in colour of these two ions?

	number of d electrons around copper	energy gap between the d orbitals
A	different	different
B	different	the same
C	the same	different
D	the same	the same

4 Buckminsterfullerene is the most commonly occurring fullerene molecule, found in small quantities in soot.

Which statement about buckminsterfullerene is **incorrect**?

A Its mass spectrum has a prominent peak at *m*/*z* value of 720.

B The carbon atoms in the molecule are each bonded to four neighbours.

C The molecule is composed of hexagons and pentagons of carbon atoms.

D Van der Waals forces occur between molecules in the solid.

5 Group I elements form diatomic molecules in the gas phase.
Which molecule has the **smallest** dipole moment?

A Na—Li

B Na—Na

C Na—Rb

D Na—Cs

6 Cyclohexane, C_6H_{12}, is prepared industrially by the hydrogenation of benzene as shown in the equation.

$$C_6H_6(l) + 3H_2(g) \rightarrow C_6H_{12}(l)$$

Using the data in the table, what is the standard enthalpy change, $\Delta_r H^\ominus$, of this reaction?

enthalpy change	value
$\Delta_c H^\ominus$ (C_6H_6(l))	–3268 kJ mol^{-1}
$\Delta_c H^\ominus$ (H_2(g))	–286 kJ mol^{-1}
$\Delta_c H^\ominus$ (C_6H_{12}(l))	–3754 kJ mol^{-1}

A –372 kJ mol^{-1}

B +372 kJ mol^{-1}

C +200 kJ mol^{-1}

D –200 kJ mol^{-1}

7 How many different orbitals are there in the 3s, 3p and 3d sub-shells respectively?

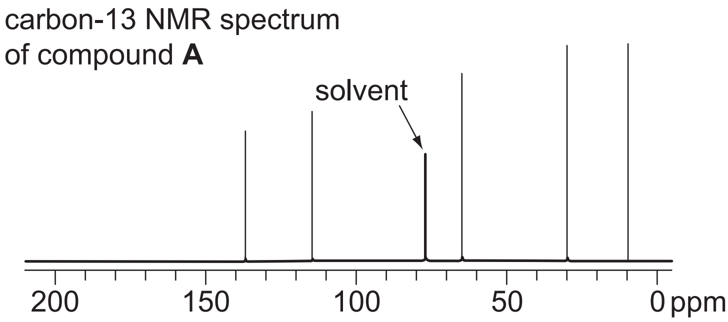
A 1, 3, 5

B 1, 4, 9

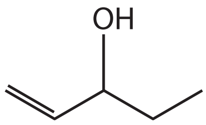
C 2, 6, 10

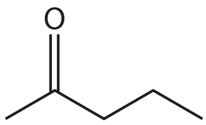
D 2, 8, 18

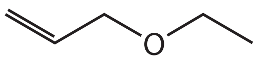
8 Compound **A** has the formula $C_5H_{10}O$. Its carbon-13 NMR spectrum is shown below.

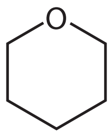


Which of the following structures is consistent with the NMR spectrum?

A 

B 

C 

D 

9 Which statement explains why phenylamine is a weaker base than methylamine?

A Phenylamine is less volatile than methylamine.

B The benzene ring in phenylamine is electron releasing.

C The lone pair of electrons on the nitrogen in phenylamine is delocalised over the benzene ring.

D The methyl group is smaller than the phenyl group.

10 Clouds and rain form when air saturated with water vapour cools.

$$H_2O(g) \rightarrow H_2O(l)$$

What are the correct signs of ΔH and ΔS for this reaction?

A both negative

B both positive

C ΔH negative, ΔS positive

D ΔH positive, ΔS negative

11 When a colourless solution of compound **J** is added to an acidified solution of a chromium compound, the solution changes colour from green to orange.

What type of reagent is **J**?

A a homogeneous catalyst

B an alkali

C an oxidising agent

D a reducing agent

12 Compound **K** is a nitrile. Reduction of **K** produces the compound $C_3H_7NH_2$.

Hydrolysis of **K** by warm $HCl(aq)$ produces compound **L**.

What is **L**?

A $CH_3CH_2NH_2$

B CH_3CH_2OH

C $CH_3CH_2CO_2H$

D $CH_3CH_2CH_2CO_2H$

13 What is the atom economy of the following synthesis of C_4H_9CN? (C_4H_9CN is the only utilised product.)

$$C_4H_9Cl + NaCN \rightarrow C_4H_9CN + NaCl$$

A 59% **B** 88% **C** 90% **D** 100%

14 Three statements about the myoglobin molecule are given.

1 Its iron(II) ion can be 6 co-ordinated.

2 It contains alpha helices.

3 It transports oxygen in the blood stream.

Which statements are correct?

A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

15 Which species is dominant when equal volumes of aqueous solutions of 0.1 mol dm^{-3} H_2SO_4, 0.1 mol dm^{-3} NaOH and 0.1 mol dm^{-3} $H_2NCH(CH_3)CO_2H$ are mixed?

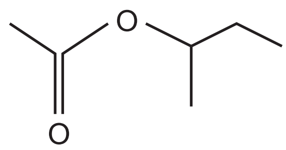
A $H_2NCH(CH_3)CO_2H$

B $H_2NCH(CH_3)CO_2^-$

C $H_3N^+CH(CH_3)CO_2^-$

D $H_3N^+CH(CH_3)CO_2H$

16 An ester has the skeletal formula shown.



Which alcohol would combine with ethanoic acid to produce this ester?

A butan-1-ol

B butan-2-ol

C propan-1-ol

D propan-2-ol

17 For which halogen is the colour and state at room temperature correct?

	halogen	colour	state
A	bromine	brown	gas
B	chlorine	green	liquid
C	fluorine	green	gas
D	iodine	grey-black	solid

18 The oxide and chloride of an element **Z** are separately mixed with water. The two resulting solutions have the same effect on litmus.

What is element **Z**?

A sodium

B magnesium

C aluminium

D phosphorus

19 The emissions from a power station contain about 14 tonnes of SO_2 per hour from the oxidation of FeS_2 contained in the coal.

What is the most practical way of preventing the SO_2 from being released into the atmosphere?

A Cool the gases and the SO_2 will liquefy and can be removed.

B Dissolve the ionic FeS_2 in hexane.

C Pass the emissions through a bed of calcium oxide.

D Pass the gases through concentrated sulfuric acid to dissolve the SO_2.

20 The interhalogen compound BrF_3 is a volatile liquid which autoionises.

$$2BrF_3 \rightleftharpoons BrF_2^+ + BrF_4^-$$

The electrical conductivity of BrF_3 decreases with increasing temperature.

Which statement is correct?

A The autoionisation process is endothermic and the shape of the cation is linear.

B The autoionisation process is endothermic and the shape of the cation is non-linear.

C The autoionisation process is exothermic and the shape of the cation is linear.

D The autoionisation process is exothermic and the shape of the cation is non-linear.

21 A given mass of an ideal gas occupies a volume V and exerts a pressure p at 27 °C.

At which temperature will the same mass of the ideal gas occupy the same volume V and exert a pressure $2p$?

A 50 °C

B 54 K

C 600 °C

D 600 K

22 At temperatures below 13 °C white tin, a shiny, ductile metallic solid, changes slowly into grey tin which is brittle.

Data for each form of tin are given.

	$\Delta_f H^{\ominus}$ / kJ mol^{-1}	$S^{\ominus}$ / J K^{-1} mol^{-1}
white	0	51.4
grey	–2.09	44.1

What is the expression for $\Delta G^{\ominus}$, in J mol^{-1}, for the formation of grey tin from white tin at 12 °C?

A $\Delta G^{\ominus} = -2.09 - 285 \times (-7.3)$

B $\Delta G^{\ominus} = -2.09 - 12 \times (+7.3)$

C $\Delta G^{\ominus} = -2090 - 12 \times (+7.3)$

D $\Delta G^{\ominus} = -2090 - 285 \times (-7.3)$

23 Which steps are involved in the mechanism of the reaction between 2-chloro-2-methylbutane and aqueous sodium hydroxide?

	first step	second step
A	heterolytic bond fission	attack of an electrophile on a carbanion
B	heterolytic bond fission	attack of a nucleophile on a carbocation
C	homolytic bond fission	attack of an electrophile on a carbanion
D	homolytic bond fission	attack of a nucleophile on a carbocation

24 What is the total number of different chloroethanes, formula $C_2H_{6-n}Cl_n$, where n can be any integer from 1 to 4?

A 4 **B** 6 **C** 7 **D** 8

25 10 cm^3 of a 0.1 mol dm^{-3} solution of hydrochloric acid was diluted with 90 cm^3 of water.

What is the pH of the resulting mixture?

A 1

B 2

C 3

D 4

26 The nickel-cadmium rechargeable battery is based upon the following overall reaction.

$$Cd + 2NiO(OH) + 4H_2O \rightarrow Cd(OH)_2 + 2Ni(OH)_2.H_2O$$

What is the oxidation number of nickel at the beginning and at the end of the reaction?

	beginning	end
A	+1.5	+2
B	+2	+3
C	+3	+2
D	+3	+4

27 Which of the following, in aqueous solutions of equal concentration, has the lowest pH?

A $ClCH_2CO_2H$

B CH_3CO_2H

C $C_2H_5NH_2$

D C_6H_5OH

28 In research on the atomic nucleus, scientists have been comparing the stability of isotopes with the same neutron : proton ratio.

Which isotope has the same neutron : proton ratio as ^{10}B?

A ^{32}P **B** ^{32}S **C** ^{40}Ar **D** ^{40}K

29 An amine $H_2N(CH_2)_6NH_2$, and an acid $HO_2C(CH_2)_3CO_2H$ react to form a condensation polymer **P**.

What is the formula of the repeat unit in **P**?

A $C_9H_{20}N_2O_2$

B $C_{10}H_{19}NO$

C $C_{11}H_{18}N_2O_2$

D $C_{11}H_{20}N_2O_2$

30 The atoms *X* and *Y* have the following electronic configurations.

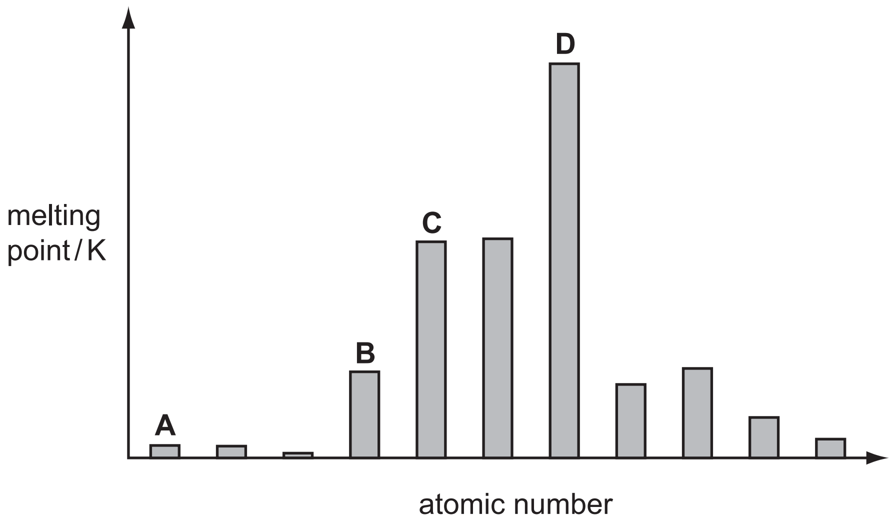
X, $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2$
Y, $1s^2\ 2s^2\ 2p^4$

What is the formula of the compound they are likely to form?

A $X^{2+}(Y^-)_2$ **B** $X^{2+}Y^{2-}$ **C** XY_4 **D** X_2Y_4

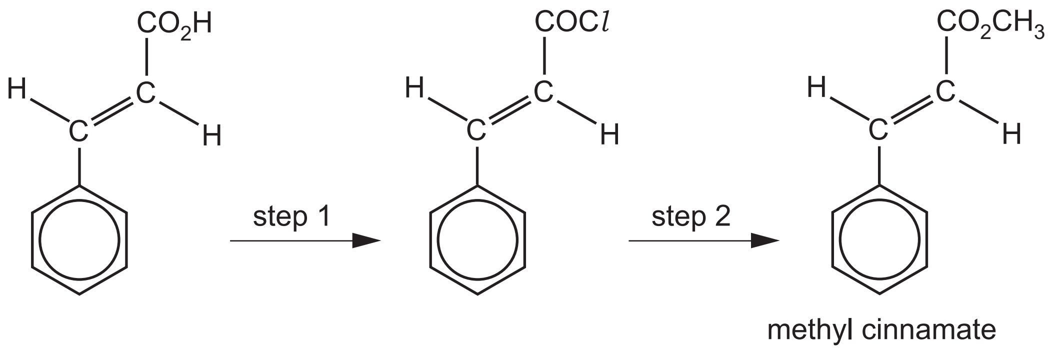
31 The bar chart shows the melting points of a series of consecutive elements arranged in order of increasing atomic number. The elements sodium to chlorine form part of this series.

Which bar represents sodium?



32 Methyl cinnamate is responsible for the spicy aroma of the matsutake mushroom added to many Japanese foods.

It can be prepared as shown.



Which reagents could be used?

	step 1	step 2
A	HCl	CH_3OH
B	HCl	CH_3CO_2H
C	PCl_5	CH_3OH
D	PCl_5	CH_3CO_2H

33 Hydrobromic acid reacts with ethene.

Which is a correct statement about the organic intermediate formed in the mechanism of this reaction?

A It has a positive charge.

B It has carbon, hydrogen and bromine atoms.

C It is a free radical.

D Its structure is planar.

34 A sample of chlorine gas, Cl_2, containing isotopes of mass numbers 35 and 37 was analysed in a mass spectrometer.

How many peaks corresponding to Cl_2^+ were recorded?

A 2 **B** 3 **C** 4 **D** 5

35 N_2O_4 is a poisonous gas. It can be disposed of safely by reaction with sodium hydroxide.

$$N_2O_4(g) + 2NaOH(aq) \rightarrow NaNO_3(aq) + NaNO_2(aq) + H_2O(l)$$

What is the minimum volume of $0.5\,mol\,dm^{-3}$ NaOH(aq) needed to dispose of 0.02 mol of N_2O_4?

A $8\,cm^3$ **B** $12.5\,cm^3$ **C** $40\,cm^3$ **D** $80\,cm^3$

36 An energy change accompanies the reaction shown.

$$K(s) \rightarrow K^+(g) + e^-$$

What is equal to the value of this energy change?

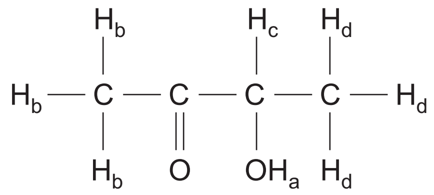
A the enthalpy change of vaporisation of potassium

B the first ionisation energy of potassium

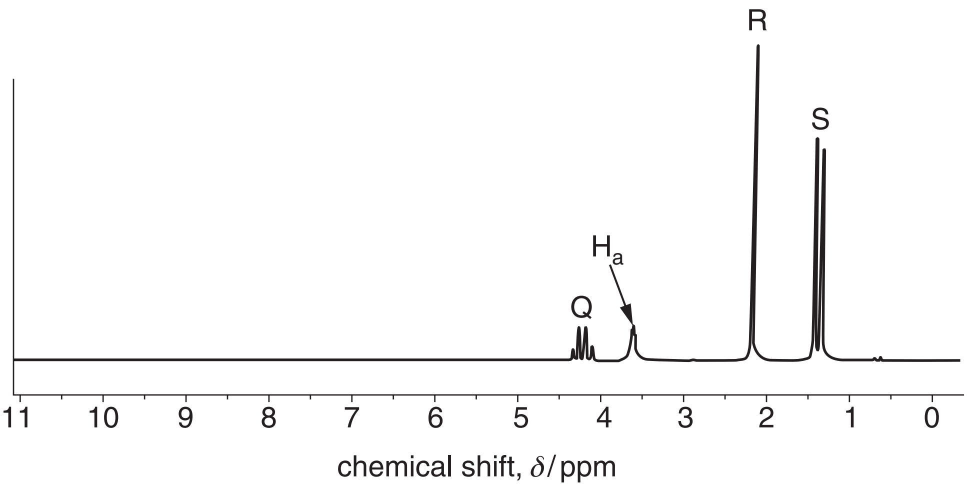
C the sum of the enthalpy change of atomisation and the electron affinity of potassium

D the sum of the enthalpy change of atomisation and the first ionisation energy of potassium

37 The different types of proton in an organic compound are labelled below.



The [1]H NMR spectrum of this compound is shown. The peak at 3.6 ppm has been labelled to show the proton responsible for the absorption.



Which protons are responsible for the lettered peaks Q, R and S?

peak	Q	R	S
A	H_c	H_d	H_b
B	H_c	H_b	H_d
C	H_d	H_b	H_c
D	H_b	H_c	H_d

38 In which process are hydrogen bonds broken?

A $H_2(l) \rightarrow H_2(g)$

B $NH_3(l) \rightarrow NH_3(g)$

C $2HI(g) \rightarrow H_2(g) + I_2(g)$

D $CH_4(g) \rightarrow C(g) + 4H(g)$

39 What mass of lead would be produced at the cathode on electrolysis of molten $PbBr_2$ by a current of 1 amp flowing for 30 minutes?

A 0.03 g

B 0.76 g

C 1.93 g

D 3.86 g

40 X is $HOCH_2CH(OH)CHO$

Y is $HOCH_2COCH_2OH$

Which statement about X and Y is correct?

A X can be directly oxidised to Y.

B X and Y have different empirical formulae.

C X and Y both react with Tollens' reagent.

D X and Y can both be reduced to $HOCH_2CH(OH)CH_2OH$.

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