



CHEMISTRY (PRINCIPAL)

Paper 1 Multiple Choice

9791/01

May/June 2016

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 working should be done in this booklet.

Electronic calculators may be used.

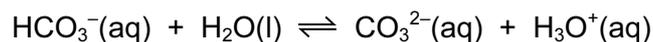
The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 3 Pre-U Certificate.

This document consists of **11** printed pages and **1** blank page.

1 Which metal is stored by mammals in the compound ferritin?

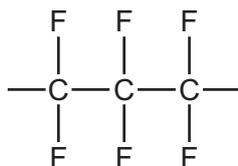
- A calcium
- B fermium
- C iron
- D tin

2 Which statement describes the acid-base behaviour taking place in the equilibrium shown?



- A $\text{HCO}_3^-(\text{aq})$ is an acid and its conjugate base is $\text{CO}_3^{2-}(\text{aq})$.
- B $\text{HCO}_3^-(\text{aq})$ is an acid and its conjugate base is $\text{H}_3\text{O}^+(\text{aq})$.
- C $\text{HCO}_3^-(\text{aq})$ is a base and its conjugate acid is $\text{CO}_3^{2-}(\text{aq})$.
- D $\text{HCO}_3^-(\text{aq})$ is a base and its conjugate acid is $\text{H}_3\text{O}^+(\text{aq})$.

3 The diagram shows a fragment of the polymer PTFE.



What is the monomer for this polymer?

- A CF_2
- B C_2F_2
- C C_2F_4
- D C_3F_6

4 Constituents of coloured glass, as used in church windows, can include three oxides: one ionic, one giant molecular (macromolecular) and one of a transition metal.

Which list contains one oxide of each type?

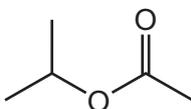
- A Al_2O_3 MgO ZnO
- B P_4O_{10} CoO CuO
- C SiO_2 CaO ZnO
- D SiO_2 PbO CoO

- 5 Elements are stored under different conditions depending on their reactivity.

Which row correctly describes the environment in which each element is stored?

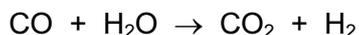
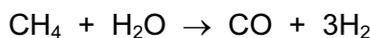
	white phosphorus, P ₄	sodium, Na
A	air	oil
B	air	water
C	water	air
D	water	oil

- 6 The skeletal formula of an ester is shown.



How many different functional group levels of carbon atom are present in this ester?

- A** 2 **B** 3 **C** 4 **D** 5
- 7 Hydrogen can be produced from methane. The two equations shown summarise the reactions involved.



What is the total number of molecules of hydrogen that could be formed from the reaction of 8.000×10^{-3} g of methane?

- A** 3.010×10^{20} **B** 9.030×10^{20} **C** 1.204×10^{21} **D** 2.408×10^{21}
- 8 What are the correct ground state electron configurations of the copper atom, Cu, and copper ions, Cu⁺ and Cu²⁺?

	Cu	Cu ⁺	Cu ²⁺
A	[Ar]4s ¹ 3d ¹⁰	[Ar]3d ¹⁰	[Ar]3d ⁹
B	[Ar]4s ² 3d ⁹	[Ar]4s ¹ 3d ⁹	[Ar]3d ⁹
C	[Ar]4s ¹ 3d ¹⁰	[Ar]4s ¹ 3d ⁹	[Ar]4s ¹ 3d ⁸
D	[Ar]4s ² 3d ⁹	[Ar]4s ² 3d ⁸	[Ar]4s ² 3d ⁷

- 9 Why are many complexes of first-row transition elements coloured?
- A The 3d and 4s electrons are of the same energy, corresponding to a region of the visible spectrum.
 - B The energy difference between 3d and 4s electrons corresponds to a region of the visible spectrum.
 - C The energy difference between 3d orbitals corresponds to a region of the visible spectrum.
 - D The lattice enthalpy of the crystals corresponds to a region of the visible spectrum.

- 10 Which species **cannot** act as a ligand in the formation of a transition metal complex?

A CH_3NH_2 B NH_4^+ C Cl^- D OH^-

- 11 Group 2 compounds show a number of trends in chemical properties on descending the group. One of these properties is that their carbonates thermally decompose to form the oxide and carbon dioxide.



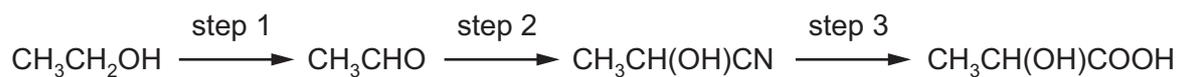
As you go down the group, which statement about the trend in the temperature of decomposition and the reason for this trend is correct?

- A It decreases because the charge density of the cation decreases.
 - B It decreases because the charge density of the cation increases.
 - C It increases because the charge density of the cation decreases.
 - D It increases because the charge density of the cation increases.
- 12 The alkynes are a series of hydrocarbons containing one $\text{C}\equiv\text{C}$ triple bond per molecule. They have the general formula $\text{C}_n\text{H}_{2n-2}$.

How many **structural** isomers are there for the alkyne containing six carbon atoms per molecule?

A 3 B 5 C 6 D 7

- 13 Lactic acid can be made from ethanol in three steps.



Which row shows the correct reaction type for each step?

	step 1	step 2	step 3
A	oxidation	addition	hydrolysis
B	oxidation	hydrolysis	addition
C	oxidation	substitution	addition
D	reduction	addition	hydrolysis

- 14 A bromine-containing organic compound, **T**, undergoes an elimination reaction when treated with hot ethanolic sodium hydroxide solution.

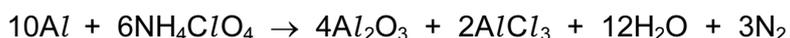
Which compound could be **T**?

- A** CH_3Br
B C_2Br_6
C $(\text{CH}_3)_2\text{C}=\text{CBr}_2$
D $\text{CH}_3\text{CH}_2\text{CBr}_3$
- 15 A sample of pure anhydrous calcium chloride was dissolved in water. An excess of silver nitrate solution was added to the calcium chloride solution. A precipitate formed.

The precipitate was collected by filtration followed by washing and drying. The mass of the precipitate was 1.260 g.

What mass of calcium chloride was dissolved in the water to form the initial solution?

- A** 0.244 g **B** 0.488 g **C** 0.976 g **D** 1.951 g
- 16 The space shuttle's upward thrust, on lift off, came from the reaction between aluminium and ammonium perchlorate.



Which statement about the overall reaction is correct?

- A** Aluminium is oxidised, chlorine is oxidised and nitrogen is reduced.
B Aluminium is oxidised, chlorine is reduced and nitrogen is oxidised.
C Aluminium is reduced, chlorine is oxidised and nitrogen is oxidised.
D Aluminium is reduced, chlorine is reduced and nitrogen is oxidised.

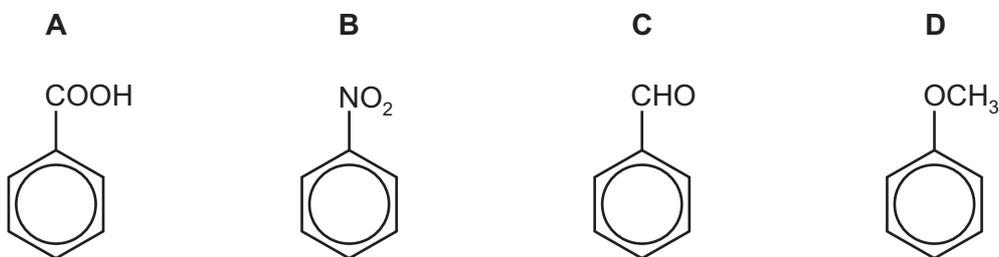
- 17 Which statement about the molecule N_2F_2 is correct?
- A It contains dative covalent bonds.
 - B It contains four unpaired electrons.
 - C It has geometric isomers.
 - D It is linear in shape.
- 18 Which is an **incorrect** statement about the elements of Group 14 and their oxides?
- A The covalent character of SnO is greater than that of CO .
 - B The electrical conductivity of Pb is greater than that of Ge .
 - C The electronegativity of C is greater than that of Si .
 - D The stability of PbO is greater than that of PbO_2 .
- 19 Which statement about the complex $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$ is **not** correct?
- A It contains Pt in the 0 oxidation state.
 - B It has four dative covalent bonds per molecule.
 - C It has geometric isomers.
 - D It is a square planar complex.
- 20 Which compound will undergo hydrolysis to produce carbon dioxide as a product?
- A CH_3COCl B H_2CO C HCOOCH_3 D $(\text{H}_2\text{N})_2\text{CO}$
- 21 Assuming ethene is the only utilised product, which process has the highest atom economy for preparing ethene?
- A $\text{C}_{10}\text{H}_{22} \rightarrow 3\text{C}_2\text{H}_4 + \text{C}_4\text{H}_{10}$
 - B $\text{C}_7\text{H}_{16} \rightarrow 2\text{C}_2\text{H}_4 + \text{C}_3\text{H}_8$
 - C $\text{C}_2\text{H}_5\text{Cl} \rightarrow \text{C}_2\text{H}_4 + \text{H}^+ + \text{Cl}^-$
 - D $\text{C}_2\text{H}_5\text{OH} \rightarrow \text{C}_2\text{H}_4 + \text{H}_2\text{O}$

22 But-1-ene reacts with hydrogen bromide to give **W** as the major organic product.

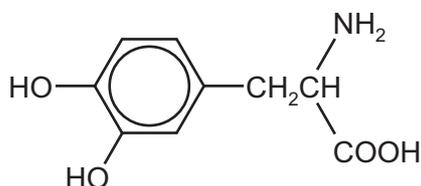
What is the mechanism of this reaction and how many chiral carbon atoms are in a molecule of **W**?

	mechanism	chiral carbon atoms in W
A	electrophilic addition	0
B	electrophilic addition	1
C	nucleophilic addition	0
D	nucleophilic addition	1

23 Which molecule will undergo aromatic electrophilic substitution to give primarily 1,2-disubstituted and 1,4-disubstituted products?



24 The molecule shown is used in the treatment of Parkinson's disease.



Which statement about the molecule is **not** correct?

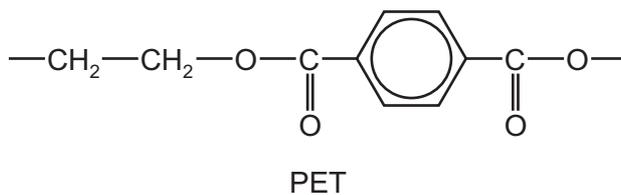
- A** It can exist as a zwitterion in aqueous solution.
 - B** It can exist in optically active forms.
 - C** It contains a carbon atom at the carbon dioxide functional group level.
 - D** One mole reacts with three moles of sodium to form a salt.
- 25 In the manufacture of polycarbonate for cycle helmets, phosgene reacts with phenol, C_6H_5OH , to produce $O=C(OC_6H_5)_2$ and hydrogen chloride.

What is the structural formula of phosgene?

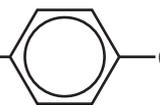
- A** $O=CCl_2$ **B** $O=C(OCl)H$ **C** $O=C(OCl)_2$ **D** $O=C(OH)Cl$

26 PET is a polymer used to make fizzy drink containers.

The diagram shows the repeat unit of PET.



What are the two monomers used to produce PET?

- A** $\text{CH}_2=\text{CH}_2$ and HOOC -- COOH
- B** $\text{HOOCCH}_2\text{CH}_2\text{COOH}$ and 
- C** $\text{HOOCCH}_2\text{CH}_2\text{COOH}$ and HO -- COOH
- D** $\text{HOCH}_2\text{CH}_2\text{OH}$ and HOOC -- COOH

27 Which is the strongest of the four acids?

- A** $\text{CH}_3\text{CHF}\text{COOH}$
- B** $\text{CH}_3\text{CH}\text{ICOOH}$
- C** $\text{CH}_3\text{CH}_2\text{COOH}$
- D** $\text{CH}_3\text{CH}(\text{CH}_3)\text{COOH}$

28 Two elements that have very similar electronegativity values chemically combine.

The compound they form is plotted on a van Arkel triangle.

Which statement about the compound must be correct?

- A** The compound is a semiconductor.
- B** The covalent character is high.
- C** The ionic character is low.
- D** The metallic character is low.

- 29 Calcium carbonate decomposes when heated.



ΔH^\ominus for this reaction is $178.3 \text{ kJ mol}^{-1}$ and ΔS^\ominus is $160.4 \text{ JK}^{-1} \text{ mol}^{-1}$.

What is the Gibbs energy change, ΔG^\ominus , at 1200°C ?

- A $-236\,000 \text{ kJ mol}^{-1}$
 B $-58.0 \text{ kJ mol}^{-1}$
 C $-14.8 \text{ kJ mol}^{-1}$
 D $+29.6 \text{ kJ mol}^{-1}$
- 30 Iron alum is a 'double salt' with the formula $\text{NH}_4\text{Fe}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$.

Which row gives the correct qualitative analysis results for an aqueous solution of the alum?

	reaction with cold NaOH(aq)	reaction with warm NaOH(aq)
A	green ppt.	NH_3 produced
B	green ppt.	NH_3 not produced
C	red-brown ppt.	NH_3 produced
D	red-brown ppt.	NH_3 not produced

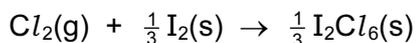
- 31 The solubility product, K_{sp} , of lead(II) chloride is 1.70×10^{-5} . The concentration of chloride ions dissolved in a sample of sea water was found to be 1.70 mol dm^{-3} .

What is the maximum possible concentration of lead(II) ions in the sample of sea water?

- A $5.88 \times 10^{-6} \text{ mol dm}^{-3}$
 B $1.00 \times 10^{-5} \text{ mol dm}^{-3}$
 C $4.12 \times 10^{-3} \text{ mol dm}^{-3}$
 D $2.57 \times 10^{-2} \text{ mol dm}^{-3}$

32 Assuming the pressure of each system remains at 1 atm throughout, in which system does the entropy decrease?

- A 1 mol of $Cl_2(g)$ at 298 K is added to 1 mol of $He(g)$ at 298 K.
 B 1 mol of $Cl_2(g)$ at 298 K is heated to 373 K.
 C 1 mol of $Cl_2(g)$ at 298 K is reacted as shown.



- D 1 mol of $Cl_2(g)$ at 1000 K undergoes fission as shown.



33 When steam is condensed, 44 kJ mol^{-1} of heat is given off.

What is the entropy change when 72 g of steam is condensed at 100°C and 1 bar pressure?

- A -472 JK^{-1} B -118 JK^{-1} C $+118 \text{ JK}^{-1}$ D $+472 \text{ JK}^{-1}$

34 The ionic model treats ions as hard spheres, and is used to calculate expected values for lattice enthalpies.

The experimental lattice enthalpy of which compound should show greatest agreement with the predicted value when the ionic model is used?

- A $AlCl_3$ B $NaCl$ C AgI D BeI_2

35 Two separate electrolyses were performed and the volumes of gases produced were measured at the same temperature and pressure.

- When molten copper(II) chloride was electrolysed for three minutes, 10 cm^3 of chlorine was collected.
- When aqueous sulfuric acid was electrolysed for three minutes, 10 cm^3 of oxygen was collected.

The current used in electrolysis 1 was a amps.

What was the current used in electrolysis 2?

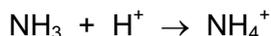
- A $\frac{a}{2}$ amps B a amps C $2a$ amps D $4a$ amps

36 An unknown gaseous hydrocarbon C_xH_y of volume V is mixed with oxygen and then completely combusted.

Which volume of oxygen reacts with the hydrocarbon?

- A $(\frac{x}{2} + \frac{y}{4})V$ B xV C $(x + \frac{y}{2})V$ D $(x + \frac{y}{4})V$

- 37 When an ammonia molecule is protonated the ammonium ion is formed as shown.



Which statement about the bond angles in the two nitrogen species is correct when the reaction takes place?

- A The bond angles decrease because a lone pair of electrons becomes a bonding pair.
 - B The bond angles increase because a lone pair of electrons becomes a bonding pair.
 - C The bond angles increase because of the size of the added atom.
 - D The bond angles remain the same because there is no change in the number of electron pairs around the central atom.
- 38 There are a number of isomeric alcohols containing six carbon atoms. Four of these are named below.

Which isomer has a carbon atom that can have its functional group level increased when the isomer is refluxed with an acidified solution of potassium dichromate(VI)?

- A 2-methylpentan-2-ol
 - B 3-methylpentan-3-ol
 - C 2,3-dimethylbutan-2-ol
 - D 3,3-dimethylbutan-2-ol
- 39 **P** is an isomer of $\text{C}_3\text{H}_6\text{Cl}_2$ which reacts with aqueous sodium hydroxide to form an organic compound **Q**.

Q contains one oxygen atom per molecule and has a ^{13}C NMR spectrum containing two peaks.

What is the identity of **P**?

- A 1,1-dichloropropane
 - B 1,2-dichloropropane
 - C 1,3-dichloropropane
 - D 2,2-dichloropropane
- 40 The infra-red spectrum of compound **X** shows a strong absorption at 1700 cm^{-1} and a very broad absorption centred around 3000 cm^{-1} . It contains 55% carbon by mass.

What is **X**?

- A butanoic acid
- B but-2-ene-1,3-diol
- C methyl propanoate
- D propanoic acid

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