



Cambridge International Examinations
Cambridge Pre-U Certificate

CHEMISTRY

9791/01

Paper 1 Part A Multiple Choice

May/June 2014

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.

This document consists of **14** printed pages and **2** blank pages.

1 What is the pattern of the increase in metallic character in the Periodic Table?

- A ascending groups and left to right across periods
- B ascending groups and right to left across periods
- C descending groups and left to right across periods
- D descending groups and right to left across periods

2 How many subshells and orbitals are there in the third shell?

	subshells	orbitals
A	2	4
B	2	8
C	3	5
D	3	9

3 Silicon and phosphorus are elements in Period 3.

Which statement about silicon and white phosphorus is correct?

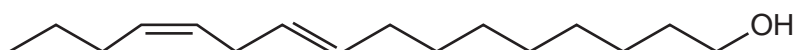
- A They both can act as semi-conductors.
- B They both form chlorides that react with water.
- C They both form dioxides readily in oxygen.
- D They both have melting points below 200 °C.

4 Concentrated sulfuric acid reacts with solid potassium bromide at room temperature.

Which substance is **not** formed in this reaction?

- A bromine
- B hydrogen sulfide
- C sulfur dioxide
- D water

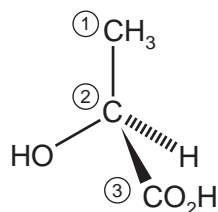
5 The diagram shows the skeletal formula of the silkworm moth sex pheromone.



How many hydrogen atoms are present in one molecule of this pheromone?

- A 26
- B 28
- C 29
- D 30

- 6 The diagram shows the structure of lactic acid.



What are the functional group levels of the carbon atoms in lactic acid?
 [0 = hydrocarbon, 1 = alcohol, 2 = carbonyl, 3 = carboxylic acid, 4 = carbon dioxide level]

	carbon atom ①	carbon atom ②	carbon atom ③
A	0	1	3
B	1	0	3
C	0	1	4
D	1	0	4

- 7 Which aim is consistent with the principles of green chemistry?

- A** avoiding catalysts that are heterogeneous
- B** solventless reactions
- C** using cheaper reagents
- D** using substitution rather than addition reactions

- 8 Br₂ is a liquid but F₂ is a gas at room temperature and pressure.

What is a valid explanation for the difference in state?

- A** Br–Br bonds are stronger than F–F bonds.
- B** Br₂ is less reactive than F₂.
- C** Br is more electronegative than F.
- D** Br₂ is more polarisable than F₂.

9 Which equation does **not** represent the standard enthalpy change stated?

	enthalpy change of	equation
A	atomisation of <i>Cl</i>	$Cl_2(g) \rightarrow 2Cl(g)$
B	combustion of H_2S	$H_2S(g) + 1.5O_2(g) \rightarrow H_2O(l) + SO_2(g)$
C	formation of H_2SO_4	$H_2(g) + 2O_2(g) + \frac{1}{8}S_8(s) \rightarrow H_2SO_4(l)$
D	solution of K_2SO_4	$K_2SO_4(s) + aq \rightarrow 2K^+(aq) + SO_4^{2-}(aq)$

10 Which quantity is **not** required in the calculation of the lattice energy of calcium hydride, CaH_2 , using the Born-Haber cycle?

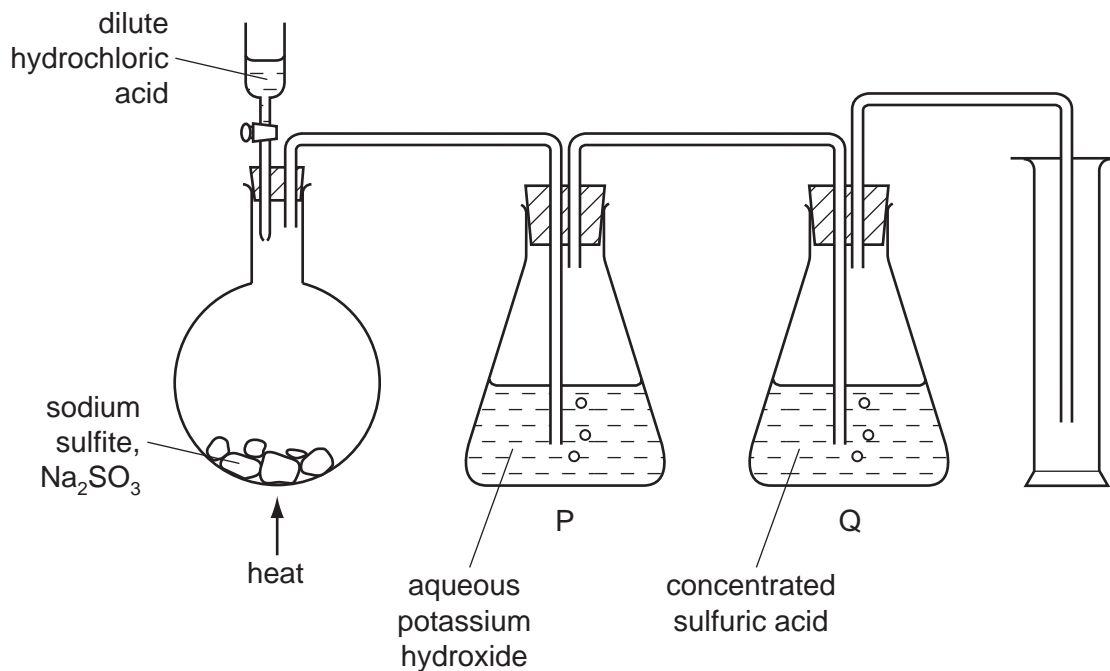
- A** first electron affinity of hydrogen
- B** second electron affinity of hydrogen
- C** first ionisation energy of calcium
- D** second ionisation energy of calcium

11 The thermal decomposition of ammonium nitrate gives only two products, steam and an oxide of nitrogen, **X**.

What is the oxidation number of nitrogen in **X**?

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

12 The apparatus shows an unsuccessful attempt to prepare and collect dry sulfur dioxide.



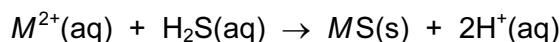
Which change would make the experiment successful?

- A omitting flask P
 - B omitting flask Q
 - C using dilute nitric acid instead of dilute hydrochloric acid
 - D using sodium sulfate instead of sodium sulfite
- 13 Iodine is far less soluble in water than it is in aqueous potassium iodide, where it forms the complex ion I_3^- . For this reason, reactions involving aqueous iodine are often carried out in potassium iodide solution.

Which equation describes the quantitative determination of iodine in the presence of excess potassium iodide?

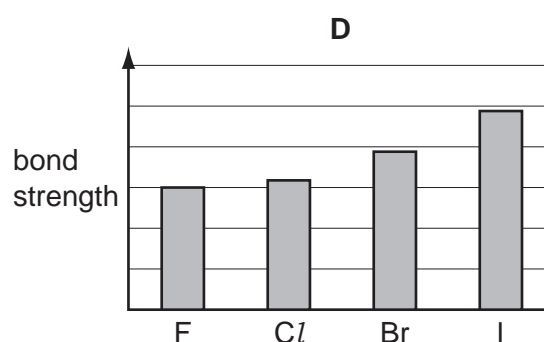
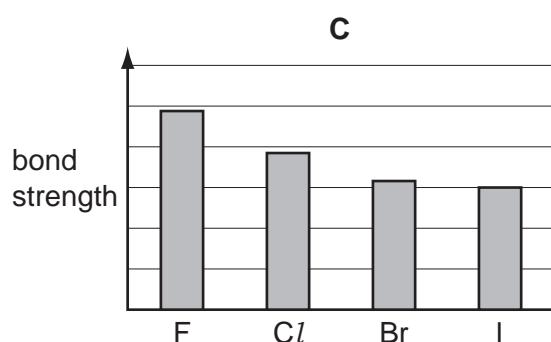
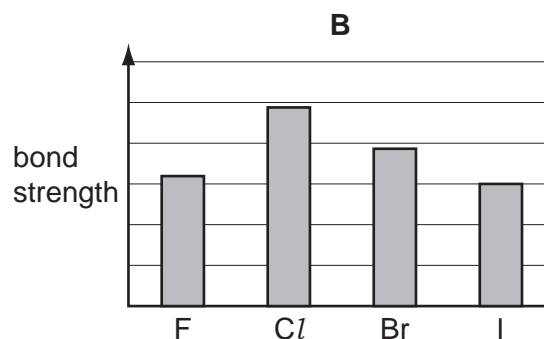
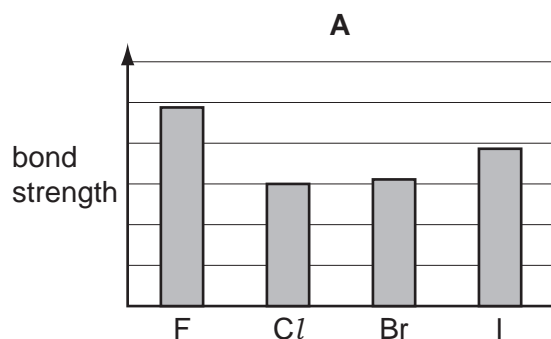
- A $\text{I}_2 + 2\text{SO}_4^{2-} \rightarrow 2\text{I}^- + \text{S}_2\text{O}_8^{2-}$
- B $2\text{I}^- + 2\text{S}_2\text{O}_3^{2-} \rightarrow \text{I}_2 + \text{S}_4\text{O}_6^{2-}$
- C $\text{I}_3^- + 2\text{SO}_4^{2-} \rightarrow 3\text{I}^- + \text{S}_2\text{O}_8^{2-}$
- D $\text{I}_3^- + 2\text{S}_2\text{O}_3^{2-} \rightarrow 3\text{I}^- + \text{S}_4\text{O}_6^{2-}$

- 14 Hydrogen sulfide, H_2S , can be used to identify a range of metal ions in solution because they form insoluble sulfides. For a metal ion, M^{2+} , the reaction can be summarised by the equation.

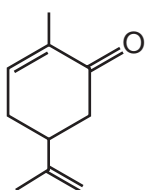


Which two terms accurately describe this reaction?

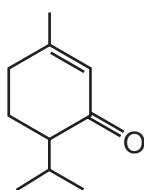
- A** disproportionation and decomposition
B disproportionation and precipitation
C precipitation and acid-base
D redox and acid-base
- 15 Antimony can be produced in a two-stage process from its ore stibnite, Sb_2S_3 .
- The ore is first roasted in oxygen, producing Sb_4O_6 and SO_2 .
- The Sb_4O_6 is then reduced by carbon, producing Sb and CO_2 .
- What volume of CO_2 , measured at room temperature and pressure, is produced on processing 10 moles of Sb_2S_3 ?
- A** 15 dm^3 **B** 180 dm^3 **C** 360 dm^3 **D** 720 dm^3
- 16 How does the strength of the halogen-halogen covalent bond change as Group 17 is descended?



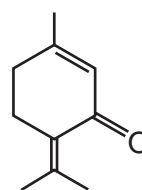
- 17 Why does magnesium have a greater electrical conductivity than sodium?
- A A magnesium atom has more protons than a sodium atom.
 B Magnesium is more electronegative than sodium.
 C Magnesium has a higher relative atomic mass than sodium.
 D One mole of magnesium has more delocalised electrons than one mole of sodium.
- 18 Carbonyl derivatives of cyclohexene are present in plant oils. The structures show three such derivatives.



P



Q



R

Which of these molecules have a chiral centre?

- A P, Q and R
 B P and Q only
 C P and R only
 D Q and R only
- 19 Which atom has the highest ratio of unpaired electrons to paired electrons in its ground state?
- A boron
 B carbon
 C nitrogen
 D oxygen
- 20 The compound of molecular formula $C_3H_4Br_2$ has structural isomers.

How many of these **structural** isomers contain $C=C$ and how many do **not** contain $C=C$?

	structural isomers with $C=C$	structural isomers without $C=C$
A	4	0
B	4	2
C	5	0
D	5	2

21 Which forms of isomerism will be shown by the molecule 2,4-dimethylhex-2-ene?

- A both geometric and optical isomerism
- B geometric isomerism only
- C optical isomerism only
- D neither geometric nor optical isomerism

22 Which row correctly describes the types of bonds in the molecules of oxygen, nitrogen and white phosphorus?

	oxygen	nitrogen	phosphorus
A	one σ and one π	one σ and two π	six σ
B	one σ and one π	two σ and one π	four σ
C	two σ	one σ and two π	four σ
D	two σ	two σ and one π	six σ

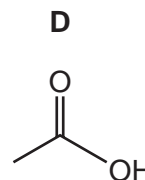
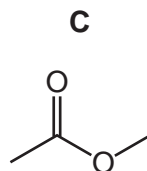
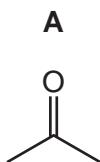
23 In the reaction of bromoethane with the cyanide ion, one carbon atom in bromoethane changes its functional group level.

Which statement correctly describes this change?

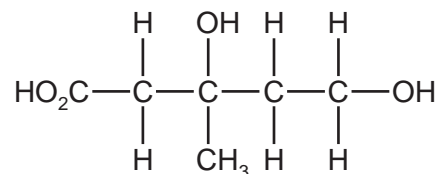
- A It changes from alcohol level to carbonyl level.
- B It changes from alcohol level to carboxylic acid level.
- C It changes from alcohol level to hydrocarbon level.
- D It changes from hydrocarbon level to carboxylic acid level.

24 An organic compound produced a silver mirror when warmed with Tollens' reagent.

What is a possible structure for the organic compound?



25 Mevalonic acid is involved in the biosynthesis of cholesterol.



mevalonic acid

When mevalonic acid is heated under reflux with acidified potassium dichromate(VI) an organic compound **X** is produced.

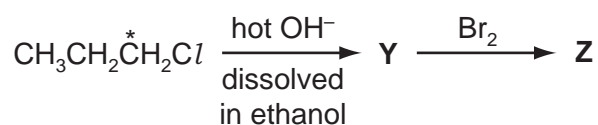
Which row is correct for **X**?

	number of chiral carbon atoms in one molecule of X	number of peaks in the carbon-13 NMR spectrum of X
A	0	4
B	0	6
C	1	4
D	1	6

26 In terms of change in functional group level, which addition reaction does **not** involve oxidation?

- A** $\text{CH}_2=\text{CH}_2 + \text{Br}_2 \rightarrow \text{CH}_2\text{BrCH}_2\text{Br}$
- B** $\text{CH}_2=\text{CH}_2 + \text{HBr} \rightarrow \text{CH}_3\text{CH}_2\text{Br}$
- C** $\text{CH}_2=\text{CH}_2 + \text{HCl} \rightarrow \text{CH}_3\text{CH}_2\text{Cl}$
- D** $\text{CH}_2=\text{CH}_2 + \text{H}_2 \rightarrow \text{CH}_3\text{CH}_3$

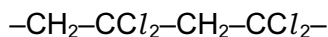
27 The diagram shows a reaction pathway.



For this reaction pathway, what is the correct sequence of changes in the functional group level of the carbon atom shown by *?

- A** It moves down one level, followed by moves up one level.
- B** It moves down one level, followed by stays the same.
- C** It stays the same, followed by moves up one level.
- D** It stays the same, followed by stays the same.

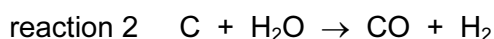
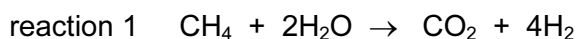
- 28 Two repeat units of a polymer are shown.



What is the product when the monomer used to make this polymer is reacted with chlorine in an organic solvent?

- A** $\text{CCl}_2=\text{CCl}_2$ **B** CCl_3CCl_3 **C** $\text{CH}_2\text{ClCCl}_3$ **D** $\text{CHCl}_2\text{CCl}_3$

- 29 Hydrogen, used as a reactant in the Haber process, can be produced industrially from either of the two reactions shown.



Assume hydrogen is the only utilised product. Which statement about the relative efficiencies of reagent use of these two reactions is correct?

- A** Reaction 1 is more efficient because it has a higher atom economy.
B Reaction 1 is more efficient because it has a lower atom economy.
C Reaction 2 is more efficient because it has a higher atom economy.
D Reaction 2 is more efficient because it has a lower atom economy.
- 30 Which molecule has the same number of atoms in a plane as a molecule of ethene, C_2H_4 ?
- A** BF_3 **B** IF_7 **C** PCl_5 **D** SF_6
- 31 A mixture of solids is treated with an excess of dilute hydrochloric acid.

A colourless gas is evolved and a white precipitate forms.

What are the solids in the mixture?

- A** calcium carbonate and magnesium hydroxide
B calcium carbonate and magnesium nitrate
C lead nitrate and calcium hydroxide
D lead nitrate and magnesium carbonate
- 32 Bone contains calcium salts and other material. When bone is strongly heated in air, calcium oxide is the only solid residue.

When 25.0 g of a bone sample is strongly heated in air, 7.0 g of solid residue remains.

What is the percentage by mass of calcium in the bone sample?

- A** 10.0% **B** 14.0% **C** 20.0% **D** 28.0%

- 33 In an experiment, 50.0 cm³ of a 0.100 mol dm⁻³ solution of a metal nitrate $M(\text{NO}_3)_3$ reacted exactly with 25.0 cm³ of a 0.100 mol dm⁻³ solution of sodium sulfite.

During this reaction the sulfite ions were oxidised.



The original solution of the metal salt contained M^{3+} ions.

What is the oxidation number of the metal in the final reaction mixture?

- A +1 B +2 C +4 D +5

- 34 The mass spectrum of CH_2F_2 would **not** contain a peak at which m/z value?

- A 14 B 19 C 38 D 52

- 35 Which does **not** represent a process that produces a detectable ion in a mass spectrometer?

- A $\text{C}_3\text{H}_6(\text{g}) + \text{H}^+(\text{g}) \rightarrow \text{C}_3\text{H}_7^+(\text{g})$
 B $\text{CH}_3\text{COCl}(\text{g}) + \text{e}^- \rightarrow \text{CH}_3\text{CO}^+(\text{g}) + \text{Cl}^-(\text{g}) + \text{e}^-$
 C $\text{Cl}_2(\text{g}) + \text{e}^- \rightarrow \text{Cl}\cdot(\text{g}) + \text{Cl}^-(\text{g})$
 D $\text{He}(\text{g}) + \text{e}^- \rightarrow \text{He}^+(\text{g}) + 2\text{e}^-$

- 36 Why does the atomic emission spectrum of hydrogen have fewer lines than that of helium?

- A H atoms, unlike He atoms, can dimerise to H_2 .
 B Hydrogen has fewer electrons.
 C Hydrogen has fewer protons.
 D There are no electron-electron interactions in H atoms.

- 37 Which description of the emission spectrum of the hydrogen atom is correct?

- A a series of lines that are evenly spaced
 B a series of lines that converge towards higher frequencies
 C a series of lines that converge towards lower energies
 D a series of lines that converge towards lower frequencies

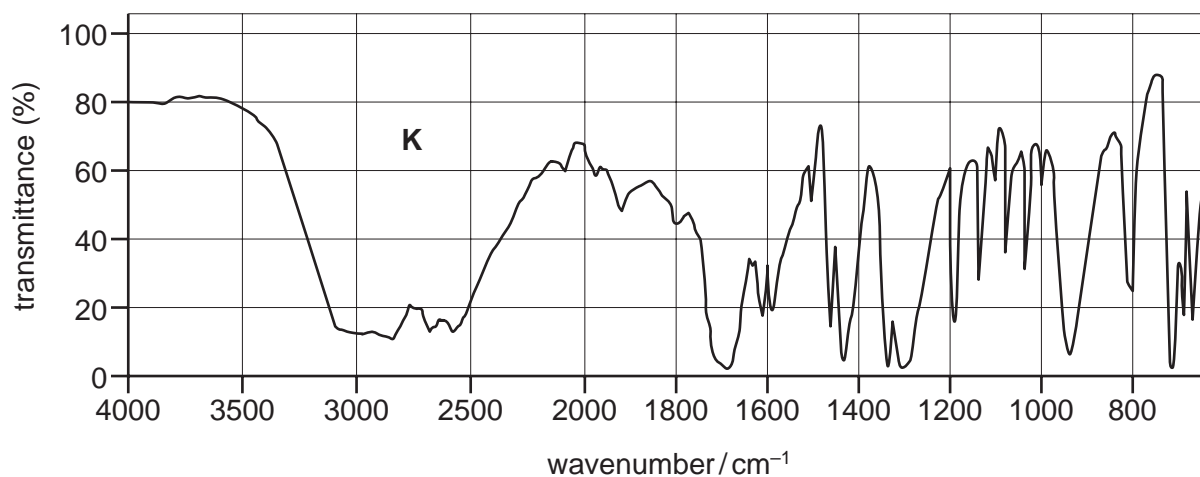
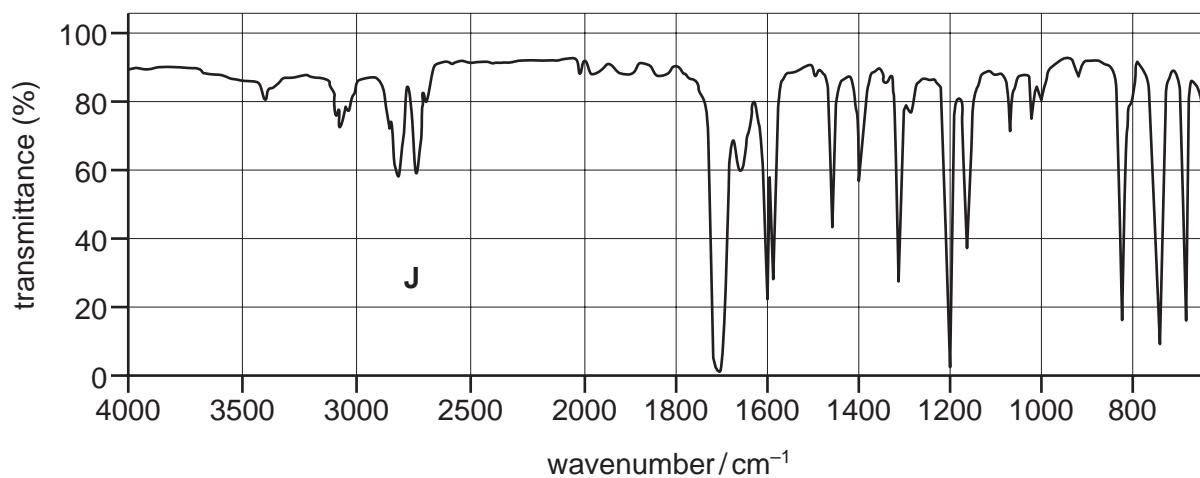
- 38 Compound **X** has a M_r of 58 and an infra-red spectrum that shows a strong absorbance at 3350 cm^{-1} .

What is compound **X**?

- A prop-2-en-1-ol
- B propanal
- C propan-1-ol
- D propanone

- 39 A sample of organic liquid **J** was placed on a watch-glass and left exposed to the atmosphere. A few days later a new substance **K** had been formed.

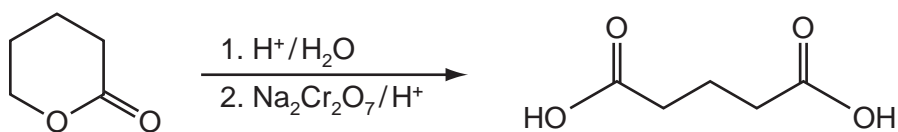
The infra-red spectra of **J** and **K** are given.



To which class of compounds do **J** and **K** belong?

	J	K
A	alcohol	carboxylic acid
B	alcohol	ketone
C	aldehyde	alcohol
D	aldehyde	carboxylic acid

- 40 How many carbon-13 NMR signals are given by the organic reactant and product in the following reaction?



	reactant	product
A	3	2
B	3	3
C	5	2
D	5	3

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