



**CHEMISTRY (PRINCIPAL)**

Paper 1 Part A Multiple Choice

**9791/01**

**May/June 2015**

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

This document consists of **13** printed pages and **3** blank pages.

1 Which of the sets is composed entirely of elements that are classed as metalloids in the Periodic Table?

A As Ge Te

B As S Te

C B Ga Si

D Ga Ge Si

2 Which row describes the structures of the first two elements in Group 15?

	nitrogen	white phosphorus
A	diatomic	monatomic
B	diatomic	tetra-atomic
C	monatomic	hexa-atomic
D	triatomic	tetra-atomic

3 When concentrated sulfuric acid is added to glucose,  $C_6H_{12}O_6$ , a strongly exothermic reaction occurs. There are two products of this reaction, one being a black solid.

What is the role of the concentrated sulfuric acid in this reaction?

A dehydrating agent

B involatile acid

C oxidising agent

D strong acid

4 What is the equation for the second ionisation energy of oxygen?

A  $O(g) \rightarrow O^{2+}(g) + 2e^{-}$

B  $O_2(g) \rightarrow O_2^{2+}(g) + 2e^{-}$

C  $O^{-}(g) + e^{-} \rightarrow O^{2-}(g)$

D  $O^{+}(g) \rightarrow O^{2+}(g) + e^{-}$

- 5 Ammonium ions in compounds used as fertilisers are oxidised in air by bacterial action as shown.



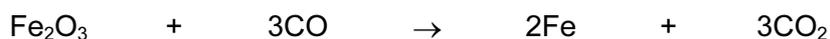
This equation is derived from two half-equations. The half-equation for the conversion of ammonium ions into nitrate ions is as follows.



What is the half-equation for the oxygen in air being reduced?

- A  $4\text{e}^- + \text{O}_2 + 2\text{H}_2\text{O} \rightarrow 4\text{OH}^-$   
 B  $4\text{e}^- + \text{O}_2 + 3\text{H}^+ \rightarrow \text{H}_2\text{O} + \text{OH}^-$   
 C  $4\text{e}^- + \text{O}_2 + 4\text{H}^+ \rightarrow 2\text{H}_2\text{O}$   
 D  $2\text{e}^- + \text{O}_2 + 2\text{H}^+ \rightarrow \text{H}_2\text{O}_2$
- 6 Many millions of tonnes of iron are produced by the reduction of iron ore which is usually in the form of iron(III) oxide.

The equation for the reaction is shown, with relative formula masses (RFM) of the substances involved.



RFM = 159.6

RFM = 28.0

RFM = 55.8

RFM = 44.0

Which calculation will give the atom economy for the production of iron in this reaction?

- A  $\frac{55.8 + 44.0}{159.6 + 28.0} \times 100$   
 B  $\frac{(55.8 \times 2)}{159.6 + (28.0 \times 3)} \times 100$   
 C  $\frac{55.8 \times 44.0}{159.6 \times 28.0} \times 100$   
 D  $\frac{55.8}{159.6 + (28.0 \times 3)} \times 100$
- 7 Which compound has the same empirical formula as its molecular formula?
- A ammonium nitrite  
 B dinitrogen tetroxide  
 C ethanoic acid  
 D propanoic acid

8 A student suggested three facts about the cyanogen molecule,  $(\text{CN})_2$ .

- 1 The molecule is linear.
- 2 The molecule contains three  $\sigma$  bonds.
- 3 The molecule contains four  $\pi$  bonds.

Which of these suggestions are correct?

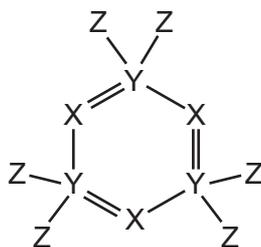
- A** 1, 2 and 3      **B** 1 and 2 only      **C** 1 and 3 only      **D** 2 and 3 only

9 Urea has the structural formula  $\text{CO}(\text{NH}_2)_2$ . Phosgene has the structural formula  $\text{COCl}_2$ .

What do these two molecules have in common?

- A** They can act as monomers to form an addition polymer.  
**B** They contain the same number of lone pairs of electrons.  
**C** They have a carbon atom at the carbonyl functional group level.  
**D** They produce carbon dioxide on hydrolysis.

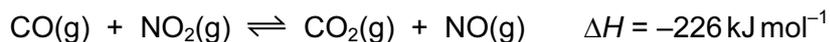
10 The diagram shows the structure of a molecule containing atoms of elements X, Y and Z.



What could be the identities of X, Y and Z?

	X	Y	Z
<b>A</b>	B	P	O
<b>B</b>	N	P	Cl
<b>C</b>	N	S	Cl
<b>D</b>	P	Si	H

- 11 Carbon monoxide, CO, reacts with nitrogen dioxide, NO<sub>2</sub>.

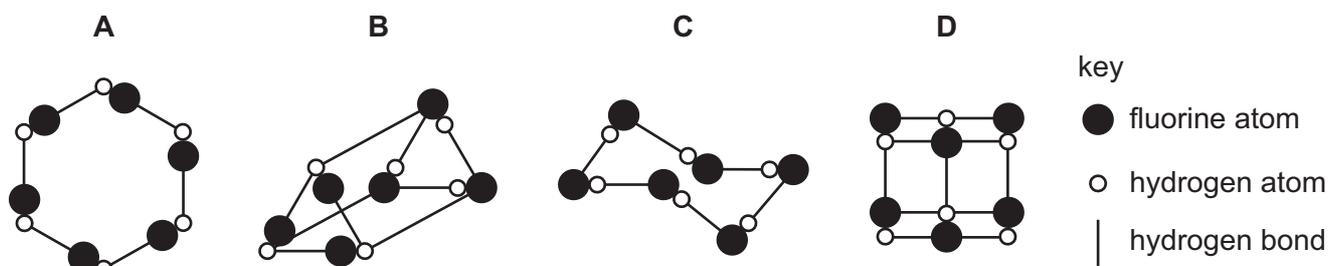


The activation energy for the **reverse** reaction is +360 kJ mol<sup>-1</sup>.

What is the activation energy for the forward reaction?

- A -586 kJ mol<sup>-1</sup>  
 B -134 kJ mol<sup>-1</sup>  
 C +134 kJ mol<sup>-1</sup>  
 D +586 kJ mol<sup>-1</sup>
- 12 Which two quantities have the same magnitude?  
 [ $E(\text{X}-\text{Y})$  represents the X-Y bond energy.]
- A  $\Delta_c H^\ominus(\text{C})$  and  $2E(\text{C}=\text{O})$   
 B  $\Delta_f H^\ominus(\text{H}_2\text{O})$  and  $\Delta_c H^\ominus(\text{H}_2)$   
 C second ionisation energy of O and electron affinity of O<sup>+</sup>  
 D  $E(\text{H}-\text{H})$  and  $\Delta_{\text{at}} H^\ominus(\text{H})$
- 13 In the liquid phase, six molecules of HF can come together in a hexamer bound by hydrogen bonding.

Using your knowledge of hydrogen bonding, which structure best represents the hexamer?

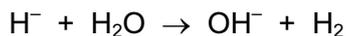


- 14 When elements react to form ionic compounds they usually form ions with the electron configuration of a noble gas.

Which ion does **not** have the electron configuration of a noble gas?

- A Ga<sup>3+</sup>                      B H<sup>-</sup>                      C Li<sup>+</sup>                      D Se<sup>2-</sup>

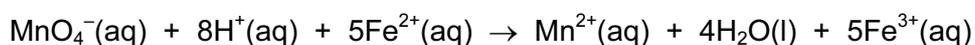
15 Ionic metal hydrides react with water.



1.0 g samples of ionic hydrides were separately added to an excess of water.

Which ionic hydride produced the greatest mass of hydrogen gas?

- A calcium hydride
  - B magnesium hydride
  - C potassium hydride
  - D sodium hydride
- 16 Acidified  $\text{MnO}_4^-$ (aq) is often used in titrations to determine the concentrations of other solutions. One such reaction is represented by the ionic equation shown.



Which statement is correct?

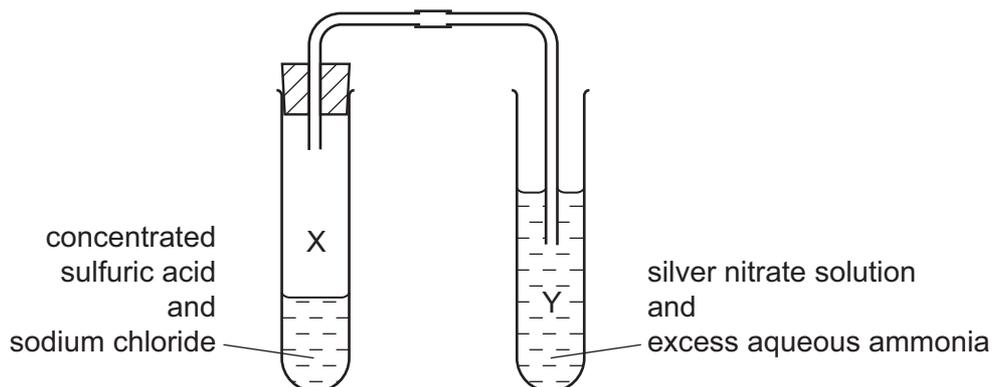
- A Each  $\text{Fe}^{2+}$  ion has gained 5 electrons.
  - B Each  $\text{H}^+$  ion is oxidised.
  - C The oxidation number of Mn has changed from  $-1$  to  $+2$ .
  - D The oxidation number of Mn has changed from  $+7$  to  $+2$ .
- 17 Liquid HF contains the ions  $\text{H}_2\text{F}^+$  and  $\text{HF}_2^-$  as a result of the equilibrium shown.



What type of reaction is this?

- A acid-base
  - B decomposition
  - C disproportionation
  - D electrolysis
- 18 When silicon tetrachloride is added to water, which description is correct?
- A  $\text{SiCl}_4$  dissolves to give a neutral solution.
  - B  $\text{SiCl}_4$  reacts to give an acidic solution and a precipitate.
  - C  $\text{SiCl}_4$  reacts to give an acidic solution only.
  - D  $\text{SiCl}_4$  reacts to give a neutral solution and a precipitate.

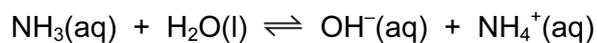
19 The diagram shows an experiment.



What is seen **just after** the two tubes are connected?

	colour of gas at X	observation at Y
<b>A</b>	colourless	no precipitate
<b>B</b>	colourless	white precipitate
<b>C</b>	green	no precipitate
<b>D</b>	green	white precipitate

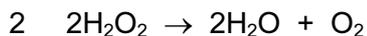
20 The reaction of ammonia with water is shown.



Which row gives the correct description of the reactants and products in this reaction?

	$\text{NH}_3(\text{aq})$	$\text{H}_2\text{O}(\text{l})$	$\text{OH}^-(\text{aq})$
<b>A</b>	acid	neutral	conjugate acid
<b>B</b>	base	acid	conjugate acid
<b>C</b>	base	acid	conjugate base
<b>D</b>	base	neutral	conjugate base

21 Two reactions of hydrogen peroxide are shown.



What change do the oxygen atoms in hydrogen peroxide undergo in each of the above reactions?

	reaction 1	reaction 2
<b>A</b>	disproportionation	reduction
<b>B</b>	oxidation	disproportionation
<b>C</b>	reduction	oxidation
<b>D</b>	reduction	disproportionation

22 Carbon monoxide reduces iodine(V) oxide to iodine.



This reaction can be used to estimate carbon monoxide quantitatively as the liberated iodine can be reacted with sodium thiosulfate.

How many moles of thiosulfate ions would reduce the iodine produced from 1 mole of carbon monoxide in the above equation?

- A** 0.1                      **B** 0.4                      **C** 2.0                      **D** 2.5

23 Which description involves the largest number of moles of the substance given?

- A** 480 cm<sup>3</sup> of HCl(g) at room temperature and pressure  
**B** 1.92 g of ozone  
**C** H<sup>+</sup>(aq) in 0.1 dm<sup>3</sup> of 0.5 mol dm<sup>-3</sup> CH<sub>3</sub>CO<sub>2</sub>H(aq)  
**D** OH<sup>-</sup>(aq) in 0.5 dm<sup>3</sup> of 0.1 mol dm<sup>-3</sup> NaOH(aq)

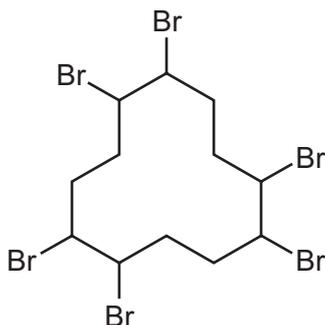
24 A 30 cm<sup>3</sup> sample of butane, C<sub>4</sub>H<sub>10</sub>, was completely reacted in a limited supply of oxygen to produce 60 cm<sup>3</sup> of carbon dioxide and 60 cm<sup>3</sup> of carbon monoxide.

All volumes were measured at room temperature and pressure.

Which volume of oxygen was used?

- A** 90 cm<sup>3</sup>                      **B** 120 cm<sup>3</sup>                      **C** 150 cm<sup>3</sup>                      **D** 165 cm<sup>3</sup>

25 The compound shown is used as a flame retardant.



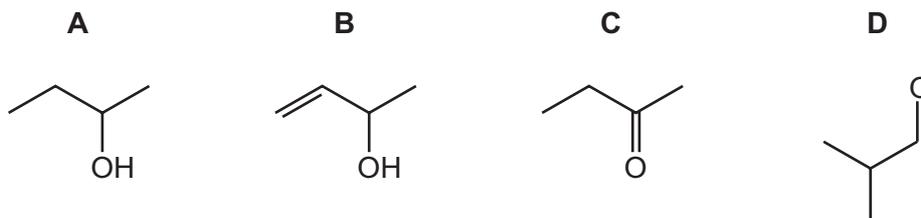
Which statement about this molecule is **not** correct?

- A** Each brominated carbon atom is chiral.  
**B** It contains six carbon atoms at the alcohol functional group level.  
**C** Its empirical formula is  $C_2H_3Br$ .  
**D** The carbon atom ring is planar.
- 26 An organic compound has the molecular formula  $C_3H_4NCl$ . Some of its isomers have one carbon atom at the carboxylic acid functional group level, one carbon atom at the alcohol functional group level and contain a triple bond.

How many such isomers does this compound have?

- A** 1                      **B** 2                      **C** 3                      **D** 4
- 27 Molecule **X** has the formula  $C_4H_8O$ . When added to hot, acidified  $Na_2Cr_2O_7$ , a colour change from orange to green was observed. Molecule **X** has an asymmetric carbon.

What is the structure of **X**?



28 Allophanic acid has the structural formula  $\text{H}_2\text{NCONHCO}_2\text{H}$ .

Which row correctly describes the functional group levels of the two carbon atoms in allophanic acid?

	carbonyl level	carboxylic acid level	carbon dioxide level
<b>A</b>	0	0	2
<b>B</b>	0	1	1
<b>C</b>	1	0	1
<b>D</b>	1	1	0

29 What occurs in the reaction between 1-chloropropane,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$ , and cyanide ions,  $\text{CN}^-$ ?

- A** an addition reaction
- B** an increase in the carbon chain length
- C** formation of an amine
- D** no change in functional group level of any carbon atom

30 Which products are formed when propanal reacts with Tollens' reagent?

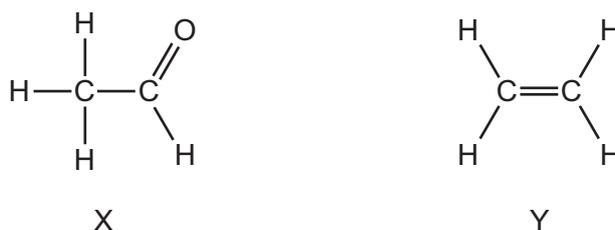
- A**  $\text{Ag}$  and  $\text{CH}_3\text{COO}^-$
- B**  $\text{Ag}$  and  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- C**  $\text{Ag}$  and  $\text{CH}_3\text{CH}_2\text{COO}^-$
- D**  $\text{Ag}_2\text{O}$  and  $\text{CH}_3\text{CH}_2\text{COO}^-$

31 Alcohols can undergo an elimination reaction to produce alkenes.

How many isomeric alkenes can be produced by the elimination of water from butan-2-ol?

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

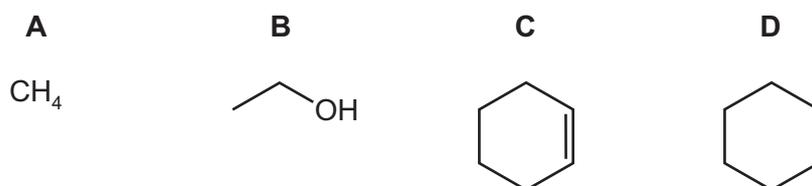
32 The diagram shows two organic molecules.



Why does molecule X react readily with HCN but molecule Y does not?

- A X contains a saturated carbon atom but Y does not.
- B X contains a single C–C bond whereas Y contains a double C=C bond.
- C X contains the polar C=O bond whereas Y contains the non-polar C=C bond.
- D X has a greater number of electrons than Y.

33 Which compound is most reactive towards chlorine?



34 Which change to a reaction process will **never** increase the atom economy of the reaction?

- A finding a reactant of lower molecular mass
- B finding a use for a waste product
- C using a catalyst
- D using a harmless alternative to a toxic reactant

35 Three test-tubes contain HCl(aq), H<sub>2</sub>SO<sub>4</sub>(aq) and HNO<sub>3</sub>(aq).

The addition of which ions to each test-tube would identify the test-tube containing H<sub>2</sub>SO<sub>4</sub>(aq)?

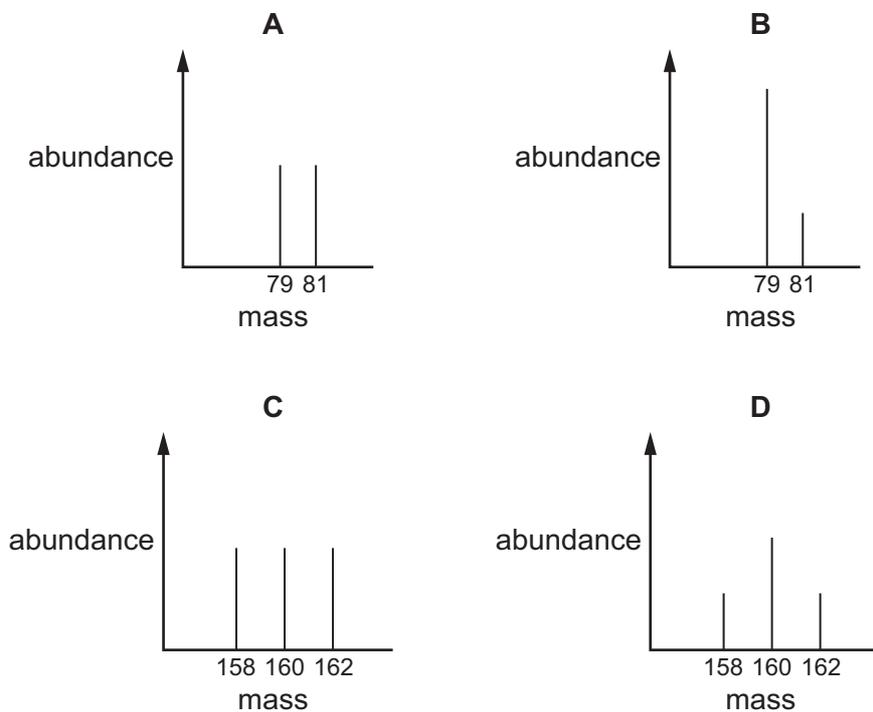
- A Ba<sup>2+</sup>(aq)      B CrO<sub>4</sub><sup>2-</sup>(aq)      C CO<sub>3</sub><sup>2-</sup>(aq)      D Pb<sup>2+</sup>(aq)

36 What is the m/z value of a significant peak found in the mass spectrum of propanal (CH<sub>3</sub>CH<sub>2</sub>CHO) and **not** found in the mass spectrum of propanone (CH<sub>3</sub>COCH<sub>3</sub>)?

- A 15                  B 29                  C 43                  D 58

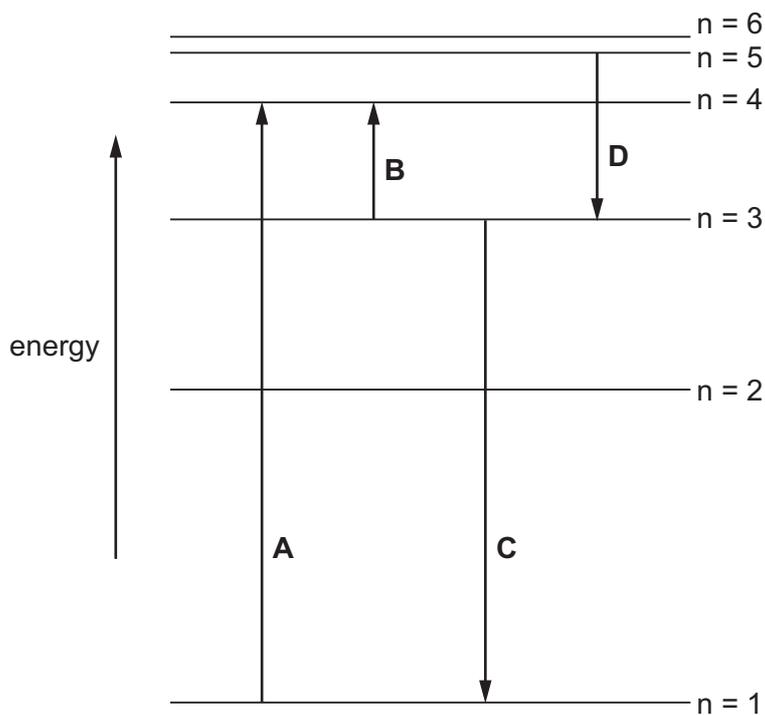
- 37 Bromochlorodifluoromethane (BCF) has been used in fire extinguishers. It is the bromine atom that gives it its flame-retarding property. BCF can be identified by mass spectrometry.

Which peaks would be present in the mass spectrum of BCF?



- 38 The diagram shows the energy levels within the hydrogen atom with some transitions between the energy levels included.

Which transition will have the highest frequency in the **emission** spectrum of the hydrogen atom?



39 Which bond will vibrate at the highest frequency?

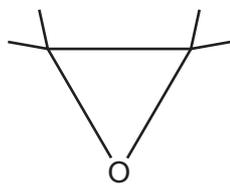
A N-H

B N-C

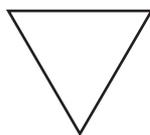
C N=C

D N≡C

40 Which molecules have the same number of peaks in their  $^{13}\text{C}$  NMR spectra?



1



2



3

A 1, 2 and 3

B 1 and 2 only

C 1 and 3 only

D 2 and 3 only





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