UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/13**

Paper 1 Multiple Choice **May/June 2010**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

* 2 2 8 8 6 3 3 3 6 9 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, 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.

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 rough working should be done in this booklet.

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

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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.

1 Which gas closely approaches ideal behaviour at room temperature and pressure?

A ammonia

B carbon dioxide

C helium

D oxygen

2 *Use of the Data Booklet is relevant to this question.*

The elements radon (Rn), francium (Fr) and radium (Ra) have consecutive proton numbers in the Periodic Table.

What is the order of their first ionisation energies?

	least endothermic ⟶		most endothermic
A	Fr	Ra	Rn
B	Fr	Rn	Ra
C	Ra	Fr	Rn
D	Rn	Ra	Fr

3 *Use of the Data Booklet is relevant to this question.*

What could be the proton number of an element that has three unpaired electrons in each of its atoms?

A 5 **B** 13 **C** 15 **D** 21

4 Given the following enthalpy changes,

$$I_2(g) + 3Cl_2(g) \rightarrow 2ICl_3(s) \qquad \Delta H^{\ominus} = -214\,kJ\,mol^{-1}$$

$$I_2(s) \rightarrow I_2(g) \qquad \Delta H^{\ominus} = +38\,kJ\,mol^{-1}$$

What is the standard enthalpy change of formation of iodine trichloride, $ICl_3(s)$?

A $+176\,kJ\,mol^{-1}$

B $-88\,kJ\,mol^{-1}$

C $-176\,kJ\,mol^{-1}$

D $-214\,kJ\,mol^{-1}$

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5 Some bond energy values are listed below.

bond	bond energy / kJ mol^{-1}
C–H	410
C–C*l*	340
C*l*–C*l*	244
Br–Br	193

These bond energy values relate to the following four reactions.

P $Br_2 \rightarrow 2Br$

Q $2C\mathit{l} \rightarrow C\mathit{l}_2$

R $CH_3 + C\mathit{l} \rightarrow CH_3C\mathit{l}$

S $CH_4 \rightarrow CH_3 + H$

What is the order of enthalpy changes of these reactions from most negative to most positive?

A P → Q → R → S

B Q → R → S → P

C R → Q → P → S

D S → P → Q → R

6 Which mass of gas would occupy a volume of 3 dm^3 at 25 °C and 1 atmosphere pressure?
[1 mol of gas occupies 24 dm^3 at 25 °C and 1 atmosphere pressure.]

A 3.2 g O_2 gas

B 5.6 g N_2 gas

C 8.0 g SO_2 gas

D 11.0 g CO_2 gas

7 Ammonium nitrate, NH_4NO_3, can decompose explosively when heated.

$$NH_4NO_3 \rightarrow N_2O + 2H_2O$$

What are the changes in the oxidation numbers of the two nitrogen atoms in NH_4NO_3 when this reaction proceeds?

A –2, –4 **B** +2, +6 **C** +4, –6 **D** +4, –4

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8 The Haber process for the manufacture of ammonia is represented by the following equation.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\,kJ\,mol^{-1}$$

Which statement is correct about this reaction when the temperature is increased?

A Both forward and backward rates increase.

B The backward rate only increases.

C The forward rate only increases.

D There is no effect on the backward or forward rate.

9 *Use of the Data Booklet is relevant to this question.*

2.920 g of a Group II metal, **X**, reacts with an excess of chlorine to form 5.287 g of a compound with formula **X**Cl_2.

What is metal **X**?

A barium

B calcium

C magnesium

D strontium

10 The table gives the concentrations and pH values of the aqueous solutions of two compounds, X and Y. Either compound could be an acid or a base.

	X	Y
concentration	$2\,mol\,dm^{-3}$	$2\,mol\,dm^{-3}$
pH	6	9

Student P concluded that X is a strong acid.

Student Q concluded that the extent of dissociation is lower in X(aq) than in Y(aq).

Which of the students are correct?

A both P and Q

B neither P nor Q

C P only

D Q only

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11 How does concentrated sulfuric acid behave when it reacts with sodium chloride?

A as an acid only

B as an acid and oxidising agent

C as an oxidising agent only

D as a reducing agent only

12 Swimming pool water can be kept free of harmful bacteria by adding aqueous sodium chlorate(I), NaOC*l*. This reacts with water to produce HOC*l* molecules which kill bacteria.

$$OCl^-(aq) + H_2O \rightleftharpoons OH^-(aq) + HOCl(aq)$$

In bright sunshine, the OCl^- ion is broken down by ultra-violet light.

$$OCl^-(aq) + \text{uv light} \rightarrow Cl^-(aq) + \tfrac{1}{2}O_2(g)$$

Which method would maintain the highest concentration of HOC*l*(aq)?

A acidify the pool water

B add a solution of chloride ions

C add a solution of hydroxide ions

D bubble air through the water

13 $Na_2S_2O_3$ reacts with dilute HC*l* to give a pale yellow precipitate. If 1 cm^3 of 0.1 mol dm^{-3} HC*l* is added to 10 cm^3 of 0.02 mol dm^{-3} $Na_2S_2O_3$ the precipitate forms slowly.

If the experiment is repeated with 1 cm^3 of 0.1 mol dm^{-3} HC*l* and 10 cm^3 of 0.05 mol dm^{-3} $Na_2S_2O_3$ the precipitate forms more quickly.

Why is this?

A The activation energy of the reaction is lower when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

B The reaction proceeds by a different pathway when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

C The collisions between reactant particles are more violent when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

D The reactant particles collide more frequently when 0.05 mol dm^{-3} $Na_2S_2O_3$ is used.

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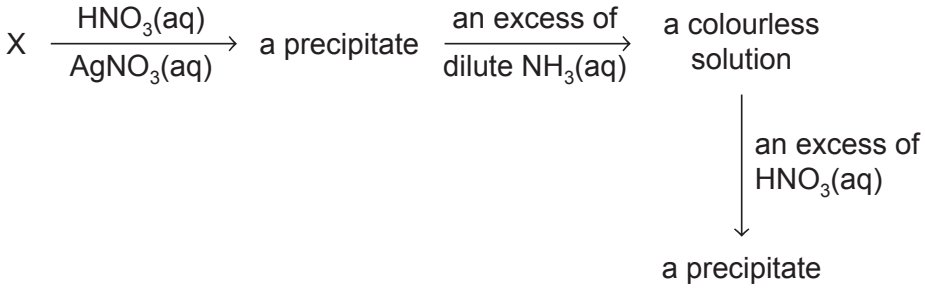
14 X is a salt of one of the halogens chlorine, bromine, iodine, or astatine (proton number 85).

The reaction scheme shows a series of reactions using a solution of X as the starting reagent.



What could X be?

A sodium chloride

B sodium bromide

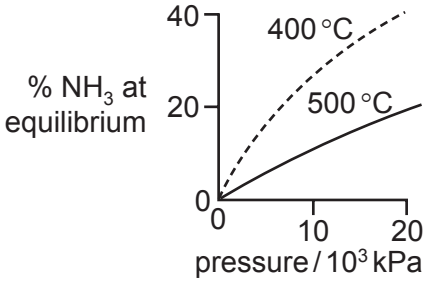
C potassium iodide

D potassium astatide

15 The percentage of ammonia obtainable, if equilibrium were established during the Haber process, is plotted against the operating pressure for two temperatures, 400 °C and 500 °C.

Which diagram correctly represents the two graphs?

A



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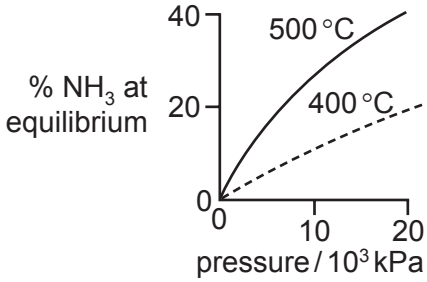

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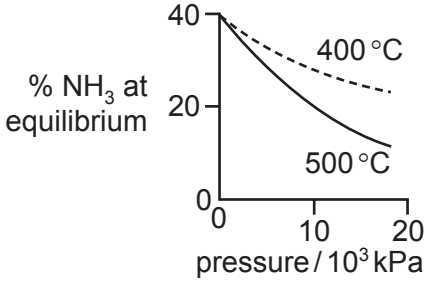

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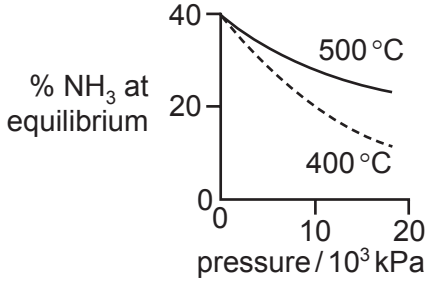

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16 Two properties of non-metallic elements and their atoms are as follows.

property 1 has an oxide that can form a strong acid in water

property 2 has **no** paired 3p electrons

Which properties do phosphorus and sulfur have?

	phosphorus	sulfur
A	1 and 2	1 only
B	1 only	1 and 2
C	1 and 2	1 and 2
D	2 only	1 only

17 Consecutive elements X, Y, Z are in the third period of the Periodic Table. Element Y has the highest first ionisation energy and the lowest melting point.

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

A aluminium, silicon, phosphorus

B magnesium, aluminium, silicon

C silicon, phosphorus, sulfur

D sodium, magnesium, aluminium

18 Which property of Group II elements (beryllium to barium) decreases with increasing atomic number?

A reactivity with water

B second ionisation energy

C solubility of hydroxides

D stability of the carbonates

19 Which element of the third period requires the least number of moles of oxygen for the complete combustion of 1 mol of the element?

A aluminium

B magnesium

C phosphorus

D sodium

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20 When gaseous chemicals are transported by road or by rail they are classified as follows.

flammable non-flammable poisonous

Which commonly transported gas is non-flammable?

A butane

B hydrogen

C oxygen

D propene

21 What will react differently with the two isomeric alcohols, $(CH_3)_3CCH_2OH$ and $(CH_3)_2CHCH_2CH_2OH$?

A acidified aqueous potassium manganate(VII)

B concentrated sulfuric acid

C phosphorus pentachloride

D sodium

22 What is formed when propanone is refluxed with a solution of $NaBH_4$?

A propanal

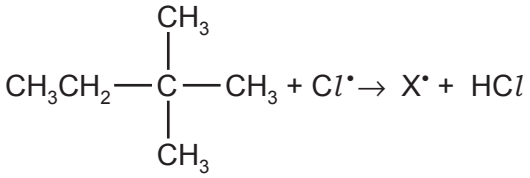
B propan-1-ol

C propan-2-ol

D propane

23 When heated with chlorine, the hydrocarbon 2,2-dimethylbutane undergoes free radical substitution.

In a propagation step the free radical $X^{\bullet}$ is formed.



How many different forms of $X^{\bullet}$ are possible?

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

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24 Which reagent will give similar results with both butanone and butanal?

A acidified aqueous potassium dichromate(VI)

B an alkaline solution containing complexed Cu^{2+} ions (Fehling's solution)

C an aqueous solution containing $[Ag(NH_3)_2]^+$ (Tollens' reagent)

D 2,4-dinitrophenylhydrazine reagent

25 Which compound is a product of the hydrolysis of $CH_3CO_2C_3H_7$ by boiling aqueous sodium hydroxide?

A CH_3OH **B** C_3H_7OH **C** $C_3H_7CO_2H$ **D** $C_3H_7CO_2^- Na^+$

26 Which compound exhibits both *cis-trans* and optical isomerism?

A $CH_3CH=CHCH_2CH_3$

B $CH_3CHBrCH=CH_2$

C $CH_3CBr=CBrCH_3$

D $CH_3CH_2CHBrCH=CHBr$

27 In many countries plastic waste is collected separately and sorted. Some of this is incinerated to provide heat for power stations.

Why is pvc, polyvinylchloride, removed from any waste that is to be incinerated?

A It destroys the ozone layer.

B It does not burn easily.

C It is easily biodegradable.

D Its combustion products are harmful.

28 Polymerisation of 1,1-dichloroethene produces a dense, high melting point substance that does not allow gases to pass through. It is used as cling wrapping.

Which sequence appears in a short length of the polymer chain?

A $\dagger CH_2CCl_2CH_2CCl_2CH_2CCl_2\dagger$

B $\dagger CHClCHClCHClCHClCHClCHCl\dagger$

C $\dagger CCl_2CCl_2CCl_2CCl_2CCl_2CCl_2\dagger$

D $\dagger CH_2CCl_2CHClCHClCH_2CCl_2\dagger$

29 When an isomer Y of molecular formula C_4H_9Br undergoes hydrolysis in aqueous alkali to form an alcohol C_4H_9OH, the rate of reaction is found to be unaffected by changes in the concentration of OH^- ions present.

Which is the most likely molecular structure of Y?

A $CH_3CH_2CH_2CH_2Br$

B $CH_3CH_2CHBrCH_3$

C $(CH_3)_2CHCH_2Br$

D $(CH_3)_3CBr$

30 Which isomer of $C_4H_{10}O$ forms three alkenes on dehydration?

A butan-1-ol

B butan-2-ol

C 2-methylpropan-1-ol

D 2-methylpropan-2-ol

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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.

31 Which reactions are redox reactions?

1 $CaBr_2 + 2H_2SO_4 \rightarrow CaSO_4 + Br_2 + SO_2 + 2H_2O$

2 $CaBr_2 + 2H_3PO_4 \rightarrow Ca(H_2PO_4)_2 + 2HBr$

3 $CaBr_2 + 2AgNO_3 \rightarrow Ca(NO_3)_2 + 2AgBr$

32 Sodium hydrogensulfide, NaSH, is used to remove hair from animal hides.

Which statements about the SH^- ion are correct?

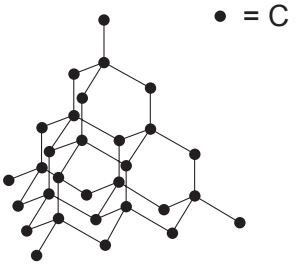
1 It contains 18 electrons.

2 Three lone pairs of electrons surround the sulfur atom.

3 Sulfur has an oxidation state of +2.

33 Which diagrams represent part of a giant molecular structure?

1



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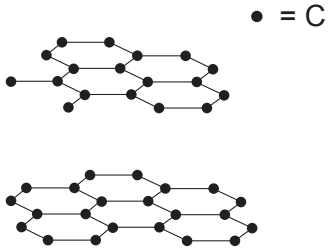

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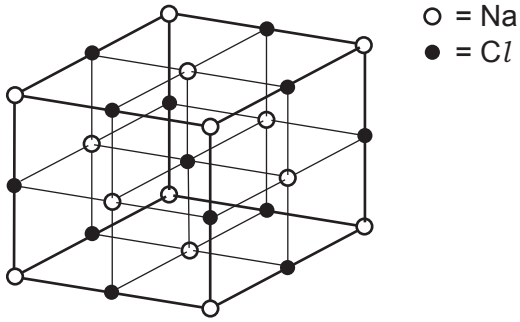

The responses **A** to **D** should be selected on the basis of

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.

34 In a car engine, non-metallic element X forms a pollutant oxide Y.

Further oxidation of Y to Z occurs in the atmosphere. In this further oxidation, 1 mol of Y reacts with ½ mol of gaseous oxygen.

What can X be?

1 carbon

2 nitrogen

3 sulfur

35 When organic refuse decomposes in water carboxylic acids are formed. The water becomes acidic and aquatic life is destroyed.

Which additives are suitable to remove this acid pollution?

1 calcium carbonate

2 calcium hydroxide

3 potassium nitrate

36 Sulfur dioxide and sulfites are used in food preservation.

Why are they used for this purpose?

1 They are reducing agents so retard the oxidation of food.

2 They inhibit the growth of aerobic bacteria.

3 They react with $NO_2(g)$ converting it to $NO(g)$.

37 Which structural formulae represent 2,2-dimethylpentane?

1 $(CH_3)_2CHCH_2CH(CH_3)_2$

2 $(CH_3)_3CCH_2CH_2CH_3$

3 $CH_3CH_2CH_2C(CH_3)_3$

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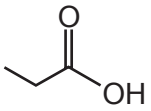
38 Which reactions are examples of nucleophilic substitution?

1 $CH_3CH_2Br + OH^- \rightarrow CH_3CH_2OH + Br^-$

2 $CH_3I + H_2O \xrightarrow{H^+} CH_3OH + HI$

3 $CH_3CH_2CH_2Cl + NH_3 \rightarrow CH_3CH_2CH_2NH_2 + HCl$

39 Propanoic acid occurs naturally as a result of the bacterial fermentation of milk, and is partly responsible for the flavour of Swiss cheese.



propanoic acid

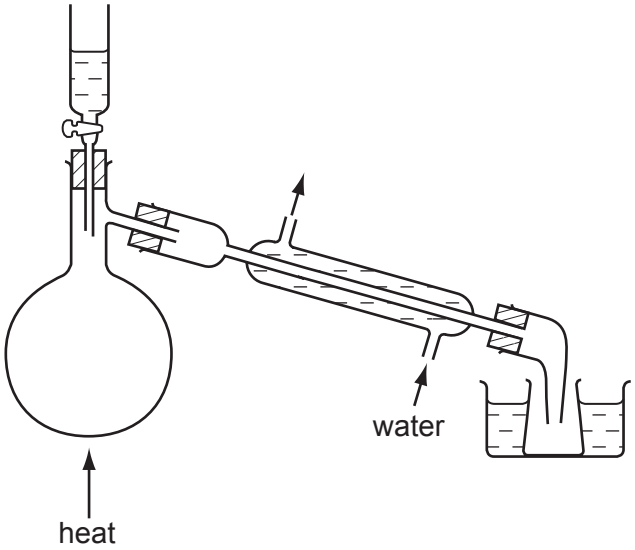
Which starting materials could be used to synthesise propanoic acid?

1 $CH_3CH_2CH_2OH$

2 CH_3CH_2CN

3 CH_3CH_2CHO

40 The diagram shows some laboratory apparatus.



Which preparations could this apparatus be used for?

1 bromoethane, from ethanol, sodium bromide and concentrated sulfuric acid

2 ethanal, from ethanol, sodium dichromate(VI) and sulfuric acid

3 1,2-dibromoethane, from bromine and ethene

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