



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE
NAME

CENTRE
NUMBER

| | | | | |
|--|--|--|--|--|
| | | | | |
|--|--|--|--|--|

CANDIDATE
NUMBER

| | | | |
|--|--|--|--|
| | | | |
|--|--|--|--|



CHEMISTRY

5070/21

Paper 2 Theory

October/November 2010

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Section A

Answer **all** questions.

Write your answers in the spaces provided in the Question Paper.

Section B

Answer any **three** questions.

Write your answers in the spaces provided in the Question Paper.

A copy of the Periodic Table is printed on page 20.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

| For Examiner's Use | |
|--------------------|--|
| Section A | |
| B6 | |
| B7 | |
| B8 | |
| B9 | |
| Total | |

This document consists of **16** printed pages and **4** blank pages.



Section A

Answer **all** the questions in this section in the spaces provided.

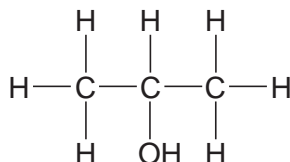
The total mark for this section is 45.

For
Examiner's
Use

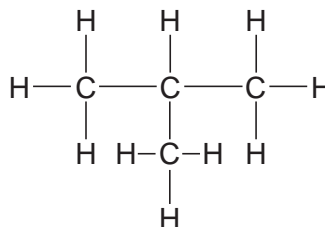
A1 The structural formulae of some compounds containing the element carbon are shown.



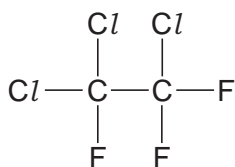
A



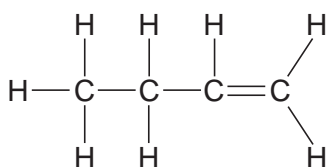
B



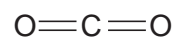
C



D



E



F

(a) Choose from the compounds **A**, **B**, **C**, **D**, **E** and **F** to answer the questions below. Each compound can be used once, more than once or not at all.

Which one of these compounds is

(i) responsible for the depletion of ozone in the upper atmosphere,

..... [1]

(ii) a poisonous gas produced by the incomplete combustion of hydrocarbons,

..... [1]

(iii) an unsaturated hydrocarbon, [1]

(iv) formed when propene reacts with steam, [1]

(v) a product of respiration, [1]

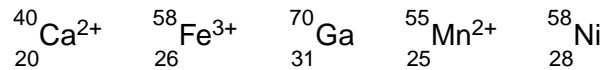
(vi) an isomer of butane? [1]

(b) Name compound **B**.

..... [1]

[Total: 7]

A2 The symbols of some atoms and ions including their nucleon number and proton number are shown below.



(a) Which **one** of these atoms or ions has the greatest number of protons?

.....[1]

(b) Which **two** of these atoms or ions have the same number of neutrons?

.....[1]

(c) State the number of electrons in the ion ${}^{55}_{25}\text{Mn}^{2+}$.

.....[1]

(d) Write the full electronic configuration of the ion ${}^{40}_{20}\text{Ca}^{2+}$.

.....[1]

(e) (i) Nickel, Ni, can be alloyed with other metals. Draw a diagram to show the structure of an alloy.

[2]

(ii) State **one** specific use of nickel other than its use in alloys.

.....[1]

(iii) Explain why alloys of nickel and iron are stronger than pure iron.

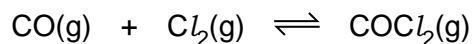
.....
.....

.....[2]

[Total:9]

A3 Carbonyl chloride, COCl_2 , is a colourless, poisonous gas formed when carbon monoxide and chlorine combine in the presence of sunlight. The forward reaction is exothermic.

For
Examiner's
Use



(a) Predict and explain how each of the following affects the position of equilibrium in this reaction:

(i) increasing the concentration of chlorine;

.....

 [2]

(ii) increasing the pressure;

.....

 [2]

(iii) increasing the temperature.

.....

 [2]

(b) Carbonyl chloride reacts with ammonia to form urea, $(\text{NH}_2)_2\text{CO}$, and ammonium chloride.

Write an equation for this reaction.

..... [2]

(c) Urea can be used as a fertiliser.

(i) How do fertilisers increase crop yields?

.....
..... [1]

(ii) Urea is produced industrially by the reaction of ammonia with carbon dioxide.

The ammonia is manufactured using the Haber process by combining the elements nitrogen and hydrogen.

State the essential conditions in the Haber process which are necessary in order to produce a high yield of ammonia.

.....
.....
..... [3]

[Total: 12]

A4 Many inks contain salts of the metals potassium, iron, cobalt and nickel in addition to ethanoic acid and gallic acid.

(a) (i) State **two** differences in the physical properties of the metals potassium and iron.

.....
.....[2]

(ii) State **one** difference in the chemical properties of potassium and iron.

.....
.....[1]

(b) Analysis of 21.25 g of gallic acid showed that it contained 10.50 g of carbon, 0.75 g of hydrogen and 10.00 g of oxygen.

Show that the empirical formula of gallic acid is $C_7H_6O_5$.

[3]

(c) Gallic acid can be used as a photographic developer. It reduces silver ions to silver.

(i) Write an equation for the reduction of silver ions to silver.

[1]

(ii) Explain why this is a reduction reaction.

.....[1]

(d) The blue colour of ink is due to the reaction between gallic acid and iron(III) ions.

Describe a standard test for iron(III) ions.

test.....

result [2]

[Total: 10]

A5 A student electrolysed an aqueous solution of potassium bromide using carbon electrodes.

(a) Draw a labelled diagram of a suitable apparatus that can be used for this electrolysis.

[2]

(b) The ions present in an aqueous solution of potassium bromide are H^+ , OH^- , K^+ and Br^- .

(i) Describe what you would observe in the region of the anode during the electrolysis.

..... [1]

(ii) At the cathode, hydrogen gas is given off.

Describe a test for hydrogen.

test

result [2]

(iii) Write an equation for the reaction at the cathode.

..... [1]

(iv) Explain why potassium is **not** discharged at the cathode.

.....

..... [1]

[Total: 7]

Section B

Answer **three** questions from this section in the spaces provided.

The total mark for this section is 30.

For
Examiner's
Use

- B6** Part of Mendeleev's original Periodic Table showing an arrangement of elements according to their similar properties is shown below. The numbers are the atomic masses of the elements.

| | | | |
|--------|----------|-----------|--------------|
| | | | Fe = 56 |
| | | | Ni / Co = 59 |
| H = 1 | | | Cu = 63.4 |
| | Be = 9.4 | Mg = 24 | Zn = 65.2 |
| | B = 11 | Al = 27.4 | element X |
| | C = 12 | Si = 28 | element Y |
| | N = 14 | P = 31 | As = 75 |
| | O = 16 | S = 32 | Se = 74.9 |
| | F = 19 | Cl = 35.5 | Br = 80 |
| Li = 7 | Na = 23 | K = 39 | Rb = 85.4 |
| | | Ca = 40 | Sr = 87.6 |

- (a) Mendeleev listed the elements in order of their atomic masses.

What determines the order of the elements in the **modern** Periodic Table?

..... [1]

- (b) Mendeleev predicted the properties of the undiscovered element X. You will find element X in the table above.

Study the pattern in which the elements are arranged in the table above. Deduce to which Group in the **modern** Periodic Table element X belongs.

..... [1]

- (c) Describe **two** other differences between Mendeleev's original Periodic Table and the modern Periodic Table.

.....

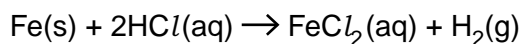
 [2]

(d) Iron, cobalt and nickel have similar properties.

- (i) State the name of the block of elements in the modern Periodic Table which includes iron, cobalt and nickel.

..... [1]

- (ii) Iron reacts with dilute hydrochloric acid.



Use ideas about particles to describe and explain the effect of temperature on the speed of this reaction.

.....

 [2]

(e) Lithium, sodium and potassium are elements which show a trend in melting points and reaction with water.

- (i) Describe the trend in the reaction of these elements with water.

.....
 [1]

- (ii) Write an equation for the reaction of sodium with water.

[1]

(iii) The melting points of lithium, sodium and potassium are:

lithium 181 °C
 sodium 98 °C
 potassium 63 °C

Predict the melting point of rubidium.

..... [1]

[Total: 10]

- B7** The table shows the boiling points of the first four members of the alkane homologous series. It also shows the enthalpy changes when these alkanes undergo complete combustion.

For
Examiner's
Use

| alkane | boiling point /°C | enthalpy change of combustion/kJ per mole |
|---------|-------------------|---|
| methane | - 161 | - 890 |
| ethane | - 88 | -1560 |
| propane | - 42 | -2219 |
| butane | 0 | -2877 |

- (a)** State **two** characteristics of a homologous series.

.....
..... [2]

- (b)** Pentane is the next member of the alkane homologous series.

- (i)** Give the molecular formula of pentane.

..... [1]

- (ii)** Predict the boiling point of pentane.

..... [1]

- (c) (i)** What information in the table tells you that the combustion of alkanes is exothermic?

..... [1]

- (ii)** In terms of bond making and bond breaking, explain why the combustion of alkanes is exothermic.

.....
.....
.....
..... [2]

(iii) The difference in the enthalpy change of combustion from one alkane to the next is approximately the same. Suggest why.

For
Examiner's
Use

.....
.....
.....[2]

(d) Methane is an atmospheric pollutant. Give one source of this pollutant.

.....[1]

[Total: 10]

B8 Proteins are naturally occurring macromolecules.

(a) (i) What do you understand by the term *macromolecule*?

.....[1]

(ii) Name another naturally occurring macromolecule.

.....[1]

(b) Proteins can be hydrolysed to amino acids.

State a suitable reagent and condition for this hydrolysis.

reagent.....

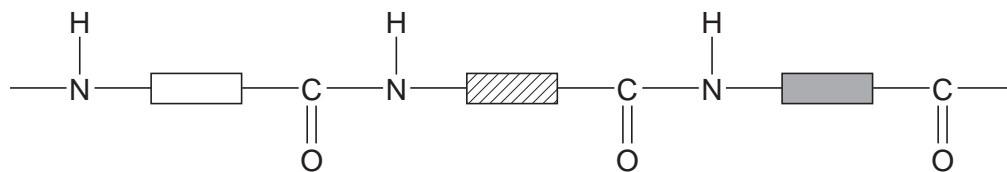
condition[2]

(c) The amino acids can be identified by paper chromatography.

Describe, with the aid of a labelled diagram, how paper chromatography can be used to identify particular amino acids.

.....
.....
.....
.....[4]

(d) The structure of a section of a protein can be represented as:



For
Examiner's
Use

(i) Describe **one** similarity in the structure of a protein and the structure of nylon.

..... [1]

(ii) Describe **one** way in which the structure of a protein differs from the structure of nylon.

.....

..... [1]

[Total: 10]

- B9** Phosphine, PH_3 , is a gas which has a smell of garlic. It is formed when white phosphorus is warmed with aqueous sodium hydroxide.

For
Examiner's
Use



- (a) Draw a 'dot-and-cross' diagram for phosphine.

Show only the outer electrons.

[1]

- (b) (i) Calculate the maximum mass of phosphine formed when 1.86 g of phosphorus reacts with excess aqueous sodium hydroxide.

[2]

- (ii) Calculate the volume of phosphine formed from 1.86 g of phosphorus at r.t.p.

[1]

- (c) Phosphine decomposes into its elements on warming. Write an equation for this reaction.

.....[2]

- (d) Phosphine reacts with hydrogen iodide to form the salt phosphonium iodide, PH_4I .

Phosphonium salts react in a similar way to ammonium salts when warmed with aqueous sodium hydroxide.

- (i) Write an equation for the reaction of phosphonium iodide with aqueous sodium hydroxide.

.....[1]

- (ii) What should you notice when sodium hydroxide is warmed with phosphonium iodide?

.....[1]

- (e) Phosphine is formed when water reacts with calcium phosphide, Ca_3P_2 .

Calcium phosphide is an ionic compound.

- (i) Write the formula for the phosphide ion.

.....[1]

- (ii) Predict one physical property of calcium phosphide.

.....[1]

[Total: 10]

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

DATA SHEET
The Periodic Table of the Elements

| | | Group | | | | | | | | | | | | | | | |
|------------------------------------|------------------------------------|-------------------------------------|--|-------------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|---------------------------------------|---------------------------------------|------------------------------------|--|-------------------------------------|---------------------------------------|----------------------------------|----------------------------------|
| | | I | II | III | IV | V | VI | VII | 0 | | | | | | | | |
| | | 1 H Hydrogen 1 | | | | | | | | | | | | | | | |
| 7 Li Lithium 3 | 9 Be Beryllium 4 | | | | | | | | | | | | | | | | |
| 23 Na Sodium 11 | 24 Mg Magnesium 12 | | | | | | | | | | | | | | | | |
| 39 K Potassium 19 | 40 Ca Calcium 20 | 45 Sc Scandium 21 | 48 Ti Titanium 22 | 51 V Vanadium 23 | 52 Cr Chromium 24 | 55 Mn Manganese 25 | 56 Fe Iron 26 | 59 Co Cobalt 27 | 59 Ni Nickel 28 | 64 Cu Copper 29 | 65 Zn Zinc 30 | 70 Ga Gallium 31 | 73 Ge Germanium 32 | 75 As Arsenic 33 | 79 Se Selenium 34 | 80 Br Bromine 35 | 84 Kr Krypton 36 |
| 85 Rb Rubidium 37 | 88 Sr Strontium 38 | 89 Y Yttrium 39 | 91 Zr Zirconium 40 | 93 Nb Niobium 41 | 96 Mo Molybdenum 42 | 101 Ru Ruthenium 44 | 103 Rh Rhodium 45 | 106 Pd Palladium 46 | 108 Ag Silver 47 | 112 Cd Cadmium 48 | 115 In Indium 49 | 119 Sn Tin 50 | 122 Sb Antimony 51 | 127 I Iodine 53 | 128 Te Tellurium 52 | 131 Xe Xenon 54 | |
| 133 Cs Caesium 55 | 137 Ba Barium 56 | 139 La Lanthanum 57 | 178 Hf Hafnium 72 | 181 Ta Tantalum 73 | 184 W Tungsten 74 | 190 Os Osmium 76 | 192 Ir Iridium 77 | 195 Pt Platinum 78 | 197 Au Gold 79 | 201 Hg Mercury 80 | 204 Tl Thallium 81 | 207 Pb Lead 82 | 209 Bi Bismuth 83 | 210 Po Polonium 84 | 210 At Astatine 85 | 222 Rn Radon 86 | |
| 223 Fr Francium 87 | 226 Ra Radium 88 | 227 Ac Actinium 89 | | | | | | | | | | | | | | | |
| | | * 58–71 Lanthanoid series | | | | | | | | | | | | | | | |
| | | † 90–103 Actinoid series | | | | | | | | | | | | | | | |
| | | 140 Ce Cerium 58 | 141 Pr Praseodymium 59 | 144 Nd Neodymium 60 | 147 Pm Promethium 61 | 150 Sm Samarium 62 | 152 Eu Europium 63 | 157 Gd Gadolinium 64 | 159 Tb Terbium 65 | 162 Dy Dysprosium 66 | 165 Ho Holmium 67 | 167 Er Erbium 68 | 169 Tm Thulium 69 | 173 Yb Ytterbium 70 | 175 Lu Lutetium 71 | | |
| | | 232 Th Thorium 90 | 231 Pa Protactinium 91 | 238 U Uranium 92 | 237 Np Neptunium 93 | 244 Pu Plutonium 94 | 243 Am Americium 95 | 247 Cm Curium 96 | 247 Bk Berkelium 97 | 251 Cf Californium 98 | 252 Es Einsteinium 99 | 257 Fm Fermium 100 | 258 Md Mendelevium 101 | 259 No Nobelium 102 | 260 Lr Lawrencium 103 | | |

Key

| | |
|---|----------|
| a | X |
| b | |

 a = relative atomic mass
 X = atomic symbol
 b = atomic (proton) number

The volume of one mole of any gas is 24dm³ at room temperature and pressure (r.t.p.).