



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
General Certificate of Education Ordinary Level

CANDIDATE  
NAME

CENTRE  
NUMBER

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CANDIDATE  
NUMBER

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**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	
<b>Section A</b>	
<b>B6</b>	
<b>B7</b>	
<b>B8</b>	
<b>B9</b>	
<b>Total</b>	

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



## Section A

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

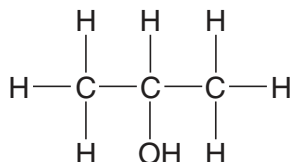
The total mark for this section is 45.

For  
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Use

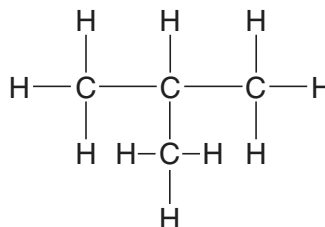
**A1** The structural formulae of some compounds containing the element carbon are shown.



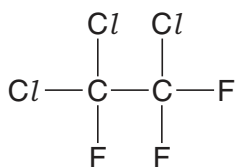
**A**



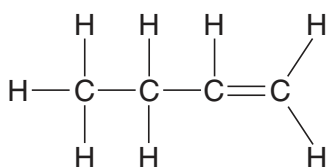
**B**



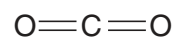
**C**



**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]

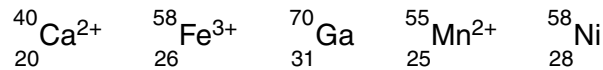
(vi) an isomer of butane? ..... [1]

(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.

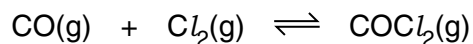
.....  
.....

.....[2]

[Total:9]

**A3** Carbonyl chloride,  $\text{COCl}_2$ , is a colourless, poisonous gas formed when carbon monoxide and chlorine combine in the presence of sunlight. The forward reaction is exothermic.

For  
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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.

For  
Examiner's  
Use

(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  $\text{H}^+$ ,  $\text{OH}^-$ ,  $\text{K}^+$  and  $\text{Br}^-$ .

(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]

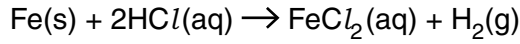


(d) Iron, cobalt and nickel have similar properties.

(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.....

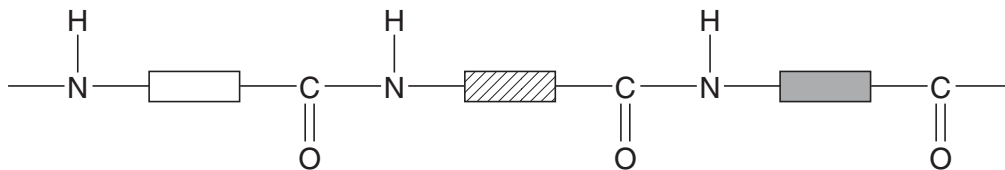
condition .....[2]

**(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,  $\text{PH}_3$ , 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,  $\text{PH}_4\text{I}$ .

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,  $\text{Ca}_3\text{P}_2$ .

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]









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**DATA SHEET**  
**The Periodic Table of the Elements**

		Group															
		I	II	III	IV	V	VI	VII	0								
		1 <b>H</b> Hydrogen 1										2 <b>He</b> Helium 2					
3 <b>Li</b> Lithium 3	4 <b>Be</b> Beryllium 4	5 <b>B</b> Boron 5	6 <b>C</b> Carbon 6	7 <b>N</b> Nitrogen 7	8 <b>O</b> Oxygen 8	9 <b>F</b> Fluorine 9	10 <b>Ne</b> Neon 10	11 <b>B</b> Boron 11	12 <b>C</b> Carbon 12	13 <b>Al</b> Aluminium 13	14 <b>Si</b> Silicon 14	15 <b>P</b> Phosphorus 15	16 <b>S</b> Sulfur 16	17 <b>Cl</b> Chlorine 17	18 <b>Ar</b> Argon 18		
19 <b>K</b> Potassium 19	20 <b>Ca</b> Calcium 20	21 <b>Sc</b> Scandium 21	22 <b>Ti</b> Titanium 22	23 <b>V</b> Vanadium 23	24 <b>Cr</b> Chromium 24	25 <b>Mn</b> Manganese 25	26 <b>Fe</b> Iron 26	27 <b>Co</b> Cobalt 27	28 <b>Ni</b> Nickel 28	29 <b>Cu</b> Copper 29	30 <b>Zn</b> Zinc 30	31 <b>Ga</b> Gallium 31	32 <b>Ge</b> Germanium 32	33 <b>As</b> Arsenic 33	34 <b>Se</b> Selenium 34	35 <b>Br</b> Bromine 35	36 <b>Kr</b> Krypton 36
37 <b>Rb</b> Rubidium 37	38 <b>Sr</b> Strontium 38	39 <b>Y</b> Yttrium 39	40 <b>Zr</b> Zirconium 40	41 <b>Nb</b> Niobium 41	42 <b>Mo</b> Molybdenum 42	43 <b>Tc</b> Technetium 43	44 <b>Ru</b> Ruthenium 44	45 <b>Rh</b> Rhodium 45	46 <b>Pd</b> Palladium 46	47 <b>Ag</b> Silver 47	48 <b>Cd</b> Cadmium 48	49 <b>In</b> Indium 49	50 <b>Sn</b> Tin 50	51 <b>Sb</b> Antimony 51	52 <b>Te</b> Tellurium 52	53 <b>I</b> Iodine 53	54 <b>Xe</b> Xenon 54
55 <b>Cs</b> Caesium 55	56 <b>Ba</b> Barium 56	57 <b>La</b> Lanthanum 57	72 <b>Hf</b> Hafnium 72	73 <b>Ta</b> Tantalum 73	74 <b>W</b> Tungsten 74	75 <b>Re</b> Rhenium 75	76 <b>Os</b> Osmium 76	77 <b>Ir</b> Iridium 77	78 <b>Pt</b> Platinum 78	79 <b>Au</b> Gold 79	80 <b>Hg</b> Mercury 80	81 <b>Tl</b> Thallium 81	82 <b>Pb</b> Lead 82	83 <b>Bi</b> Bismuth 83	84 <b>Po</b> Polonium 84	85 <b>At</b> Astatine 85	86 <b>Rn</b> Radon 86
87 <b>Fr</b> Francium 87	88 <b>Ra</b> Radium 88	89 <b>Ac</b> Actinium 89															

140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	142 <b>Nd</b> Neodymium 60	143 <b>Pm</b> Promethium 61	144 <b>Nd</b> Neodymium 60	145 <b>Sm</b> Samarium 62	146 <b>Eu</b> Europium 63	147 <b>Pm</b> Promethium 61	148 <b>Sm</b> Samarium 62	149 <b>Gd</b> Gadolinium 64	150 <b>Eu</b> Europium 63	151 <b>Gd</b> Gadolinium 64	152 <b>Tb</b> Terbium 65	153 <b>Dy</b> Dysprosium 66	154 <b>Ho</b> Holmium 67	155 <b>Er</b> Erbium 68	156 <b>Tm</b> Thulium 69	157 <b>Yb</b> Ytterbium 70	158 <b>Lu</b> Lutetium 71
232 <b>Th</b> Thorium 90	231 <b>Pa</b> Protactinium 91	238 <b>U</b> Uranium 92	237 <b>Np</b> Neptunium 93	238 <b>U</b> Uranium 92	244 <b>Pu</b> Plutonium 94	243 <b>Am</b> Americium 95	247 <b>Cm</b> Curium 96	247 <b>Bk</b> Berkelium 97	247 <b>Cf</b> Californium 98	251 <b>Es</b> Einsteinium 99	252 <b>Fm</b> Fermium 100	257 <b>Md</b> Mendelevium 101	259 <b>No</b> Nobelium 102	260 <b>Lr</b> Lawrencium 103				

\* 58–71 Lanthanoid series  
† 90–103 Actinoid series

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

a	<b>X</b>	b
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The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).