O

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

2626221654

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	

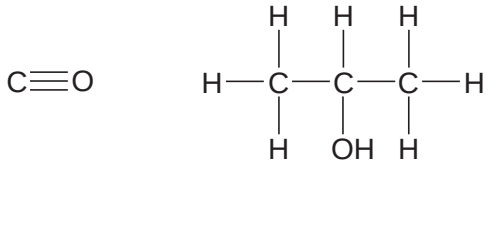
This document consists of **16** printed pages and **4** blank pages.

Section A

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

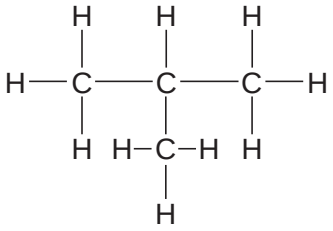
The total mark for this section is 45.

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

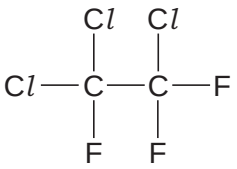


A

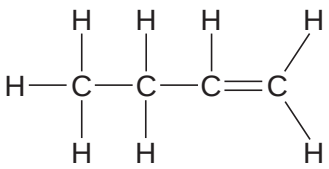
B



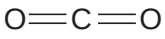
C



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 num... shown below.

$^{40}_{20}Ca^{2+}$ $^{58}_{26}Fe^{3+}$ $^{70}_{31}Ga$ $^{55}_{25}Mn^{2+}$ $^{58}_{28}Ni$

(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 $^{55}_{25}Mn^{2+}$.

.....[1]

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

.....[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 mo... and chlorine combine in the presence of sunlight. The forward reaction is exothermic.

$$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$$

(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, $(NH_2)_2CO$, 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 et… 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]

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.

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	A*l* = 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	C*l* = 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.

.....

.....

.....

(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.

$$Fe(s) + 2HCl(aq) \longrightarrow FeCl_2(aq) + H_2(g)$$

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.

alkane	boiling point /^{o}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 ... approximately the same. Suggest why.

.....

.....

.....[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.

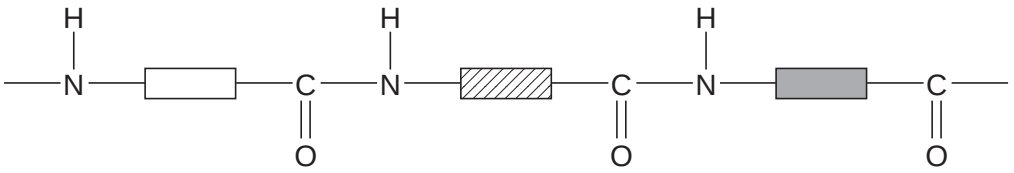
.....

.....

.....

.....[4]

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



(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 phosph... warmed with aqueous sodium hydroxide.

$$4P + 3NaOH + 3H_2O \rightarrow PH_3 + 3NaH_2PO_2$$

(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]

BLANK PAGE

BLANK PAGE

BLANK PAGE

BLANK PAGE

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	0
							1 H Hydrogen 1									4 He Helium 2
7 Li Lithium	9 Be Beryllium 4										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K otassium	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	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	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	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	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	209 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium	226 Ra Radium 88	227 Ac Actinium 89 †															

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

8–71 Lanthanoid series
90–103 Actinoid series

y

a
X
b

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

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).