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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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3079818904

CHEMISTRY **5070/21**

Paper 2 Theory **May/June 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 **18** printed pages and **2** blank pages.

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Section A

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

The total mark for this section is 45.

A1 Choose from the following elements to answer the questions below.

bromine

calcium

copper

chlorine

hydrogen

iodine

iron

nickel

sulfur

vanadium

zinc

Each element can be used once, more than once or not at all.

Name an element which

(a) is a catalyst in the hydrogenation of unsaturated vegetable oils to make margarine,

..... [1]

(b) has an ion which, in solution, reacts with aqueous sodium hydroxide to give a white precipitate that redissolves in excess sodium hydroxide,

..... [1]

(c) has six electrons in its outer shell,

..... [1]

(d) is formed during the electrolysis of dilute sulfuric acid using inert electrodes,

..... [1]

(e) will displace bromine from aqueous calcium bromide,

..... [1]

(f) is above magnesium in the reactivity series.

..... [1]

[Total: 6]

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A2 Aqueous hydrogen peroxide, $H_2O_2(aq)$, is used to sterilise contact lenses. $H_2O_2(aq)$ slowly decomposes at room temperature to make water and oxygen.

The decomposition can be made faster by

- using a more concentrated solution of $H_2O_2(aq)$,
- heating the $H_2O_2(aq)$,
- adding an enzyme called peroxidase.

(a) Construct the equation for the decomposition of $H_2O_2(aq)$.

..... [1]

(b) Explain why concentrated $H_2O_2(aq)$ decomposes faster than dilute $H_2O_2(aq)$.

.....

.....

..... [2]

(c) Explain why hot $H_2O_2(aq)$ decomposes faster than cold $H_2O_2(aq)$.

.....

.....

..... [2]

(d) Explain, using ideas about activation energy, why an enzyme such as peroxidase makes the decomposition of $H_2O_2(aq)$ faster.

.....

.....

..... [2]

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(e) The table shows some information about an investigation on the decompos… H_2O_2(aq) using two different catalysts. In each experiment, 0.100 g of the catalyst … 25.0 cm^3 of H_2O_2(aq) were used. The concentration and temperature of the H_2O_2(aq) were kept constant.

catalyst	time taken to collect 50 cm^3 of oxygen / s	total volume of oxygen made at the end of the reaction / cm^3
manganese(IV) oxide	25	95
peroxidase	10	

(i) What is the total volume of oxygen made at the end of the reaction in which peroxidase was used as a catalyst?

volume of oxygen = ... cm^3 [1]

(ii) Describe, with the aid of a labelled diagram, how you could carry out an experiment to collect the measured volumes of gases recorded in the table.

.....

.....

..... [2]

[Total: 10]

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A3 Analysis of a compound **Z** obtained from the planet Mars showed **Z** has the following composition.

element	percentage by mass
potassium	39.4
iron	28.3
oxygen	32.3

(a) Show that the empirical formula of **Z** is K_2FeO_4.

.....

.....

.....

.....

..... [2]

(b) K_2FeO_4 can be prepared in the laboratory by the reaction between iron(III) oxide, Fe_2O_3, chlorine, Cl_2, and potassium hydroxide, KOH.

$$Fe_2O_3 + 3Cl_2 + 10\,KOH \rightarrow 2K_2FeO_4 + 6KCl + 5H_2O$$

A 2.00 g sample of Fe_2O_3 is added to 20.0 cm^3 of 4.00 mol dm^{-3} KOH.

(i) Calculate the amount, in moles, of Fe_2O_3 used.

.....

..... [2]

(ii) Calculate the amount, in moles, of KOH used.

.....

..... [1]

(iii) Which reagent, Fe_2O_3 or KOH, is in excess in this reaction?

.....

Explain your answer.

.....

..... [1]

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(c) During the reaction chlorine molecules, Cl_2, are converted into chloride ions, Cl^-.
Is this conversion oxidation or reduction?

.....

Explain your answer.

.....

..... [1]

(d) A few drops of aqueous K_2FeO_4 are added to a test-tube containing $3\,cm^3$ of aqueous potassium iodide. The solution in the test-tube changes from colourless to pale brown.
Given this information, what can you deduce about the chemical properties of K_2FeO_4?

..... [1]

[Total: 8]

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A4 Magnesium bromide and sodium oxide are both ionic compounds.

(a) Complete the following table.

ion	number of			atomic number	mass number
	protons	neutrons	electrons		
Mg^{2+}	12	12			
Br^{-}				35	81

[3]

(b) Draw diagrams to show the electronic configurations and charges of the ions present in sodium oxide.

[2]

(c) Explain why magnesium bromide has a high melting point.

.....

..... [1]

(d) Explain why solid sodium oxide does not conduct electricity.

.....

..... [1]

[Total: 7]

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A5 Mobile phones are made from a large number of different substances.
The table shows the composition of a typical mobile phone.

substance	percentage, by mass, of a typical mobile phone
plastics	56
ceramics	16
copper	15
iron	3
other materials	10

(a) One of the plastics used in a mobile phone is poly(ethene).

(i) What type of polymerisation occurs when poly(ethene) is made?

..... [1]

(ii) Draw the structure of the monomer needed to make poly(ethene).

[1]

(b) There is a growing awareness that mobile phones should be recycled.

(i) State **two** advantages of recycling the substances used to make mobile phones.

.....

.....

.....

..... [2]

(ii) Suggest **one** disadvantage of recycling the substances used to make a mobile phone.

.....

..... [1]

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(c) The copper used in mobile phones is purified using electrolysis.

For this electrolysis name

the electrolyte used, ...

the material used for the anode, ...

the material used for the cathode. ..... [3]

(d) One of the reasons why copper is used in mobile phones is because it is a good conductor of electricity.

(i) Draw a labelled diagram to show the metallic bonding in copper.

[2]

(ii) Explain how copper conducts electricity.

.....

..... [1]

(e) The iron used in a mobile phone must not rust.

(i) Suggest **one** way to stop the iron used from rusting.

..... [1]

(ii) Explain how this method for rust prevention works.

.....

..... [1]

(iii) Explain why aluminium does not corrode very easily.

.....

..... [1]

[Total: 14]

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Section B

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

The total mark for this section is 30.

B6 Paraffin (kerosene) is a mixture of hydrocarbons. It is used as a fuel for the jet engines of an aircraft.

(a) Paraffin is separated from crude oil using fractional distillation.
What property of paraffin is used to separate it from crude oil?

..... [1]

(b) There is an alkane molecule in paraffin which contains 12 carbon atoms.
What is the formula of this alkane?

..... [1]

(c) When paraffin burns in a jet engine some nitrogen monoxide, NO, is formed. This is because the high temperature of the engine allows nitrogen to react with oxygen.

Write an equation to describe how nitrogen monoxide is formed in this reaction. Calculate the mass of nitrogen monoxide formed from 55 kg of nitrogen.

.....

.....

.....

.....

mass of nitrogen monoxide = …… kg [3]

(d) Nitrogen monoxide is involved in the formation of sulfur trioxide from sulfur dioxide.

$2NO + O_2 \rightarrow 2NO_2$
$NO_2 + SO_2 \rightarrow NO + SO_3$

(i) Write the overall equation for the formation of sulfur trioxide from sulfur dioxide.

..... [1]

(ii) Explain how the reactions above suggest that nitrogen monoxide is acting as a catalyst.

.....

..... [1]

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(e) Nitrogen monoxide reacts with carbon monoxide as shown in the equation.

$$2NO + 2CO \rightarrow N_2 + 2CO_2$$

Identify, with reasons, the substance oxidised and the substance reduced.

.....

.....

..... [2]

(f) Using the information that one mole contains 6.02×10^{23} particles, calculate the number of electrons in one mole of NO molecules.

.....

..... [1]

[Total: 10]

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B7 Alkynes are a homologous series of organic compounds.
Alkynes contain the C≡C group. They react in a similar way to alkenes.

The table shows some information about the first five alkynes.

alkyne	molecular formula	boiling point / °C
ethyne	C_2H_2	–84
propyne	C_3H_4	–23
	C_4H_6	8
pentyne	C_5H_8	40
hexyne		

(a) Suggest the name of the alkyne with the molecular formula C_4H_6.

..... [1]

(b) Draw the structure of propyne.

[1]

(c) **(i)** Estimate the boiling point of hexyne.

…….. °C [1]

(ii) Write the molecular formula of hexyne.

..... [1]

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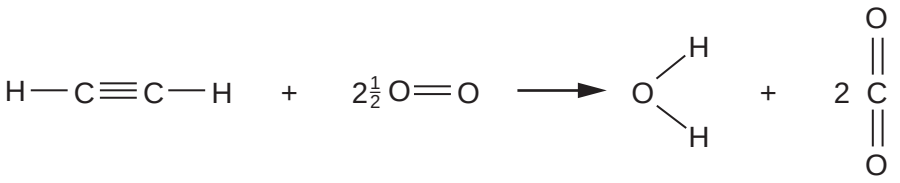
(d) Ethyne reacts with oxygen in an exothermic reaction.



(i) Explain why the combustion of ethyne is an exothermic reaction.
Use ideas about the energy changes that take place during bond breaking and bond forming.

.....

.....

.....

..... [2]

(ii) The complete combustion of one mole of ethyne releases 1410 kJ of energy.
Calculate the energy released when 1000 dm^3 of ethyne, measured at room temperature and pressure, is completely combusted.

energy released = ... kJ [2]

(e) Ethyne is bubbled through aqueous bromine.

(i) Suggest a possible molecular formula of the product of this reaction.

..... [1]

(ii) What would you see during the reaction?

..... [1]

[Total: 10]

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B8 One of the reactions in the manufacture of nitric acid involves the oxidation of ammonia. The reaction is exothermic.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g) \qquad \Delta H = -909\,kJ\,mol^{-1}$$

(a) The reaction is carried out at a pressure of 10 atmospheres and a temperature of 900°C.

(i) Predict and explain the effect on the position of equilibrium if the reaction is carried out at 10 atmospheres pressure and **700°C** rather than 900°C.

.....

.....

..... [2]

(ii) Predict and explain the effect on the position of equilibrium if the reaction is carried out at 900°C and **20 atmospheres pressure** rather than 10 atmospheres.

.....

.....

..... [2]

(b) A factory uses 100 tonnes of ammonia each day to produce 160 tonnes of nitrogen monoxide, NO.
Calculate the percentage yield of nitrogen monoxide.

percentage yield = ... % [3]

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(c) Ammonium nitrate, NH_4NO_3, is a soluble salt.
The salt decomposes when heated gently to form steam and a colourless gas **X**.

(i) Ammonium nitrate can be prepared by the reaction between aqueous ammonia and dilute nitric acid.
Name the experimental technique used to prepare aqueous ammonium nitrate and briefly describe how solid ammonium nitrate is obtained from the aqueous solution.

.....

.....

..... [2]

(ii) Predict the formula of gas **X**.

..... [1]

[Total: 10]

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B9 There is much international concern that an increase in the atmospheric concentration of methane and carbon dioxide can lead to global warming.

The table shows the atmospheric concentration of methane and carbon dioxide over the last 20 years.

year	percentage, by volume, of methane in the atmosphere	percentage, by volume, of carbon dioxide in the atmosphere
1988	1.68×10^{-3}	3.49×10^{-2}
1993	1.71×10^{-3}	3.55×10^{-2}
1998	1.73×10^{-3}	3.65×10^{-2}
2003	1.78×10^{-3}	3.75×10^{-2}
2008	1.79×10^{-3}	3.85×10^{-2}

Methane is about 30 times more effective than carbon dioxide as a greenhouse gas.

(a) Give **one** source of atmospheric methane.

..... [1]

(b) Describe **two** possible consequences of an increase in global warming.

.....

.....

..... [2]

(c) Use the information above to explain why scientists are as concerned about methane in the atmosphere as carbon dioxide.

.....

.....

..... [2]

(d) Draw a 'dot-and-cross' diagram for methane, CH_4.
You only need to draw the outer electrons of the carbon atom.

[1]

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(e) Explain why both carbon dioxide and methane are gases at room temperature.
Use ideas about structure and bonding.

.....

..... [1]

(f) Methane can be manufactured by reacting carbon dioxide with hydrogen. Water is the only other product.

Construct the equation for this reaction.

..... [1]

(g) Methane reacts with chlorine. Name the type of reaction that takes place and identify **two** products of the reaction.

type of reaction .....

products of reaction .....

..... [2]

[Total: 10]

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DATA SHEET
The Periodic Table of the Elements

Group I	Group II						Group III	Group IV	Group V	Group VI	Group VII	Group 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 1	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 Potassium 9	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 7	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 5	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 7	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

58–71 Lanthanoid series
90–103 Actinoid series

ey

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.).

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