CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

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	

[Turn over

2

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 decomposition of $H_2O_2(aq)$ using two different catalysts. In each experiment, 0.100 g of the catalyst and 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]

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.

....

....

....

....

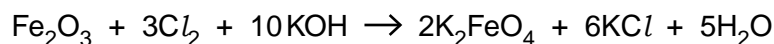... [2]

(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.

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

A 2.00 g sample of Fe_2O_3 is added to 20.0 cm³ 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]

(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]

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]

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]

(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]

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.

$$2NO + O_2 \rightarrow 2NO_2$$
$$NO_2 + SO_2 \rightarrow NO + SO_3$$
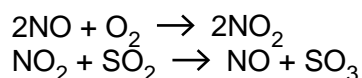
(i) Write the overall equation for the formation of sulfur trioxide from sulfur dioxide.

.... [1]

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

....

.... [1]

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

$$2NO + 2CO \rightarrow N_2 + 2CO_2$$
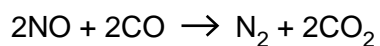
Identify, with reasons, the substance oxidised and the substance reduced.

....

....

.... [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]

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]

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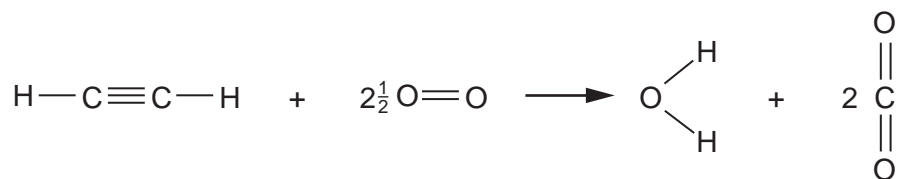
(i) Explain why the combustion of ethyne is an exothermic reaction.
Use ideas about the energy changes that take place during bond breaking and bond forming.

....

....

....

.... [2]

(ii) The complete combustion of one mole of ethyne releases 1410 kJ of energy.
Calculate the energy released when 1000 dm³ of ethyne, measured at room temperature and pressure, is completely combusted.

energy released = ... kJ [2]

(e) Ethyne is bubbled through aqueous bromine.

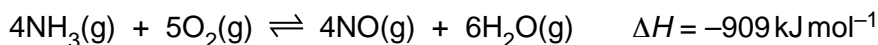(i) Suggest a possible molecular formula of the product of this reaction.

.... [1]

(ii) What would you see during the reaction?

.... [1]

[Total: 10]

B8 One of the reactions in the manufacture of nitric acid involves the oxidation of ammonia. This 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]

(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]

B9 There is much international concern that an increase in the atmospheric concentrations 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]

(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	II												III	IV	V	VI	VII	0
							1 **H** Hydrogen 1											4 **He** Helium 2
7 **Li** Lithium 3	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 11	24 **Mg** Magnesium 12												27 **A*l*** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **C*l*** Chlorine 17	40 **Ar** Argon 18
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	**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 55	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 **T*l*** 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 87	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

Key

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.).

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