Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

5907051958

CHEMISTRY **5070/21**

Paper 2 Theory **October/November 2014**

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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, 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.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

A copy of the Periodic Table is printed on page 16.
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.

This document consists of **16** printed pages.

DC (NH/SW) 72256/4

CAMBRIDGE
International Examinations

[Turn over

Section A

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

The total mark for this section is 45.

A1 The diagram shows part of the Periodic Table. Only some of the elements are shown.

							H										
													C	N	O		
Na	Mg											Al	Si	P			
K	Ca						Fe			Cu	Zn						
Rb																	

(a) Answer each of the following questions using only those elements shown in the diagram. Each element may be used once, more than once or not at all.

Give one element which

(i) has a giant molecular structure,

....[1]

(ii) combines with oxygen to form a gas which contributes to acid rain,

....[1]

(iii) forms an ion of type X^+ which has only three completely filled shells of electrons,

....[1]

(iv) has an atom with only seven protons in its nucleus,

....[1]

(v) has an atom with only six electrons,

....[1]

(vi) has a chloride of type XCl_2, whose aqueous solution forms a white precipitate on addition of sodium hydroxide.

....[1]

(b) Under reduced pressure, potassium reacts with oxygen to form potassium oxide, K_2O.
Construct the equation for this reaction.

....[1]

(c) Aluminium is higher than zinc in the reactivity series.
Explain why aluminium foil does not react with an aqueous solution of zinc ions.

....

....[2]

[Total: 9]

A2 The table shows some properties of the Group 0 elements (noble gases).

element	density of liquid element in g/cm^3	boiling point /°C
helium	0.15	–269
neon	1.20	–246
argon	1.40	–186
krypton		–152
xenon	3.52	

(a) Predict

(i) the density of liquid krypton, ...[1]

(ii) the boiling point of xenon. ....[1]

(b) Argon is a gas at room temperature.

(i) Describe the arrangement and motion of the particles in a gas.

arrangement ....

motion ....
[2]

(ii) State one use of argon.

....[1]

(c) The noble gases are unreactive.
Explain why.

....[1]

(d) Several compounds of the noble gases have been made in recent years.

Xenon(IV) fluoride, XeF_4, reacts with water to form a mixture which contains xenon, xenon(VI) oxide, XeO_3, and hydrogen fluoride, HF.

Complete the equation for the reaction of xenon(IV) fluoride with water.

$$.... XeF_4 \ + \ .... H_2O \ \rightarrow \ Xe \ + \ 2XeO_3 \ + \ 12HF$$ [1]

(e) The noble gases make up about 1% of the air.
Describe and explain how fractional distillation can be used to separate the gases in the air.

....

....

....

....[3]

[Total: 10]

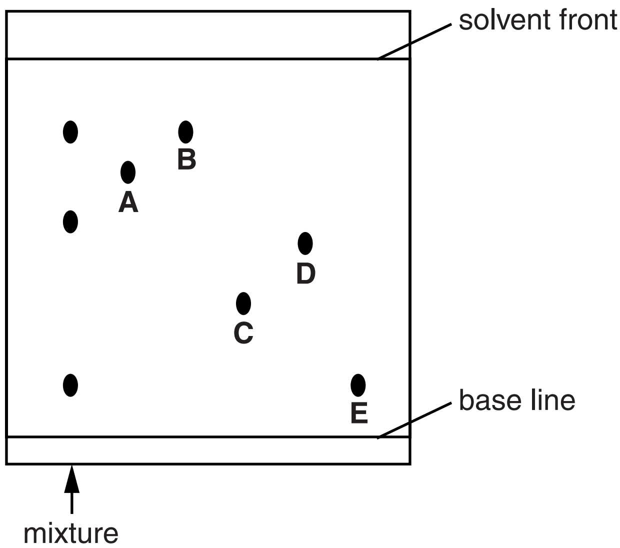
A3 Paper chromatography can be used to separate metal ions in a mixture and identify them by comparison with known samples of metal ions (**A**–**E**).

(a) Draw a labelled diagram to show the apparatus used in paper chromatography.

On your diagram show
- the solvent,
- where the mixture of metal ions and known samples of metal ions are placed at the start of the experiment.

[2]

(b) The completed chromatogram is shown below.



(i) Which of the metal ions, **A**–**E**, were present in the mixture?

....[1]

(ii) Calculate the R_f value of metal ion **A**.

R_f value = ...[1]

(c) Ammonia can be used as a locating agent for some metal ions on the chromatogram.

(i) Suggest why a locating agent may need to be used.

....

....[1]

(ii) Aqueous ammonia is added slowly to aqueous copper(II) sulfate until the ammonia is in excess.

Describe what you would observe as the ammonia is added.

....

....

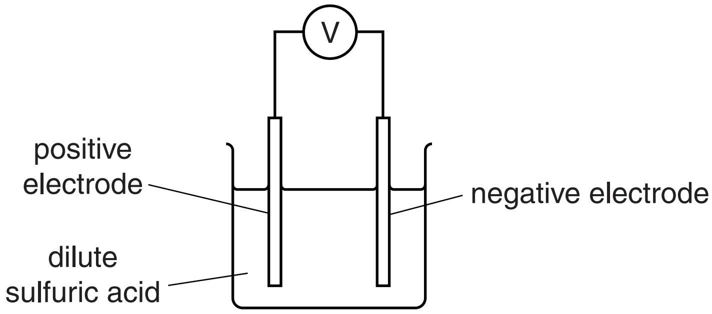
....[2]

(iii) Construct the ionic equation, with state symbols, for the reaction of aqueous copper(II) sulfate with aqueous sodium hydroxide.

....[2]

[Total: 9]

A4 The diagram shows a simple electrochemical cell.



The voltages produced by different combinations of metal electrodes are shown in the table below. The more reactive metal is always the negative electrode.

positive electrode	negative electrode	voltage / V
copper	zinc	1.10
copper	tin	0.48
copper	magnesium	2.70
copper	iron	0.78
silver	copper	0.46

(a) (i) Write an equation showing the conversion of zinc to zinc ions.

....[1]

(ii) How does the table above show that copper is above silver in the reactivity series?

....

....[1]

(iii) Which combination of metals in the table above will give the highest voltage?

....[1]

(iv) Use the information in the table to deduce the order of reactivity of the metals copper, iron, magnesium, tin and zinc. Explain your answer.

most reactive ....

....

....

....

least reactive ....

....

....[2]

(b) Refer to the structure of metals to explain

(i) why metals are malleable,

....

....

....[2]

(ii) why metals conduct electricity.

....[1]

(c) Explain why plating iron with tin prevents the iron from rusting.

....

....[1]

[Total: 9]

A5 A student titrates 20.0 cm^3 of a metal hydroxide, $M(OH)_2$, of concentration 0.060 mol / dm^3 with a strong acid of concentration 0.050 mol / dm^3.
It requires 24.0 cm^3 of acid to neutralise the metal hydroxide.

(a) **(i)** Calculate the number of moles of acid in 24.0 cm^3 of the acid.

.... moles [1]

(ii) Calculate the number of moles of OH^- ions in 20.0 cm^3 of the metal hydroxide.

.... moles [1]

(iii) Deduce whether the acid used is more likely to be hydrochloric acid or sulfuric acid.
Explain your answer.

....

....[1]

(b) A student added excess calcium carbonate to 50 cm^3 of 0.10 mol / dm^3 hydrochloric acid.

(i) Construct an equation for the reaction of calcium carbonate with hydrochloric acid.

.... [1]

(ii) The volume of gas produced in the first 2 minutes is 24 cm^3.

Calculate the average rate of reaction over the first 2 minutes, in cm^3/s.

reaction rate = ... cm^3/s [1]

(iii) The student repeats the experiment using 50 cm^3 of 0.10 mol / dm^3 ethanoic acid.

Use the kinetic particle theory to explain why the rate of reaction is slower with ethanoic acid than with hydrochloric acid.

....

....

....

....

....

.... [3]

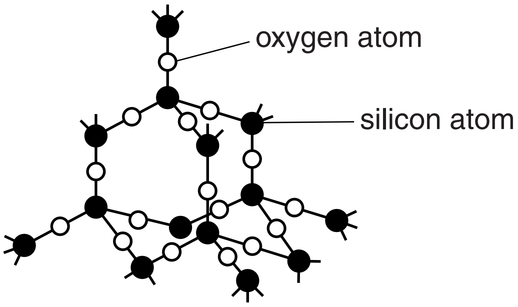
[Total: 8]

Section B

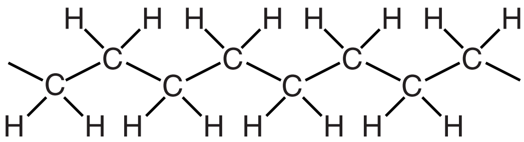
Answer **three** questions from this section in the spaces provided.

The total mark for this section is 30.

B6 Parts of the structures of silicon dioxide and poly(ethene) are shown below.



silicon dioxide



poly(ethene)

(a) The melting point of silicon dioxide is 1610 °C.
Poly(ethene) starts to melt at 130 °C.

Explain, in terms of structure and bonding, the difference between the melting points of these two substances.

....

....

....

....

....

....[4]

(b) What type of polymerisation is used to make poly(ethene)?

....[1]

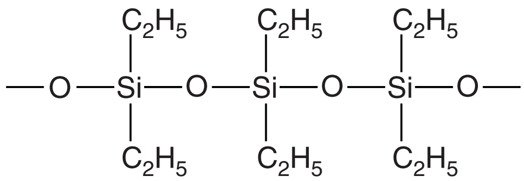
(c) Poly(ethene) is made from ethene monomers.
Explain why ethene is both a hydrocarbon and an unsaturated compound.

....

....

....[2]

(d) Silicone fluids are polymers. Part of the structure of a silicone fluid is shown below.



The monomer used in making this silicone fluid is a saturated compound with two –OH groups.

Deduce the structure of this monomer.

[1]

(e) The compound used to make the monomer of the silicone fluid has the following composition by mass.

$$C = 18.6\,g,\ Cl = 55.0\,g,\ H = 4.65\,g,\ Si = 21.7\,g$$

Deduce the empirical formula of this compound.

empirical formula ....[2]

[Total: 10]

B7 Three important processes in the carbon cycle are combustion, respiration and photosynthesis.

(a) Construct the equation for the complete combustion of propane, C_3H_8.

....[1]

(b) **(i)** Describe how the processes in the carbon cycle regulate the amount of carbon dioxide in the atmosphere.

....

....

....[2]

(ii) Carbon dioxide is a greenhouse gas.
What do you understand by the term *greenhouse gas*?

....[1]

(iii) Methane is also a greenhouse gas.
Give one source of methane in the atmosphere.

....[1]

(iv) The percentage of methane by volume in the air is 0.00014%.
Calculate the mass of methane in $1\,000\,dm^3$ of air.

mass = ...g [2]

(c) Plants use water in photosynthesis. Water containing the radioactive isotope ^{18}O is fed to a plant.

The resulting radioactivity in the products of photosynthesis is shown in the equation below.

$$6CO_2 + 6H_2{}^{18}O \rightarrow \underset{\text{glucose}}{C_6H_{12}O_6} + 6{}^{18}O_2$$

(i) What does this tell you about the origin of the oxygen in each of the products?

....

....[1]

(ii) Deduce the number of protons, neutrons and electrons in an atom of ^{18}O.

protons ....

neutrons ....

electrons .... [2]

[Total: 10]

B8 Sulfuric acid is manufactured by the Contact process.

(a) In some chemical plants zinc sulfide, ZnS, is roasted in air to form zinc oxide and sulfur dioxide.

Construct the balanced equation for this reaction.

....[1]

(b) The sulfur dioxide is then converted to sulfur trioxide.

$$2SO_2(g) \quad + \quad O_2(g) \quad \rightleftharpoons \quad 2SO_3(g) \quad \Delta H = -98\,\text{kJ/mol}$$

(i) Describe how and explain why increasing the pressure affects the position of equilibrium. The temperature remains constant.

....

....

....[2]

(ii) Describe how and explain why increasing the temperature affects the position of equilibrium. The pressure remains constant.

....

....

....[2]

(iii) Vanadium(V) oxide is used as a catalyst in the conversion of sulfur dioxide to sulfur trioxide.

Explain how using vanadium(V) oxide reduces the energy costs of the Contact process.

....

....

....[2]

(c) Sulfuric acid is used to make superphosphate fertilisers. A mixture of the fertiliser and calcium sulfate is formed. This mixture is used by farmers.

$$Ca_3(PO_4)_2 \;+\; 2H_2SO_4 \;\rightarrow\; \underbrace{Ca(H_2PO_4)_2}_{\text{calcium superphosphate}} \;+\; 2CaSO_4$$

(i) Calculate the percentage by mass of calcium sulfate in the mixture of calcium superphosphate and calcium sulfate.
(The relative formula mass of calcium superphosphate is 234.)

.... % [2]

(ii) Suggest one problem involved in either the transport of this mixture or its use as a fertiliser.

....

....[1]

[Total: 10]

B9 Bromate(V) ions, BrO_3^-, react with bromide ions, Br^-, in acidic solution to form bromine.

$$BrO_3^-(aq) + 5Br^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$$

(a) **(i)** Explain why the acidity of the reaction mixture decreases as the reaction proceeds.

....

....[2]

(ii) State the colour of aqueous bromine.

....[1]

(iii) Explain, using the kinetic particle theory, why increasing the temperature increases the rate of this reaction.

....

....

....[2]

(b) Bromine oxidises aqueous iodide ions to iodine.
Write the equation for this reaction.

....[1]

(c) Aqueous potassium iodide can be used to test for oxidising agents.

Describe and explain the colour change when excess aqueous potassium iodide is added to aqueous acidified potassium manganate(VII), $KMnO_4$.

....

....[2]

(d) Describe how aqueous bromine is used to test for an unsaturated hydrocarbon.

....[1]

(e) Draw a 'dot-and-cross' diagram for a bromine molecule.
Show only the outer electrons.

[1]

[Total: 10]

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 **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 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 **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 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 24 dm^3 at room temperature and pressure (r.t.p.).