Cambridge O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3930609037

CHEMISTRY **5070/21**

Paper 2 Theory **October/November 2015**

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 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.

This document consists of **17** printed pages and **3** blank pages.

CAMBRIDGE International Examinations

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 gases to answer the questions below.

ammonia
argon
carbon dioxide
chlorine
ethane
ethene
nitrogen
nitrogen(II) oxide
oxygen
sulfur dioxide

Each of these gases can be used once, more than once or not at all.

Which gas

(a) forms approximately 1% of the air,

.....[1]

(b) bleaches damp litmus paper,

.....[1]

(c) reacts with water to form an alkaline solution,

.....[1]

(d) can undergo polymerisation,

.....[1]

(e) is a compound formed in the atmosphere as a result of lightning activity,

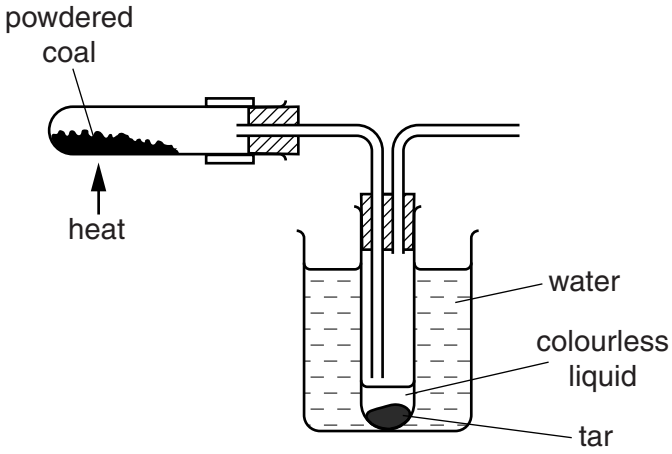
.....[1]

(f) is a diatomic molecule containing a total of 16 electrons?

.....[1]

[Total: 6]

A2 Coal is a mixture of carbon compounds with a small amount of sulfur.
A sample of coal is heated in the absence of air using the apparatus shown.



The distillate is a mixture of a colourless liquid and tar.

(a) The colourless liquid contains ammonia, NH_3.

Draw a 'dot-and-cross' diagram for ammonia.
Show only the outer shell electrons.

[2]

(b) The tar contains ethanoic acid.
When warmed in the presence of sulfuric acid, ethanoic acid reacts with propanol to form an ester.

Name and draw the structure of this ester showing all the atoms and all the bonds.

name.....

structure

[2]

(c) The tar also contains a compound with the following composition.

element	percentage by mass
carbon	76.60
hydrogen	6.38
oxygen	17.02

Deduce the empirical formula of this compound.

empirical formula .....[2]

(d) When coal is burned, an acidic gas is produced which decolourises acidified aqueous potassium manganate(VII). This gas contributes to acid rain.

(i) Identify this gas and describe how acid rain is formed.

.....

.....

.....[2]

(ii) Give one adverse effect of acid rain on buildings.

.....[1]

(iii) Acid rain can have an adverse effect on respiration.

Write an equation to represent the process of respiration.

.....[2]

[Total: 11]

A3 A layer of ozone is present in the stratosphere about 30 km above the Earth's surface.

(a) Compounds with formulae such as CCl_3F and C_2ClF_5 are responsible for the depletion of ozone.

(i) Give the general name for these compounds.

.....[1]

(ii) Explain, in terms of human health, why it is important that the ozone in the stratosphere does not become too depleted.

.....

.....[2]

(b) In the stratosphere, ozone, O_3, is broken down to oxygen by photochemical reactions.

(i) What is meant by the term *photochemical reaction*?

.....

.....[1]

(ii) Construct an equation for the breakdown of ozone molecules to oxygen molecules.

.....[1]

(c) Ozone oxidises Fe^{2+} ions to Fe^{3+} ions.

Complete the ionic equation for this reaction.

$$\ldots. Fe^{2+} + \ldots. H^+ + O_3 \rightarrow \ldots. Fe^{3+} + H_2O + O_2$$ [1]

[Total: 6]

A4 Copper is a metal.

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

[2]

(b) Explain why metals are malleable.

.....

.....

.....[2]

(c) Copper corrodes slowly in damp air.
One of the corrosion products has the formula $CuCO_3.Cu(OH)_2$.

(i) Calculate the percentage by mass of copper in this compound.

[2]

(ii) How could you show that $CuCO_3.Cu(OH)_2$ contains carbonate ions?

.....

.....

.....[2]

(d) Copper is oxidised by concentrated sulfuric acid.
This redox reaction can be represented by equations **A** and **B**.

A $Cu \longrightarrow Cu^{2+} + 2e^-$

B $4H^+ + SO_4^{2-} + 2e^- \longrightarrow 2H_2O + SO_2$

Which reaction, **A** or **B**, is oxidation and which is reduction? Explain your answer.

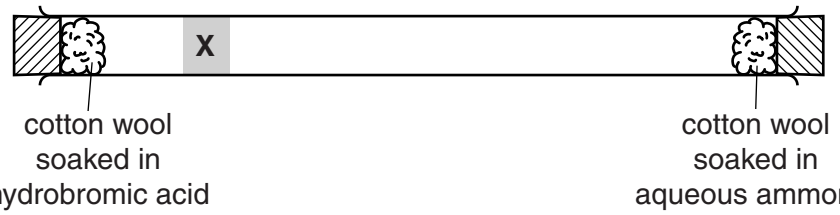
.....

.....

.....[2]

[Total: 10]

A5 A student set up a tube as shown in the diagram.



Concentrated hydrobromic acid produces fumes of hydrogen bromide.
Concentrated aqueous ammonia produces fumes of ammonia.

(a) After some time, solid ammonium bromide appeared on the walls of the tube at point **X**.

Use the kinetic particle theory to explain this result.

.....

.....

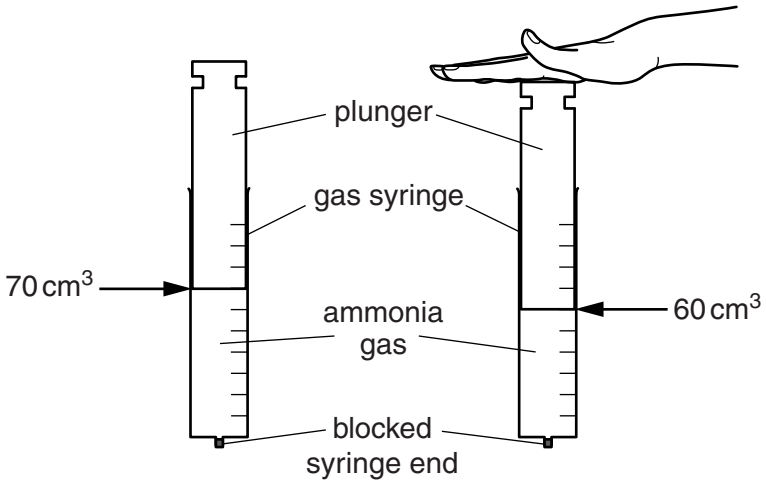
.....

.....

.....

.....[4]

(b) A gas syringe is filled with 70 cm^3 of ammonia gas.
The pressure on the plunger is increased.
The temperature does not change but the volume in the syringe decreases to 60 cm^3.



Use the kinetic particle theory to explain why the volume decreases.

.....

.....[1]

[Total: 5]

A6 When 1 mole of sodium hydroxide reacts with excess hydrochloric acid, 57.1 kJ of energy is released.

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

(a) Calculate the energy released when 12.0 g of sodium hydroxide reacts with excess hydrochloric acid.

[2]

(b) Calculate the volume of 0.200 mol / dm^3 HCl which contains 2.19 g of HCl.

[2]

(c) Aqueous hydrochloric acid contains chloride ions.

Describe a test for chloride ions.

test .....

result .....[2]

(d) Zinc oxide reacts with both hydrochloric acid and sodium hydroxide.

Which term describes this behaviour of zinc oxide?

.....[1]

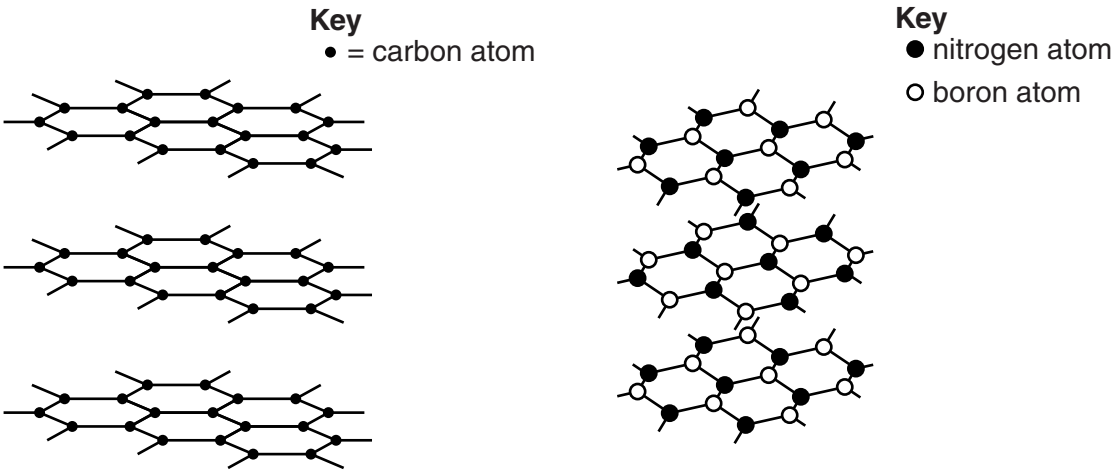
[Total: 7]

Section B

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

The total mark for this section is 30.

B7 The structures of graphite and boron nitride are shown below.



graphite boron nitride

(a) Like graphite, boron nitride feels slippery to the touch.

Explain, in terms of structure and bonding, why boron nitride feels slippery to the touch.

.....

.....

.....[2]

(b) An isotope of boron is represented by the symbol $^{11}_{5}B$.

Deduce the number of protons and neutrons in this isotope of boron.

number of protons .....

number of neutrons .....[1]

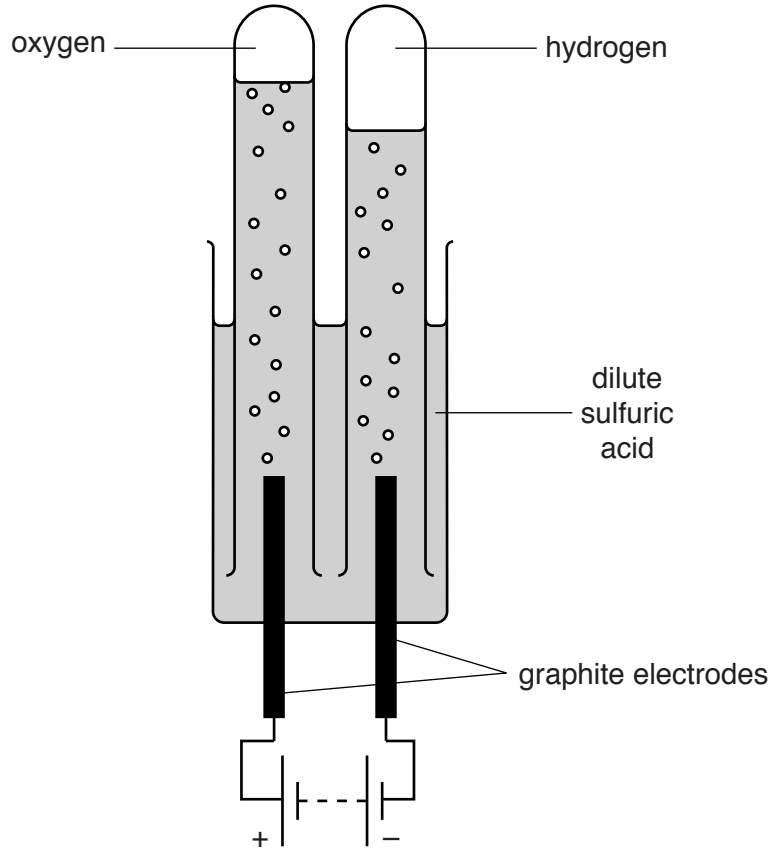
(c) Explain why graphite has a high melting point.

.....

.....

.....[2]

(d) Dilute sulfuric acid can be electrolysed using graphite electrodes.



(i) Graphite is a good electrical conductor.

Explain why graphite conducts electricity.

.....[1]

(ii) Give another property of graphite that makes it useful as an electrode in this electrolysis.

.....[1]

(e) During the electrolysis of dilute sulfuric acid, oxygen is released at the anode (positive electrode) and hydrogen is released at the cathode (negative electrode).

(i) Complete the equation for the reaction at the anode.

$$4OH^- \rightarrow O_2 + \text{.....} + \text{.....}$$ [1]

(ii) Construct the equation for the reaction at the cathode.

.....[1]

(iii) Explain why the volume of hydrogen produced is approximately double that of the oxygen.

.....

.....[1]

[Total: 10]

[Turn over

B8 A sample of 0.030 g of small pieces of magnesium is added to 20 cm^3 of 0.10 mol/dm^3 hydrochloric acid.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

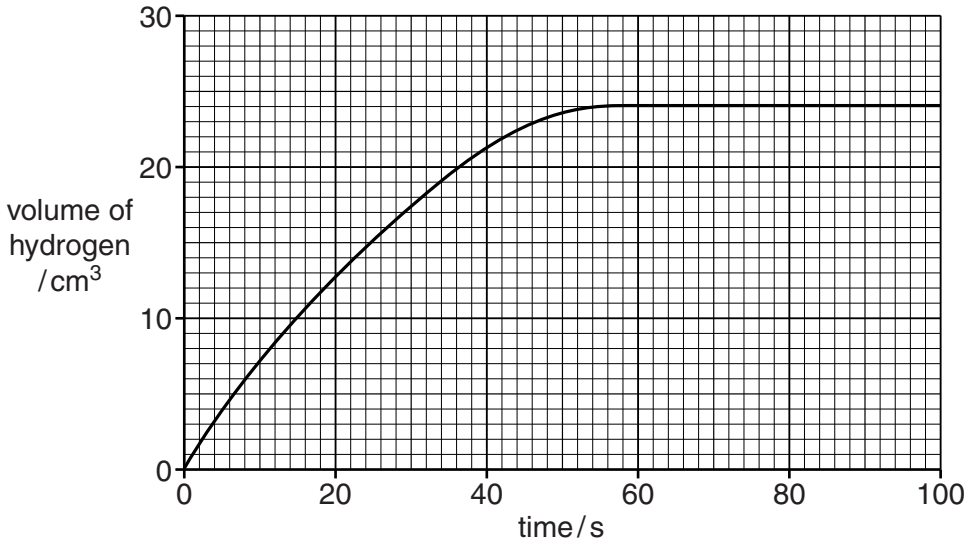
(a) (i) Show by calculation which reactant is in excess.

[3]

(ii) What would you observe in this reaction?

.....[1]

(b) The graph shows how the volume of hydrogen gas produced, at room temperature and pressure, changes with time.



Calculate the total mass of hydrogen formed.

mass of hydrogen = ... g [2]

(c) The experiment is repeated at the same temperature and pressure. The same mass of magnesium is added but magnesium powder is used instead of small pieces.

The rate of reaction is faster. Explain why.

.....

.....

.....[2]

(d) Magnesium reacts with nitrogen when heated. The ionic compound magnesium nitride, Mg_3N_2, is formed.

(i) Construct the equation, including state symbols, for this reaction.

.....[1]

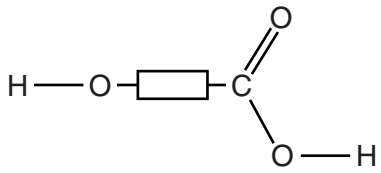
(ii) Deduce the charge on the nitride ion.

.....[1]

[Total: 10]

[Turn over

B9 The structure of glycolic acid can be represented as shown.



(a) Glycolic acid is a solid at room temperature.

Describe the arrangement and motion of the molecules in glycolic acid at room temperature.

arrangement .....

motion .....[2]

(b) Glycolic acid can polymerise with itself to form a polyester called poly(glycolic acid).

(i) What type of polymer is a polyester?

.....[1]

(ii) Draw a section of the polymer chain of poly(glycolic acid) showing at least two repeating units.

[2]

(c) Glycolic acid is produced by heating methanal, carbon monoxide and water in the presence of a sulfuric acid catalyst.

$$\underset{\text{methanal}}{CH_2O} + CO + H_2O \rightarrow \underset{\text{glycolic acid}}{CH_2(OH)COOH}$$

(i) A sample of 1800 g of methanal reacts with excess carbon monoxide and water. The percentage yield of glycolic acid is 45%.

Calculate the mass, in grams, of glycolic acid produced.

mass of glycolic acid = ... g [3]

(ii) Glycolic acid is a weak acid. Sulfuric acid is a strong acid.

Explain the difference between a strong acid and a weak acid.

.....

.....

.....[2]

[Total: 10]

B10 Methanol is manufactured by reacting carbon monoxide with hydrogen. The forward reaction is exothermic.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \qquad \Delta H = -91\,kJ/mol$$

(a) Predict and explain the effect of increasing the pressure on the position of equilibrium. The temperature remains constant.

.....

.....

.....[2]

(b) Predict and explain the effect of decreasing the temperature on the position of equilibrium. The pressure remains constant.

.....

.....

.....[2]

(c) The rate of reaction decreases when the temperature is lowered.

Explain why.

.....

.....

.....[2]

(d) The reaction is catalysed by copper.

(i) Describe and explain the effect of a catalyst on this reaction.

.....

.....

.....[2]

(ii) Copper is a transition element. Many transition elements are catalysts.

Give **two** other properties of copper that identify it as a transition element.

.....

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