Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **May/June 2017**

1 hour 15 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.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

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.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **14** printed pages and **2** blank pages.

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1 **(a)** State the name of the process that is used to

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(i) separate oxygen from liquid air,

..... [1]

(ii) separate the individual dyes in ink,

..... [1]

(iii) produce ethanol from simple sugars,

..... [1]

(iv) obtain water from aqueous sodium chloride,

..... [1]

(v) separate the precipitate formed when aqueous silver nitrate is added to aqueous sodium chloride.

..... [1]

(b) State what is meant by the terms

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(i) *element*,

.....

..... [1]

(ii) *compound*,

View solution

.....

..... [1]

(iii) *ion*.

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.....

..... [1]

[Total: 8]

2 Carbon and silicon are elements in Group IV of the Periodic Table. Both carbon and silicon exist as more than one isotope.

(a) Define the term *isotopes*.

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.....

..... [2]

(b) Complete the following table which gives information about carbon atoms and silicon atoms.

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	carbon	silicon
proton number		
electronic structure		
nucleon number	12	28
number of neutrons in one atom		

[3]

(c) Silicon has a giant structure which is similar to the structure of diamond.

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(i) Name the type of bond which is present between silicon atoms in silicon.

..... [1]

(ii) Suggest **two** physical properties of silicon.
Use your knowledge of structure and bonding to explain why silicon has these physical properties.

property 1 .....

reason 1 .....

property 2 .....

reason 2 .....

[4]

(d) Samples of air taken from industrial areas are found to contain small amounts of carbon monoxide.

(i) Explain how this carbon monoxide is formed.

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.....

..... [2]

(ii) State why carbon monoxide should **not** be inhaled.

View solution

..... [1]

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(e) Carbon dioxide, CO_2, is a gas at room temperature and pressure, whereas silicon(IV) oxide, SiO_2, is a solid.

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(i) Name the type of structure which the following compounds have.

carbon dioxide ..... [1]

silicon(IV) oxide ..... [1]

(ii) Use your knowledge of structure and bonding to explain why carbon dioxide is a gas at room temperature and pressure, whereas silicon(IV) oxide is a solid.

.....

.....

.....

..... [3]

(f) Silicon(IV) oxide is an acidic oxide. When silicon(IV) oxide reacts with alkalis, the salts formed contain the ion SiO_3^{2-}.

Write a chemical equation for the reaction between silicon(IV) oxide and aqueous sodium hydroxide.

..... [2]

[Total: 20]

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3 This question is about nitrogen and some of its compounds.

(a) Nitrogen in the air can be converted into ammonia by the Haber process. The chemical equation for the reaction is shown.

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$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(i) State the temperature and pressure used in the Haber process.

temperature .....

pressure .....

[2]

(ii) Name the catalyst used in the Haber process.

View solution

..... [1]

(b) The ammonia produced in the Haber process can be oxidised to nitrogen(II) oxide at 900 °C. The reaction is exothermic.

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(i) Balance the chemical equation for this reaction.

$$4NH_3 + ...O_2 \rightleftharpoons .....NO + ...H_2O$$

[2]

(ii) Suggest a reason, other than cost, why a temperature greater than 900 °C is **not** used.

..... [1]

(iii) Suggest a reason why a temperature less than 900 °C is **not** used.

..... [1]

(c) Nitrogen(II) oxide can be reacted with oxygen and water to produce nitric acid as the only product.

Write a chemical equation for this reaction.

View solution

..... [2]

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(d) Describe how you would prepare a pure dry sample of copper(II) nitrate crystals in the laboratory using dilute nitric acid and solid copper(II) carbonate.
Include a series of key steps in your answer.
You should include a chemical equation for the reaction.

View solution

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 15]

Question 4 starts on the next page.

4 Nickel, copper and zinc are three consecutive elements in the Periodic Table.

View solution

(a) Nickel and copper are transition elements.

State **three** chemical properties of transition elements.

.....

.....

..... [3]

(b) Copper(II) oxide is a basic oxide but zinc oxide is an amphoteric oxide. Both oxides are insoluble in water.

You are provided with a mixture of solid copper(II) oxide and solid zinc oxide. Describe how you would obtain a sample of copper(II) oxide from this mixture.

.....

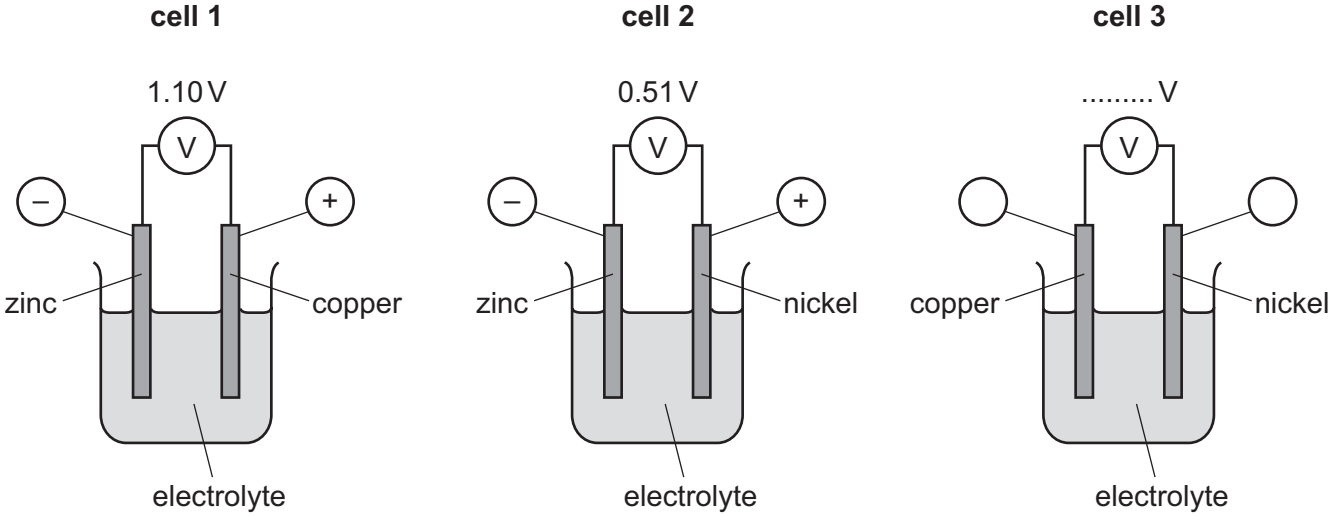
.....

.....

..... [3]

View solution

(c) Three cells are set up each using two metals.



(i) Write the ionic half-equation for the reaction occurring at the zinc electrode in **cell 1**.

..... [2]

(ii) Put the **three** metals, copper, nickel and zinc, in order of reactivity.

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most reactive .....

↓ .....

least reactive .....

[1]

(iii) Complete the labelling in **cell 3** by writing the polarity (+/–) of each electrode in the circles and calculating the reading on the voltmeter. [2]

[Total: 11]

View solution

5 **(a)** The elements in Group VII are known as the halogens. Some halogens react with aqueous solutions of halides.

(i) Complete the table by adding a ✓ to indicate when a reaction occurs and a ✗ to indicate when no reaction occurs.

View solution

	aqueous potassium chloride	aqueous potassium bromide	aqueous potassium iodide
chlorine	✗	✓	
bromine		✗	
iodine			✗

[3]

(ii) Write a chemical equation for the reaction between chlorine and aqueous potassium bromide.

..... [1]

(b) A sample of vanadium chloride was weighed and dissolved in water. An excess of aqueous silver nitrate, acidified with dilute nitric acid, was added. A precipitate of silver chloride was formed. The ionic equation for this reaction is shown.

View solution

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

The mass of silver chloride formed was 2.87 g.

(i) State the colour of the precipitate of silver chloride.

..... [1]

(ii) The relative formula mass of silver chloride, AgCl, is 143.5.

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Calculate the number of moles in 2.87 g of AgCl.

moles of AgCl = ... mol [1]

(iii) Use your answer to **(b)(ii)** and the ionic equation to deduce the number of moles of chloride ions, Cl^-, that produced 2.87 g of AgCl.

View solution

moles of Cl^- = ... mol [1]

(iv) The amount of vanadium chloride in the sample was 0.01 moles.

Use this and your answer to **(b)(iii)** to deduce the **whole number** ratio of moles of vanadium chloride : moles of chloride ions.
Deduce the formula of vanadium chloride.

View solution

moles of vanadium chloride : moles of chloride ions ..... : .....

formula of vanadium chloride .....

[2]

(c) Astatine is at the bottom of Group VII. Use your knowledge of the properties of the halogens to

(i) predict the physical state of astatine at room temperature and pressure, View solution

..... [1]

(ii) write a chemical equation for the reaction between sodium and astatine. View solution

..... [2]

(d) Iodine reacts with chlorine. The chemical equation is shown. View solution

$$I_2 + Cl_2 \rightarrow 2ICl$$

Use the bond energies to answer the questions.

bond	bond energy in kJ / mol
I–I	151
Cl–Cl	242
I–Cl	208

(i) Calculate the total amount of energy required to break the bonds in 1 mole of I_2 and 1 mole of Cl_2.

..... kJ [1]

(ii) Calculate the total amount of energy given out when the bonds in 2 moles of ICl are formed. View solution

..... kJ [1]

(iii) Use your answers to **(d)(i)** and **(d)(ii)** to calculate the overall energy change for the reaction. View solution

$$I_2 + Cl_2 \rightarrow 2ICl$$

..... kJ / mol [1]

[Total: 15]

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6 **(a)** An homologous series is a 'family' of organic compounds whose names have the same ending.

(i) Name the homologous series for which the names of the organic compounds end in *-ene* and *-oic acid*.

-ene ..... [1]

-oic acid ..... [1]

(ii) State **two** characteristics of an homologous series.

View solution

.....

..... [2]

(b) Propan-1-ol is a member of the homologous series of alcohols. It reacts in the same way as ethanol with acidified potassium manganate(VII) and with carboxylic acids.

View solution

Name the **type** of compound that is formed when propan-1-ol is heated with

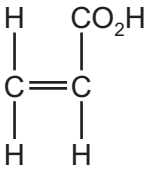
acidified potassium manganate(VII), ...

ethanoic acid and a suitable catalyst. .....

[2]

(c) The structure of prop-2-enoic (acrylic) acid is shown.

View solution



(i) What would you see if prop-2-enoic acid were added to

aqueous bromine, ...

a solution of sodium carbonate. .....

[2]

(ii) Prop-2-enoic acid can be polymerised to form poly(acrylic acid).

Suggest the type of polymerisation that occurs and draw **one** repeat unit of the polymer.

type of polymerisation .....

repeat unit

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[3]

[Total: 11]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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