Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

CHEMISTRY   **0620/04**

Paper 4 Theory (Extended)   **For Examination from 2016**

SPECIMEN PAPER

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, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
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 **18** printed pages and **2** blank pages.

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[Turn over

1 The following table gives information about six substances.

substance	melting point / °C	boiling point / °C	electrical conductivity as a solid	electrical conductivity as a liquid
A	839	1484	good	good
B	−188	−42	poor	poor
C	776	1497	poor	good
D	−117	78	poor	poor
E	1607	2227	poor	poor
F	−5	102	poor	good

(a) Which substance could be a metal?

[1]

(b) State **all** the substances that are liquid at room temperature?

[1]

(c) Which substance could have a macromolecular structure similar to that of silicon(IV) oxide?

[1]

(d) Which substance could be propane?

[1]

(e) Which substance could be sodium chloride?

[1]

[Total: 5]

2   The table gives the composition of three particles.

particle	number of protons	number of electrons	number of neutrons
A	15	15	16
B	15	18	16
C	15	15	17

(a) What is the evidence in the table for each of the following?

   (i) Particle **A** is an atom.

   ....

   .... [1]

   (ii) **A**, **B** and **C** are all particles of the same element.

   ....

   .... [1]

   (iii) Particles **A** and **C** are isotopes of the same element.

   ....

   .... [2]

(b) (i) What is the electronic structure of particle **A**?

   .... [1]

   (ii) Is element **A**, a metal or a non-metal? Give a reason for your choice.

   ....

   .... [1]

[Total: 6]

3 Kinetic theory explains the properties of matter in terms of the arrangement and movement of particles.

(a) Nitrogen is a gas at room temperature. Nitrogen molecules, N_2, are spread far apart and move in a random manner at high speed.

(i) Draw the electronic structure of a nitrogen molecule.
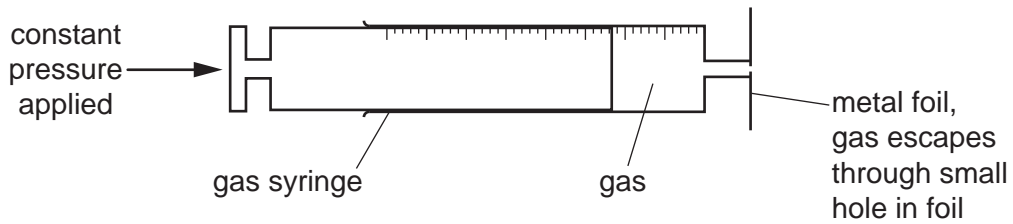Show only the outer electron shells.

[2]

(ii) Compare the movement and arrangement of the molecules in solid nitrogen to those in nitrogen gas.

[3]

(b) A sealed container contains nitrogen gas. The pressure of the gas is due to the molecules of the gas hitting the walls of the container.
Use the kinetic theory to explain why the pressure inside the container increases when the temperature is increased.

[2]

The following apparatus can be used to measure the rate of diffusion of a gas.

constant
pressure →
applied

gas syringe   gas   metal foil,
gas escapes
through small
hole in foil

The following results were obtained.

gas	temperature /°C	rate of diffusion in cm^3/min
nitrogen	25	1.00
chlorine	25	0.63
nitrogen	50	1.05

(c) (i) Explain why nitrogen gas diffuses faster than chlorine gas.

....

.... [2]

(ii) Explain why the nitrogen gas diffuses faster at the higher temperature.

.... [1]

[Total: 10]

4 Chromium is a transition element.

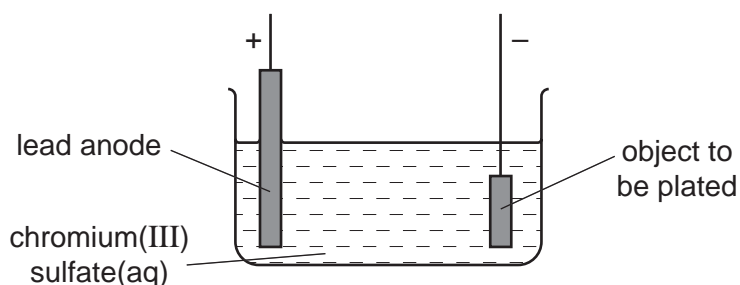**(a) (i)** State **two** differences in the physical properties of chromium and sodium.

....

.... [2]

(ii) State **two** differences in the chemical properties of chromium and sodium.

....

....

.... [2]

(b) Chromium is used to electroplate steel objects. The diagram shows how this could be done.

(i) Give **two** reasons why steel objects are plated with chromium.

....

.... [2]

(ii) The formula of the chromium(III) ion is Cr^{3+} and of the sulfate ion is SO_4^{2-}. Give the formula of chromium(III) sulfate.

.... [1]

(iii) Write the ionic half-equation for the reaction at the negative electrode (cathode).

.... [2]

(iv) A colourless gas, which relights a glowing splint, is formed at the positive electrode (anode).

State the name of this gas.

.... [1]

(v) During electroplating, it is necessary to add more chromium(III) sulfate but during copper plating using a copper anode, it is not necessary to add more copper(II) sulfate.
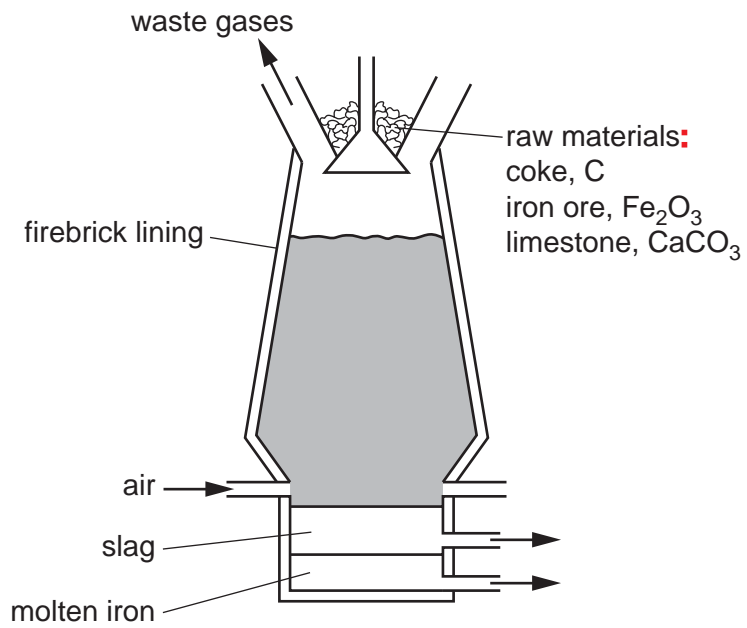
Explain this difference.

....

....

.... [2]

[Total: 12]

5 Iron is extracted from its ore, hematite, in the blast furnace.

waste gases

firebrick lining

raw materials**:**
coke, C
iron ore, Fe_2O_3
limestone, $CaCO_3$

air

slag

molten iron

Describe the reactions involved in this extraction.

Include one equation for a redox reaction and one for an acid/base reaction.

....

....

....

....

....

....

....

....

....

.... [5]

[Total: 5]

9

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6 Soluble salts can be made using a base and an acid.

(a) Complete this method of preparing dry crystals of the soluble salt cobalt(II) chloride-6-water from the insoluble base cobalt(II) carbonate.

step 1
Add an excess of cobalt(II) carbonate to hot dilute hydrochloric acid.

step 2

....

....

step 3

....

....

step 4

....

.... [4]

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(b) (i) 5.95 g of cobalt(II) carbonate were added to 40 cm^3 of hydrochloric acid, concentration 2.0 mol/dm^3.

Calculate the maximum yield of cobalt(II) chloride-6-water and show that the cobalt(II) carbonate was in excess.

$$CoCO_3 + 2HCl \rightarrow CoCl_2 + CO_2 + H_2O$$

$$CoCl_2 + 6H_2O \rightarrow CoCl_2.6H_2O$$
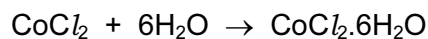
maximum yield:

number of moles of HCl used = ……………………………………………..…..……..

number of moles of CoCl$_2$ formed = ……………………………………………..…..……

number of moles of CoCl$_2$.6H$_2$O formed = …………………………………….…..…..

mass of one mole of CoCl$_2$.6H$_2$O = 238 g

maximum yield of CoCl$_2$.6H$_2$O = …………………………………………….…..…. g

to show that cobalt(II) carbonate is in excess:

number of moles of HCl used = ………………………….……… (use your value from above)

mass of one mole of CoCO$_3$ = 119 g

number of moles of CoCO$_3$ in 5.95 g of cobalt(II) carbonate = ………………………… [5]

(ii) Explain how these calculations show that cobalt(II) carbonate is in excess.

……………………………………………………………………………………………………. [1]

[Total: 10]

7 Iodine reacts with chlorine to form dark brown iodine monochloride.

$$I_2 + Cl_2 \rightarrow 2ICl$$
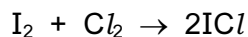
This reacts with more chlorine to give yellow iodine trichloride.
An equilibrium forms between these iodine chlorides.

$$ICl(l) + Cl_2(g) \rightleftharpoons ICl_3(s)$$
$$\text{dark brown} \qquad\qquad \text{yellow}$$
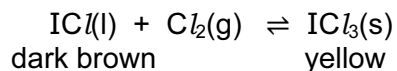
(a) What do you understand by the term *equilibrium*?

....

....

.... [2]

(b) When the equilibrium mixture is heated, it becomes a darker brown colour.
Suggest if the reverse reaction is endothermic or exothermic. Give a reason for your choice.

....

....

.... [1]

(c) The pressure on the equilibrium mixture is decreased.

(i) How would this affect the position of equilibrium? Give a reason for your choice.

It would move to the ....

reason ....

.... [1]

(ii) Describe what you would observe.

....

.... [1]

(d) Calculate the overall energy change for the reaction between iodine and chlorine using the bond energy values shown.

$$I_2 + Cl_2 \rightarrow 2ICl$$
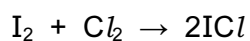
Bond	Energy / kJ per mol
I−I Cl−Cl I−Cl	151 242 208

Show your working.

[3]

(e) Draw a labelled energy level diagram for the reaction between iodine and chlorine using the information in **(d)**.

[2]

[Total: 10]

8 The alcohols form an homologous series.

(a) Give **three** characteristics of an homologous series.

....

....

....

.... [3]

(b) The following two alcohols are members of an homologous series and they are isomers.

$$CH_3 — CH_2 — CH_2 — CH_2 — OH \quad and \quad (CH_3)_2CH — CH_2 — OH$$
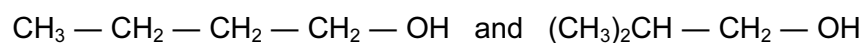
(i) Explain why they are isomers.

....

....

.... [2]

(ii) Deduce the structural formula of another alcohol which is also an isomer of these alcohols.

[1]

(c) Copper(II) oxide can oxidise butanol to liquid **X**, whose pH is 4.

mineral wool
soaked in butanol   copper(II) oxide

heat

liquid **X**
formed by
oxidation of
butanol.
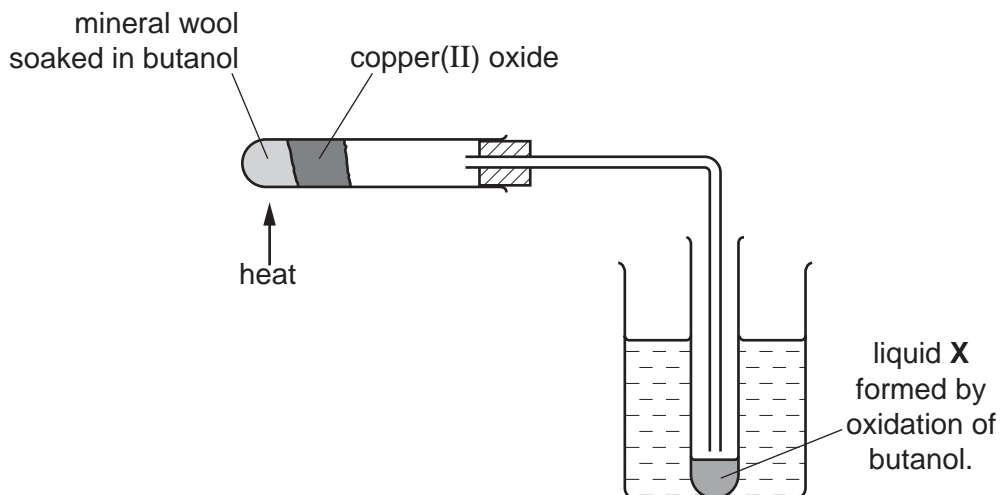
(i) Give the name of another reagent which can oxidise butanol.

[1]

(ii) Which homologous series does liquid **X** belong to?

[1]

(iii) State the formula of liquid **X**.

[1]

(d) The alcohol ethanol can be made by fermentation. Yeast is added to aqueous glucose.

$$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$
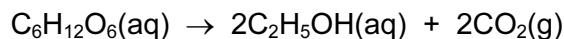
Carbon dioxide is given off and the mixture becomes warm, as the reaction is exothermic. The graph shows how the rate of reaction varies over several days.
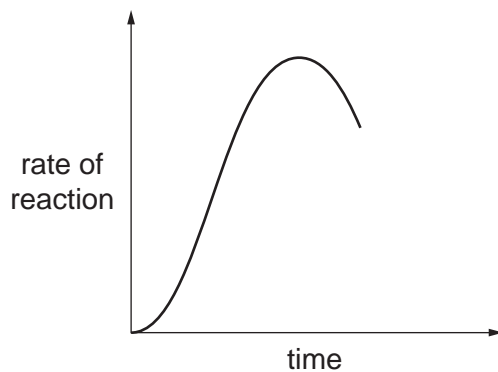
    (i) Suggest a method of measuring the rate of this reaction.

    ....

    .... [2]

    (ii) Why does the rate initially increase?

    ....

    .... [1]

   (iii) Suggest **two** reasons why the rate eventually decreases.

    ....

    .... [2]

[Total: 14]

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9 There are two types of polymerisation, addition and condensation.

(a) Explain the difference between these two types of polymerisation.

....

....

.... [2]

(b) Some plastics, formed by polymerisation, are non-biodegradable.

Describe **two** pollution problems that are caused by non-biodegradable plastics.

....

....

....

.... [2]

(c) The polymer known as PVA is used in paints and adhesives. Its structural formula is shown below.

$$—CH_2—CH—CH_2—CH—$$
$$\qquad\quad|\qquad\qquad|$$
$$\qquad OCOCH_3 \quad OCOCH_3$$
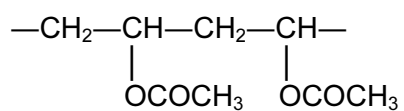
Deduce the structural formula of its monomer.

[1]

(d) A condensation polymer can be made from the following monomers.

$$HOOC(CH_2)_4COOH \quad and \quad H_2N(CH_2)_6NH_2$$
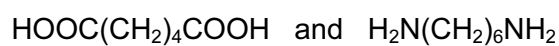
Draw the structural formula of this polymer.

[3]

[Total: 8]

The Periodic Table of the Elements

Group								
I	II	III	IV	V	VI	VII	VIII	

Key

atomic number
atomic symbol
name
relative atomic mass

| | | | | | | | | He helium 2 |

1
H
hydrogen
1

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.)

| lanthanoids | 57–71 |
| actinoids | 89–103 |

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