



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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CHEMISTRY

0620/31

Paper 3 (Extended)

May/June 2015

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 12.

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 **12** printed pages.



1 (a) Coal is a solid fossil fuel.

Name **two** other fossil fuels.

..... [2]

(b) Two of the elements present in a sample of coal are carbon and sulfur.

A sample of coal was heated in the absence of air and the products included water, ammonia and hydrocarbons.

Name **three** other elements present in this sample of coal.

..... [2]

(c) Sulfur, present in coal, is one major cause of acid rain. Sulfur burns to form sulfur dioxide which reacts with rain water to form sulfuric acid.

(i) Describe how the high temperatures in vehicle engines are another cause of acid rain.

.....
.....
..... [3]

(ii) Give **two** harmful effects of acid rain.

.....
..... [2]

(d) In 2010, a large coal-burning power station in the UK was converted to burn both coal and wood.

Explain why the combustion of wood rather than coal can reduce the effect of the emissions from this power station on the level of carbon dioxide in the atmosphere.

.....
.....
.....
..... [3]

[Total: 12]

2 Iron from the Blast Furnace is impure. It contains about 5% of impurities, mainly carbon, sulfur, silicon and phosphorus, which have to be removed when this iron is converted into steel.

(a) Explain how the addition of oxygen and calcium oxide removes these impurities. Include an equation for a reaction of oxygen and a word equation for a reaction of calcium oxide in this process.

.....
.....
.....
.....
.....
.....

[5]

(b) Mild steel is the most common form of steel. Mild steel contains a maximum of 0.3% of carbon. High carbon steel contains 2% of carbon. It is less malleable and much harder than mild steel.

(i) Give a use of mild steel.

..... [1]

(ii) Suggest a use of high carbon steel.

..... [1]

(iii) Explain why metals are malleable.

.....
.....
.....
..... [3]

(iv) Suggest an explanation why high carbon steel is less malleable and harder than mild steel.

.....
.....
..... [2]

[Total: 12]

- 3 (a) The reactions between metals and acids are redox reactions.



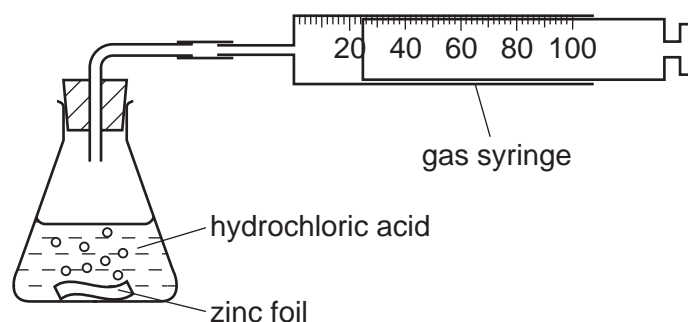
- (i) Which change in the above reaction is oxidation, Zn to Zn^{2+} or 2H^+ to H_2 ? Give a reason for your choice.

.....
 [2]

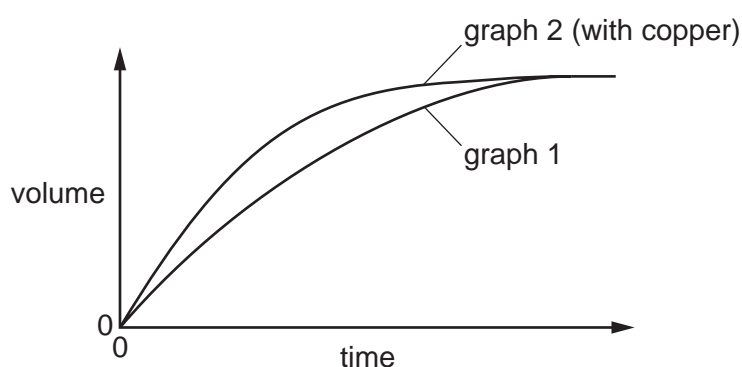
- (ii) Which reactant in the above reaction is the oxidising agent? Give a reason for your choice.

.....
 [2]

- (b) The rate of reaction between a metal and an acid can be investigated using the apparatus shown below.



A piece of zinc foil was added to 50 cm^3 of hydrochloric acid, of concentration 2.0 mol/dm^3 . The acid was in excess. The hydrogen evolved was collected in the gas syringe and its volume measured every minute. The results were plotted and labelled as graph 1.



The experiment was repeated to show that the reaction between zinc metal and hydrochloric acid is catalysed by copper. A small volume of aqueous copper(II) chloride was added to the acid before the zinc was added. The results of this experiment were plotted on the same grid and labelled as graph 2.

- (i) Explain why the reaction mixture in the second experiment contains copper metal. Include an equation in your explanation.

.....
..... [2]

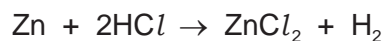
- (ii) Explain how graph 2 shows that copper catalyses the reaction.

.....
.....
..... [3]

- (c) If the first experiment was repeated using ethanoic acid, CH₃COOH, instead of hydrochloric acid, how and why would the graph be different from graph 1?

.....
.....
.....
..... [4]

- (d) Calculate the maximum mass of zinc which will react with 50 cm³ of hydrochloric acid, of concentration 2.0 mol/dm³.



Show your working.

[3]

[Total: 16]

4 The alcohols form a homologous series.

(a) (i) Give **three** characteristics which all members of a homologous series share.

.....

 [3]

(ii) Give the name of the third member of this series.

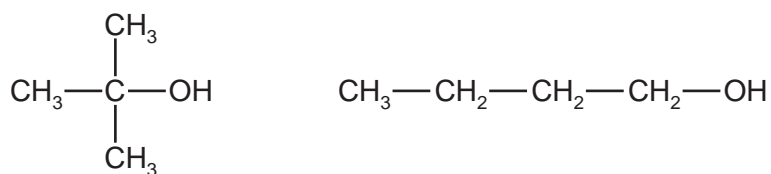
name [1]

(iii) Deduce the molecular formula of the alcohol whose $M_r = 158$. Show your working.

.....

 [2]

(b) Explain why the following two alcohols are isomers.



.....
 [2]

(c) This question is based on typical reactions of butan-1-ol.

- (i) When butan-1-ol, $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-OH}$, is passed over the catalyst silicon(IV) oxide, water is lost.

Deduce the name and the structural formula of the organic product in this reaction.

name

structural formula

[2]

- (ii) Suggest the name of the ester formed from butanol and ethanoic acid.

..... [1]

- (iii) Butan-1-ol is oxidised by acidified potassium manganate(VII).

Deduce the name and the structural formula of the organic product in this reaction.

name

structural formula

[2]

[Total: 13]

5 The halogens are a group of non-metals in Group VII of the Periodic Table.

(a) The reactivity of the halogens decreases down the group.

Describe an experiment which shows that chlorine is more reactive than iodine. Include an equation in your answer.

.....

.....

.....

..... [3]

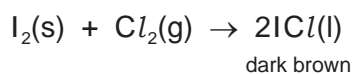
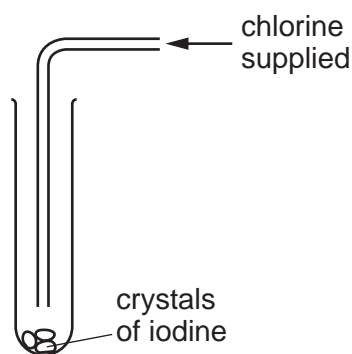
(b) The halogens form interhalogen compounds. These are compounds which contain two different halogens.

Deduce the formula of the compound which has the composition 0.013 moles of iodine atoms and 0.065 moles of fluorine atoms.

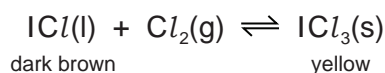
.....

..... [2]

(c) Iodine reacts with chlorine to form a dark brown liquid, iodine monochloride.



When more chlorine is added and the tube is sealed, a reversible reaction occurs and the reaction comes to equilibrium.



(i) Give another example of a reversible reaction.

..... [1]

(ii) Explain the term *equilibrium*.

.....

..... [2]

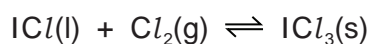
- (d) Chlorine is removed from the tube and a new equilibrium is formed.

Explain why there is less of the yellow solid and more dark brown liquid in the new equilibrium mixture.

.....
.....
..... [2]

- (e) A sealed tube containing the equilibrium mixture is placed in ice-cold water. There is an increase in the amount of yellow solid in the equilibrium mixture.

What can you deduce about the forward reaction in this equilibrium?



Explain your deduction.

.....
.....
.....
..... [3]

[Total: 13]

6 Acid-base reactions are examples of proton transfer.

(a) Ethylamine is a weak base and sodium hydroxide is a strong base.

(i) In terms of proton transfer, explain what is meant by the term *weak base*.

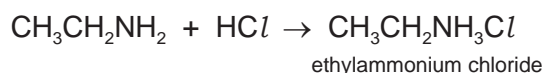
.....
 [2]

(ii) Given aqueous solutions of both bases, describe how you could show that sodium hydroxide is the stronger base. How could you ensure a 'fair' comparison between the two solutions?

.....

 [3]

(b) Ethylamine reacts with acids to form salts.



(i) Complete the equation for the reaction between sulfuric acid and ethylamine. Name the salt formed.



name of salt [3]

(ii) Amines and their salts have similar chemical properties to ammonia and ammonium salts.

Suggest a reagent that could be used to displace the weak base, ethylamine, from its salt ethylammonium chloride.

..... [1]

(c) Gases diffuse, which means that they move to occupy the total available volume.

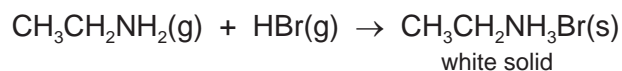
(i) Explain, using kinetic particle theory, why gases diffuse.

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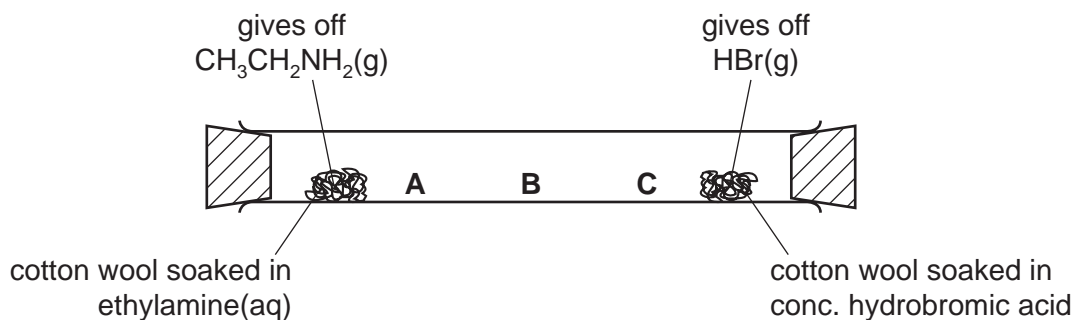
.....

..... [2]

(ii) When the colourless gases hydrogen bromide and ethylamine come into contact, a white solid is formed.



The following apparatus can be used to compare the rates of diffusion of the two gases ethylamine and hydrogen bromide.



Predict at which position, **A**, **B** or **C**, the white solid will form. Explain your choice.

.....

.....

..... [3]

[Total: 14]

DATA SHEET
The Periodic Table of the Elements

		Group																																																																																														
I	II	III	IV	V	VI	VII	0																																																																																									
7 Li Lithium 3	9 Be Beryllium 4	1 H Hydrogen 1	11 B Boron 5	12 C Carbon 6	13 Al Aluminium 13	14 N Nitrogen 7	15 O Oxygen 8	16 F Fluorine 9	17 Ne Neon 10	18 Ar Argon 18	19 K Potassium 19	20 Ca Calcium 20	21 Sc Scandium 21	22 Ti Titanium 22	23 V Vanadium 23	24 Cr Chromium 24	25 Mn Manganese 25	26 Fe Iron 26	27 Co Cobalt 27	28 Ni Nickel 28	29 Cu Copper 29	30 Zn Zinc 30	31 Ga Gallium 31	32 Ge Germanium 32	33 As Arsenic 33	34 Se Selenium 34	35 Br Bromine 35	36 Kr Krypton 36	37 Rb Rubidium 37	38 Sr Strontium 38	39 Y Yttrium 39	40 Zr Zirconium 40	41 Nb Niobium 41	42 Mo Molybdenum 42	43 Tc Technetium 43	44 Ru Ruthenium 44	45 Rh Rhodium 45	46 Pd Palladium 46	47 Ag Silver 47	48 Cd Cadmium 48	49 In Indium 49	50 Sn Tin 50	51 Sb Antimony 51	52 Te Tellurium 52	53 I Iodine 53	54 Xe Xenon 54	55 Cs Caesium 55	56 Ba Barium 56	57 La Lanthanum 57	72 Hf Hafnium 72	73 Ta Tantalum 73	74 W Tungsten 74	75 Re Rhenium 75	76 Os Osmium 76	77 Ir Iridium 77	78 Pt Platinum 78	79 Au Gold 79	80 Hg Mercury 80	81 Tl Thallium 81	82 Pb Lead 82	83 Bi Bismuth 83	84 Po Polonium 84	85 At Astatine 85	86 Rn Radon 86	87 Fr Francium 87	88 Ra Radium 88	89 Ac Actinium 89	90 Th Thorium 90	91 Pa Protactinium 91	92 U Uranium 92	93 Np Neptunium 93	94 Pu Plutonium 94	95 Am Americium 95	96 Cm Curium 96	97 Bk Berkelium 97	98 Cf Californium 98	99 Es Einsteinium 99	100 Fm Fermium 100	101 Md Mendelevium 101	102 No Nobelium 102	103 Lr Lawrencium 103	104 Rf Rutherfordium 104	105 Db Dubnium 105	106 Sg Seaborgium 106	107 Bh Bohrium 107	108 Hs Hassium 108	109 Mt Meitnerium 109	110 Ds Darmstadtium 110	111 Rg Roentgenium 111	112 Cn Copernicium 112	113 Nh Nihonium 113	114 Fl Flerovium 114	115 Mc Moscovium 115	116 Lv Livermorium 116	117 Ts Tennessine 117	118 Og Oganesson 118
133 Cs Caesium 55	137 Ba Barium 56	226 Ra Radium 88	227 Ac Actinium 89	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	145 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	163 Ho Holmium 67	164 Er Erbium 68	167 Tm Thulium 69	168 Yb Ytterbium 70	173 Lu Lutetium 71	175 Lr Lawrencium 103																																																																														

*58-71 Lanthanoid series
†90-103 Actinoid series

Key

a	X
b	

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

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