Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1045436086

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.

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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]

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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.

$$Zn + 2H^+ \rightarrow Zn^{2+} + H_2$$

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

.....

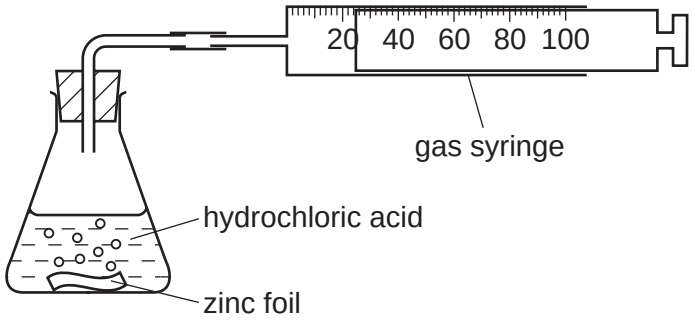
..... [2]

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

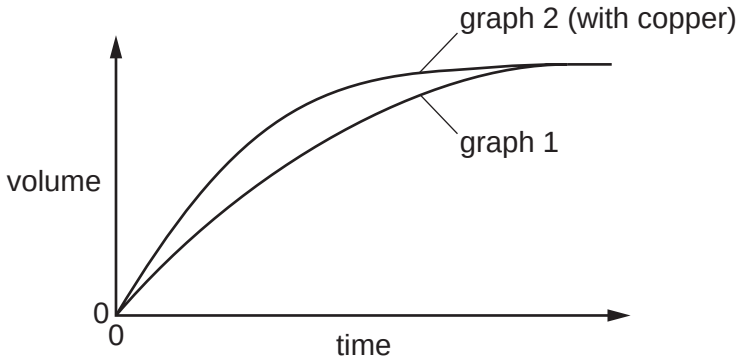
.....

..... [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, CH_3COOH, 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 cm^3 of hydrochloric acid, of concentration 2.0 mol/dm^3.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

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]

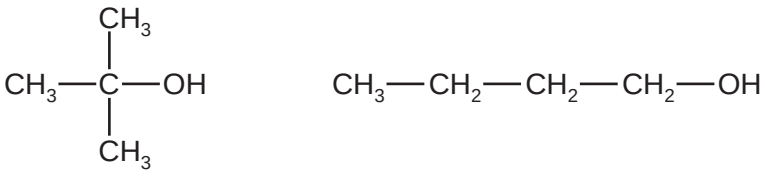
(iii) Deduce the molecular formula of the alcohol whose M_r = 158. Show your working.

.....

.....

..... [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, $CH_3–CH_2–CH_2–CH_2–OH$, 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]

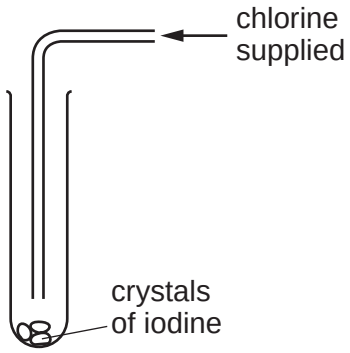
(b) The halogens form interhalogen compounds. These are compounds which contain two different halogens.

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.



$$I_2(s) + Cl_2(g) \rightarrow \underset{\text{dark brown}}{2ICl(l)}$$

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

$$\underset{\text{dark brown}}{ICl(l)} + Cl_2(g) \rightleftharpoons \underset{\text{yellow}}{ICl_3(s)}$$

(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?

$$\mathrm{IC}l(\mathrm{l}) + \mathrm{C}l_2(\mathrm{g}) \rightleftharpoons \mathrm{IC}l_3(\mathrm{s})$$

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.

$$CH_3CH_2NH_2 + HCl \rightarrow \underset{\text{ethylammonium chloride}}{CH_3CH_2NH_3Cl}$$

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

$$.....CH_3CH_2NH_2 + ... \rightarrow .....$$

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]

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

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

.....

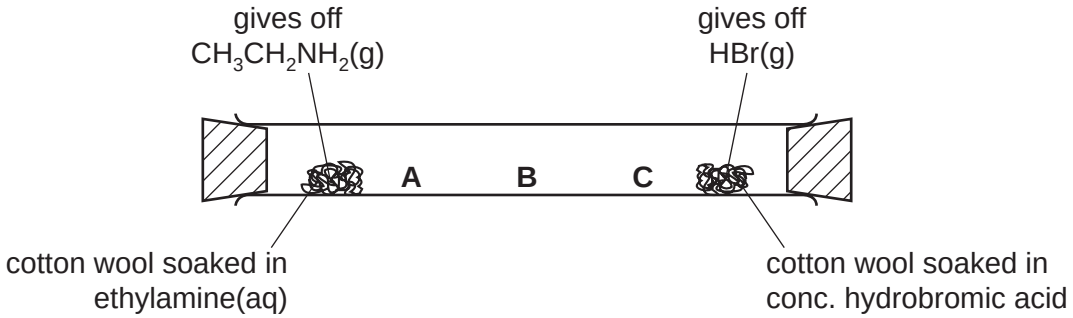
.....

..... [2]

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

$$CH_3CH_2NH_2(g) + HBr(g) \rightarrow \underset{\text{white solid}}{CH_3CH_2NH_3Br(s)}$$

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]

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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	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															
				140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**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	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

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

Key: a = relative atomic mass; **X** = atomic symbol; b = proton (atomic) number

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

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