

Centre Number	Candidate Number	Name
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CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

**CHEMISTRY**

**0620/03**

Paper 3

October/November 2003

**1 hour 15 minutes**

Candidates answer on the Question Paper.  
No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your name, Centre number and candidate number at the top of this page.  
Write in dark blue or black pen in the spaces provided on the Question Paper.  
You may use a pencil for any diagrams, graphs or rough working.  
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.

The number of marks is given in brackets [ ] at the end of each question or part question.  
A copy of the Periodic Table is printed on page 12.

For Examiner's Use	
1	
2	
3	
4	
5	
<b>TOTAL</b>	

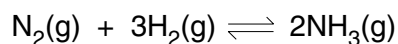
If you have been given a label, look at the details. If any details are incorrect or missing, please fill in your correct details in the space given at the top of this page.

Stick your personal label here, if provided.

This document consists of **10** printed pages and **2** blank pages.



- 1 Ammonia contains the elements nitrogen and hydrogen. It is manufactured from these elements in the Haber process.



The forward reaction is exothermic.

- (a) (i) Nitrogen is obtained from liquid air by fractional distillation. Why does this technique separate liquid oxygen and nitrogen?

.....  
 .....

- (ii) Name **two** raw materials from which hydrogen is manufactured.

.....[3]

- (b) The table shows how the percentage of ammonia in the equilibrium mixture varies with pressure at 600 °C.

percentage ammonia	8	12	15	20
pressure/atm	200	300	400	500

- (i) Explain why the percentage of ammonia increases as the pressure increases.

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

- (ii) How would the percentage of ammonia change if the measurements had been made at a lower temperature?  
 Explain your answer.

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

- (iii) State **two** of the reaction conditions used in the Haber Process.

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

(c) Ammonia is a base.

(i) Name a particle that an ammonia molecule can accept from an acid.

.....

(ii) Write an equation for ammonia acting as a base.

.....[3]

(d) Given aqueous solutions,  $0.1 \text{ mol/dm}^3$ , of sodium hydroxide and ammonia, describe how you could show that ammonia is the weaker base.

.....

.....[2]

(e) Another compound that contains nitrogen and hydrogen is hydrazine,  $\text{N}_2\text{H}_4$ .

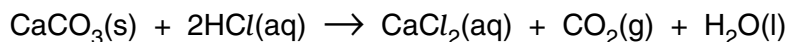
(i) Draw the structural formula of hydrazine. Hydrogen can form only one bond per atom but nitrogen can form three.

(ii) Draw a diagram that shows the arrangement of the valency electrons in one molecule of hydrazine. Hydrazine is a covalent compound.  
Use x to represent an electron from a nitrogen atom.  
Use o to represent an electron from a hydrogen atom.

[3]

2 Some of the factors that can determine the rate of a reaction are concentration, temperature and light intensity.

- (a) A small piece of calcium carbonate was added to an excess of hydrochloric acid. The time taken for the carbonate to react completely was measured.



The experiment was repeated at the same temperature, using pieces of calcium carbonate of the same size but with acid of a different concentration. In all the experiments an excess of acid was used.

concentration of acid / mol dm <sup>-3</sup>	4	2	2	.....
number of pieces of carbonate	1	1	2	1
time / s	.....	80	.....	160

- (i) Complete the table (assume the rate is proportional to both the acid concentration and the number of pieces of calcium carbonate). [3]

- (ii) Explain why the reaction rate would increase if the temperature was increased.

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

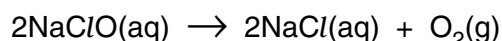
- (iii) Explain why the rate of this reaction increases if the piece of carbonate is crushed to a powder.

.....[1]

- (iv) Fine powders mixed with air can explode violently. Name an industrial process where there is a risk of this type of explosion.

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

- (b) Sodium chlorate(I) decomposes to form oxygen and sodium chloride. This is an example of a photochemical reaction. The rate of reaction depends on the intensity of the light.



- (i) Describe how the rate of this reaction could be measured.

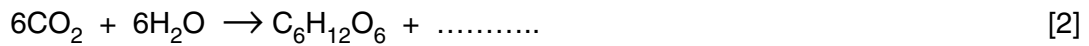
.....  
 .....[2]

(ii) How could you show that this reaction is photochemical?

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

(c) Photosynthesis is another example of a photochemical reaction. Glucose and more complex carbohydrates are made from carbon dioxide and water.

(i) Complete the equation.



(ii) Glucose can be represented as



Draw the structure of a more complex carbohydrate that can be formed from glucose by condensation polymerisation.

[2]

3 Zinc blende is the common ore of zinc. It is usually found mixed with an ore of lead and traces of silver.

(a) (i) Describe how zinc blende is changed into zinc oxide.

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

(ii) Write an equation for the reduction of zinc oxide by carbon.

.....[2]

(iii) The boiling point of lead is 1740 °C and that of zinc is 907 °C. Explain why, when both oxides are reduced by heating with carbon at 1400 °C, only lead remains in the furnace.

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

(b) A major use of zinc is to make diecasting alloys. These contain about 4% of aluminium and they are stronger and less malleable than pure zinc.

(i) Give one other large scale use of zinc.

.....[1]

(ii) Describe the structure of a typical metal, such as zinc, and explain why it is malleable.

.....

.....

.....[3]

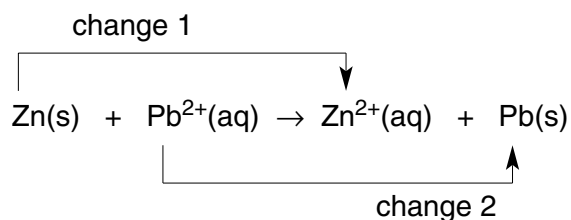
(iii) Suggest why the introduction of a different metallic atom into the structure makes the alloy stronger than the pure metal.

.....

.....[2]

(c) A solution of an impure zinc ore contained zinc, lead and silver(I) ions. The addition of zinc dust will displace both lead and silver.

(i) The ionic equation for the displacement of lead is as follows.



Which change is reduction? Explain your answer.

.....

.....[2]

(ii) Write an ionic equation for the reaction between zinc atoms and silver(I) ions.

.....[2]

- 4 Esters occur naturally in plants and animals. They are manufactured from petroleum. Ethyl ethanoate and butyl ethanoate are industrially important as solvents.

(a) (i) Explain the term *solvent*.

.....[1]

(ii) Give the formula of ethyl ethanoate.

[1]

(iii) Ethyl ethanoate can be made from ethanol and ethanoic acid. Describe how these chemicals can be made.

ethanol from ethene

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

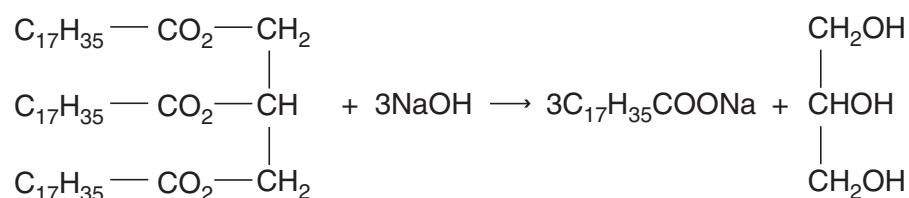
ethanoic acid from ethanol

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

(iv) Name **two** chemicals from which butyl ethanoate can be made.

.....[1]

(b) The following equation represents the alkaline hydrolysis of a naturally occurring ester.



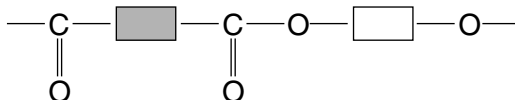
(i) Which substance in the equation is an alcohol? Underline the substance in the equation above.

[1]

(ii) What is the major use for compounds of the type  $\text{C}_{17}\text{H}_{35}\text{COONa}$ ?

.....[1]

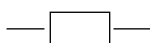
(c) A polymer has the structure shown below.



(i) What type of polymer is this?

.....[1]

(ii) Complete the following to give the structures of the two monomers from which the above polymer could be made.



[2]

(d) Esters are frequently used as solvents in chromatography. A natural macromolecule was hydrolysed to give a mixture of amino acids. These could be identified by chromatography.

(i) What type of macromolecule was hydrolysed?

.....[1]

(ii) What type of linkage was broken by hydrolysis?

.....[1]

(iii) Explain why the chromatogram must be sprayed with a locating agent before the amino acids can be identified.

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

(iv) Explain how it is possible to identify the amino acids from the chromatogram.

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



5 Sulphur dioxide,  $\text{SO}_2$ , and sulphur trioxide,  $\text{SO}_3$ , are the two oxides of sulphur.

(a) Sulphur dioxide can kill bacteria and has bleaching properties. Give a use of sulphur dioxide that depends on each of these properties.

(i) ability to kill bacteria .....[1]

(ii) bleaching properties .....[1]

(b) Sulphur trioxide can be made from sulphur dioxide.

(i) Why is this reaction important industrially?

.....[1]

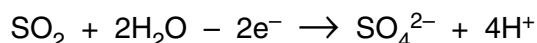
(ii) Complete the word equation.

sulphur dioxide + .....  $\rightarrow$  sulphur trioxide [1]

(iii) What are the conditions for this reaction?

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

(c) Sulphur dioxide is easily oxidised in the presence of water.



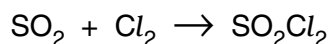
(i) What colour change would be observed when an excess of aqueous sulphur dioxide is added to an acidic solution of potassium manganate(VII)?

.....[2]

(ii) To aqueous sulphur dioxide, acidified barium chloride solution is added. The mixture remains clear. When bromine is added, a thick white precipitate forms. What is the white precipitate? Explain why it forms.

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

(d) Sulphur dioxide reacts with chlorine in an addition reaction to form sulphuryl chloride.



8.0 g of sulphur dioxide was mixed with 14.2 g of chlorine. The mass of one mole of  $\text{SO}_2\text{Cl}_2$  is 135 g.

Calculate the mass of sulphuryl chloride formed by this mixture.

Calculate the number of moles of  $\text{SO}_2$  in the mixture = .....

Calculate the number of moles of  $\text{Cl}_2$  in the mixture = .....

Which reagent was not in excess? .....

How many moles of  $\text{SO}_2\text{Cl}_2$  were formed = .....

Calculate the mass of sulphuryl chloride formed = ..... g

[5]





**DATA SHEET**  
**The Periodic Table of the Elements**

		Group									
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4	1 <b>H</b> Hydrogen 1	11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	13 <b>Al</b> Aluminium 13	14 <b>N</b> Nitrogen 7	15 <b>O</b> Oxygen 8	16 <b>F</b> Fluorine 9	17 <b>Ne</b> Neon 10	18 <b>Ar</b> Argon 18	19 <b>K</b> Potassium 19
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12	27 <b>Co</b> Cobalt 27	28 <b>Ni</b> Nickel 28	29 <b>Cu</b> Copper 29	30 <b>Zn</b> Zinc 30	31 <b>P</b> Phosphorus 15	32 <b>S</b> Sulphur 16	33 <b>Cl</b> Chlorine 17	34 <b>Se</b> Selenium 34	35 <b>Br</b> Bromine 35	36 <b>Kr</b> Krypton 36
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20	41 <b>Nb</b> Niobium 41	42 <b>Mo</b> Molybdenum 42	43 <b>Tc</b> Technetium 43	44 <b>Ru</b> Ruthenium 44	45 <b>Rh</b> Rhodium 45	46 <b>Pd</b> Palladium 46	47 <b>Ag</b> Silver 47	48 <b>Cd</b> Cadmium 48	49 <b>In</b> Indium 49	50 <b>Tl</b> Thallium 81
85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38	91 <b>Zr</b> Zirconium 40	93 <b>Nb</b> Niobium 41	94 <b>Mo</b> Molybdenum 42	95 <b>Tc</b> Technetium 43	96 <b>Ru</b> Ruthenium 44	97 <b>Rh</b> Rhodium 45	98 <b>Pd</b> Palladium 46	99 <b>Cd</b> Cadmium 48	100 <b>Sr</b> Strontium 38	101 <b>Pb</b> Lead 82
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	178 <b>Hf</b> Hafnium 72	181 <b>Ta</b> Tantalum 73	182 <b>W</b> Tungsten 74	186 <b>Re</b> Rhenium 75	190 <b>Os</b> Osmium 76	192 <b>Ir</b> Iridium 77	195 <b>Pt</b> Platinum 78	197 <b>Au</b> Gold 79	201 <b>Hg</b> Mercury 80	202 <b>Po</b> Polonium 84
87 <b>Fr</b> Francium 87	226 <b>Ra</b> Radium 88	227 <b>Ac</b> Actinium 89	232 <b>Th</b> Thorium 90	238 <b>U</b> Uranium 92	238 <b>U</b> Uranium 92	238 <b>U</b> Uranium 92	238 <b>U</b> Uranium 92	238 <b>U</b> Uranium 92	238 <b>U</b> Uranium 92	238 <b>U</b> Uranium 92	238 <b>U</b> Uranium 92
			140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	157 <b>Gd</b> Gadolinium 64	162 <b>Dy</b> Dysprosium 66	165 <b>Ho</b> Holmium 67	169 <b>Tm</b> Thulium 69
			175 <b>Lu</b> Lutetium 71	173 <b>Yb</b> Ytterbium 70	173 <b>Yb</b> Ytterbium 70	173 <b>Yb</b> Ytterbium 70	173 <b>Yb</b> Ytterbium 70	173 <b>Yb</b> Ytterbium 70	173 <b>Yb</b> Ytterbium 70	173 <b>Yb</b> Ytterbium 70	173 <b>Yb</b> Ytterbium 70
			103 <b>Lr</b> Lawrencium 103	102 <b>No</b> Nobelium 102	101 <b>Md</b> Mendelevium 101	100 <b>Fm</b> Fermium 100	99 <b>Es</b> Einsteinium 99	98 <b>Cf</b> Californium 98	97 <b>Bk</b> Berkelium 97	96 <b>Cm</b> Curium 96	95 <b>Am</b> Americium 95

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

**Key**

a	<b>X</b>
b	†

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

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