



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

CENTRE  
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**CHEMISTRY**

**0620/31**

Paper 3 (Extended)

**October/November 2013**

**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 a pencil for any diagrams, graphs or rough working.  
Do not use staples, paper clips, highlighters, 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.

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



1 For each of the following, name an element which matches the description.

(a) It is used as a fuel in nuclear reactors.

..... [1]

(b) It is the only non-metal which is a good conductor of electricity.

..... [1]

(c) Inert electrodes are made from this metal.

..... [1]

(d) This gaseous element is used to fill balloons in preference to hydrogen.

..... [1]

(e) An element which can form an ion of the type  $X^{3-}$ .

..... [1]

(f) It has the same electron distribution as the calcium ion,  $Ca^{2+}$ .

..... [1]

(g) The element is in Period 5 and Group VI.

..... [1]

[Total: 7]

- 2 (a) Give **three** differences in physical properties between the Group I metal, potassium, and the transition element, iron.
1. ....
  2. ....
  3. .... [3]

(b) The following metals are in order of reactivity.

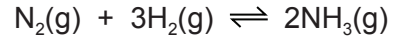
- potassium
- zinc
- copper

For those metals which react with water or steam, name the products of the reaction, otherwise write 'no reaction'.

- potassium .....
- .....
- zinc .....
- .....
- copper .....
- ..... [5]

[Total: 8]

3 Ammonia is manufactured by the Haber process.



The forward reaction is exothermic.

(a) Describe how the reactants are obtained.

(i) Nitrogen

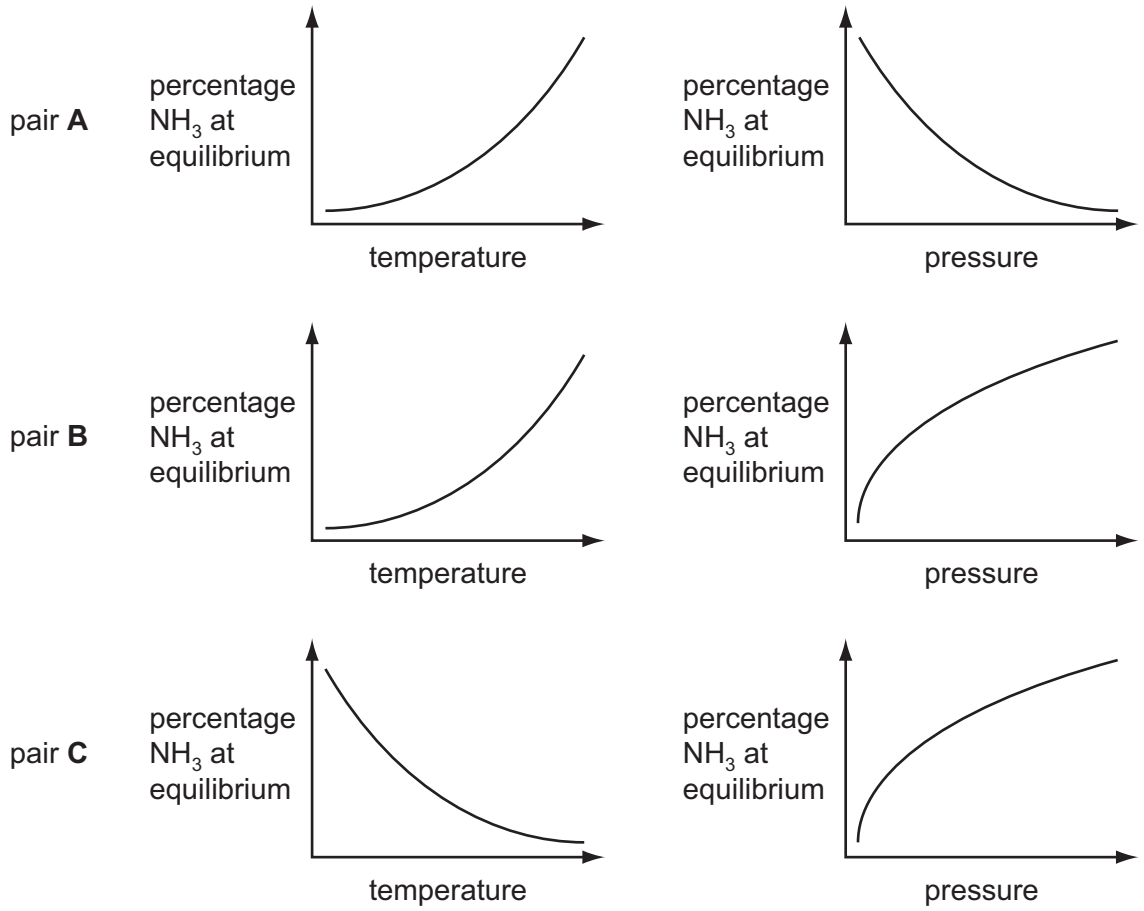
.....  
..... [2]

(ii) Hydrogen

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

(b) The percentage of ammonia in the equilibrium mixture varies with temperature and pressure.

(i) Which pair of graphs, **A**, **B** or **C**, shows correctly how the percentage of ammonia at equilibrium varies with temperature and pressure?



The pair with **both graphs correct** is ..... [1]

(ii) Give a full explanation of why the pair of graphs you have chosen in (i) is correct.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

(iii) Catalysts do not alter the position of equilibrium. Explain why a catalyst is used in this process.

.....

.....

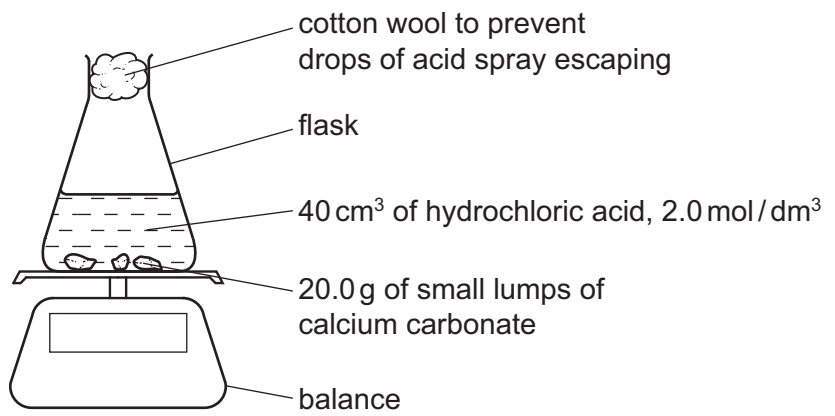
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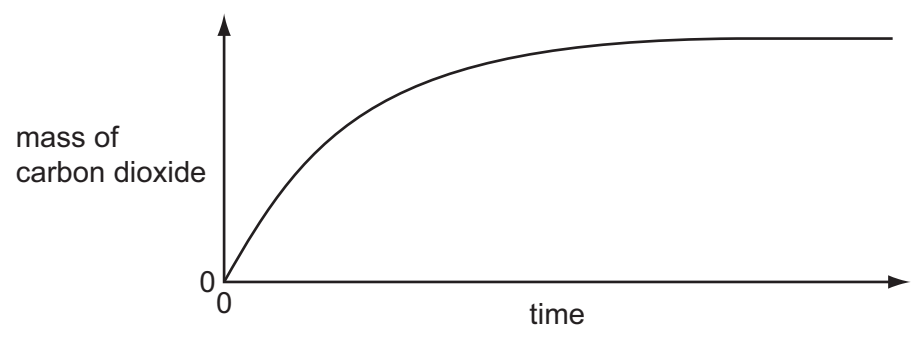
..... [2]

[Total: 14]

4 20.0g of small lumps of calcium carbonate and 40 cm<sup>3</sup> of hydrochloric acid, concentration 2.0 mol/dm<sup>3</sup>, were placed in a flask on a top pan balance. The mass of the flask and contents was recorded every minute.



The mass of carbon dioxide given off was plotted against time.



In all the experiments mentioned in this question, the calcium carbonate was in excess.

(a) (i) Explain how you could determine the mass of carbon dioxide given off in the first five minutes.

..... [1]

(ii) Label the graph **F** where the reaction rate is the fastest, **S** where it is slowing down and **0** where the rate is zero. [2]

(iii) Explain how the shape of the graph shows where the rate is fastest, where it is slowing down and where the rate is zero.

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

(b) Sketch on the same graph, the line which would have been obtained if 20.0g of small lumps of calcium carbonate and 80 cm<sup>3</sup> of hydrochloric acid, concentration 1.0 mol/dm<sup>3</sup>, had been used. [2]

(c) Explain in terms of collisions between reacting particles each of the following.

(i) The reaction rate would be slower if 20.0 g of larger lumps of calcium carbonate and 40 cm<sup>3</sup> of hydrochloric acid, concentration 2.0 mol/dm<sup>3</sup>, were used.

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

(ii) The reaction rate would be faster if the experiment was carried out at a higher temperature.

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

(d) Calculate the maximum mass of carbon dioxide given off when 20.0 g of small lumps of calcium carbonate react with 40 cm<sup>3</sup> of hydrochloric acid, concentration 2.0 mol/dm<sup>3</sup>.



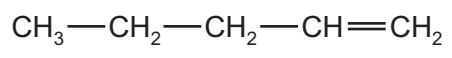
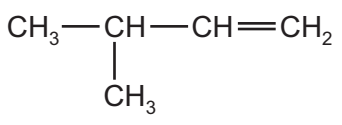
number of moles of HCl used =

mass of carbon dioxide = ..... g [4]

[Total: 15]

5 The alkenes are unsaturated hydrocarbons. They form a homologous series, the members of which have the same chemical properties. They undergo addition reactions and are easily oxidised.

(a) The following hydrocarbons are isomers.



(i) Explain why these two hydrocarbons are isomers.

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

(ii) Give the structural formula of another hydrocarbon which is isomeric with the above.

[1]

(b) Give the structural formula and name of each of the products of the following addition reactions.

(i) ethene and bromine

structural formula of product

name of product ..... [2]

(ii) propene and hydrogen

structural formula of product

name of product ..... [2]

(iii) but-1-ene and water

structural formula of product

name of product ..... [2]



(c) Alkenes can be oxidised to carboxylic acids.

- (i) For example, propene,  $\text{CH}_3-\text{CH}=\text{CH}_2$ , would produce ethanoic acid,  $\text{CH}_3-\text{COOH}$ , and methanoic acid,  $\text{H}-\text{COOH}$ . Deduce the formulae of the alkenes which would form the following carboxylic acids when oxidised.

ethanoic acid and propanoic acid

only ethanoic acid

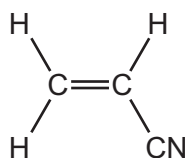
[2]

- (ii) Describe the colour change you would observe when an alkene is oxidised with acidified potassium manganate(VII).

..... [2]

(d) Alkenes polymerise to form addition polymers.

Draw the structural formula of poly(cyanoethene), include at least **two** monomer units. The structural formula of the monomer, cyanoethene, is given below.



[3]

[Total: 16]

6 Lead is an excellent roofing material. It is malleable and resistant to corrosion. Lead becomes coated with basic lead carbonate which protects it from further corrosion.

(a) Lead has a typical metallic structure which is a lattice of lead ions surrounded by a 'sea' of mobile electrons. This structure is held together by attractive forces called a metallic bond.

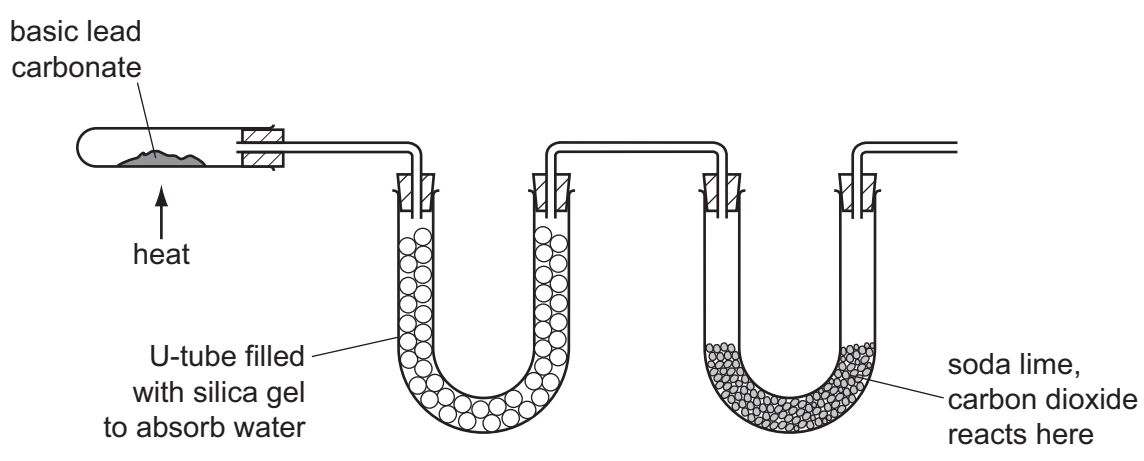
(i) Explain why there are attractive forces in a metallic structure.

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

(ii) Explain why a metal, such as lead, is malleable.

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

(b) Basic lead(II) carbonate is heated in the apparatus shown below. Water and carbon dioxide are produced.



(i) Silica gel absorbs water. Silica gel often contains anhydrous cobalt(II) chloride. When this absorbs water it changes from blue to pink. Suggest a reason.

..... [1]

(ii) Soda lime is a mixture of sodium hydroxide and calcium oxide. Why do these two substances react with carbon dioxide?

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

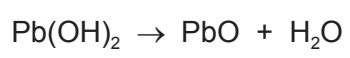
(iii) Name **two** substances formed when soda lime reacts with carbon dioxide.

..... [2]



For  
miner's  
e

(c) Basic lead(II) carbonate has a formula of the type  $x\text{PbCO}_3 \cdot y\text{Pb(OH)}_2$  where x and y are whole numbers.  
Determine x and y from the following information.



When heated, the basic lead(II) carbonate gave 2.112 g of carbon dioxide and 0.432 g of water.

Mass of one mole of  $\text{CO}_2 = 44 \text{ g}$

Mass of one mole of  $\text{H}_2\text{O} = 18 \text{ g}$

Number of moles of  $\text{CO}_2$  formed = ..... [1]

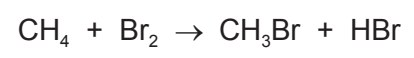
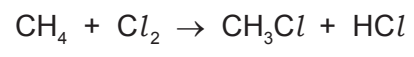
Number of moles of  $\text{H}_2\text{O}$  formed = ..... [1]

x = ..... and y = .....

Formula of basic lead(II) carbonate is ..... [1]

[Total: 12]

7 (a) The following are two examples of substitution reactions. Only the reaction in chlorine is a photochemical reaction.



(i) Explain the phrase *substitution reaction*.

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

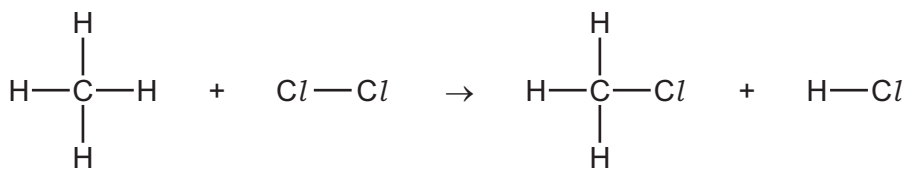
(ii) How do photochemical reactions differ from other reactions?

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

(b) Bond forming is exothermic, bond breaking is endothermic. Explain the difference between an exothermic reaction and an endothermic reaction.

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

(c) Use the bond energies to show that the following reaction is exothermic.  
Bond energy is the amount of energy (kJ/mol) which must be supplied to break one mole of the bond.



Bond energies in kJ/mol

- Cl-Cl +242
- C-Cl +338
- C-H +412
- H-Cl +431

bonds broken                      energy in kJ/mol

.....

.....

total energy = .....

bonds formed                      energy in kJ/mol

.....

.....

total energy = .....

..... [4]

[Total: 8]





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

		Group																																			
I	II	III	IV	V	VI	VII	0																														
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	14 <b>N</b> Nitrogen 7	16 <b>O</b> Oxygen 8	19 <b>F</b> Fluorine 9	20 <b>Ne</b> Neon 10																													
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12	27 <b>Al</b> Aluminium 13	28 <b>Si</b> Silicon 14	31 <b>P</b> Phosphorus 15	32 <b>S</b> Sulfur 16	35.5 <b>Cl</b> Chlorine 17	40 <b>Ar</b> Argon 18																														
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20	45 <b>Sc</b> Scandium 21	48 <b>Ti</b> Titanium 22	51 <b>V</b> Vanadium 23	52 <b>Cr</b> Chromium 24	55 <b>Mn</b> Manganese 25	56 <b>Fe</b> Iron 26	59 <b>Co</b> Cobalt 27	59 <b>Ni</b> Nickel 28	64 <b>Cu</b> Copper 29	65 <b>Zn</b> Zinc 30	70 <b>Ga</b> Gallium 31	73 <b>Ge</b> Germanium 32	75 <b>As</b> Arsenic 33	79 <b>Se</b> Selenium 34	80 <b>Br</b> Bromine 35	84 <b>Kr</b> Krypton 36																				
85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38	89 <b>Y</b> Yttrium 39	91 <b>Zr</b> Zirconium 40	93 <b>Nb</b> Niobium 41	96 <b>Mo</b> Molybdenum 42	101 <b>Ru</b> Ruthenium 44	106 <b>Pd</b> Palladium 46	108 <b>Ag</b> Silver 47	112 <b>Cd</b> Cadmium 48	115 <b>In</b> Indium 49	122 <b>Sb</b> Antimony 51	127 <b>I</b> Iodine 53	131 <b>Xe</b> Xenon 54																								
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	139 <b>La</b> Lanthanum 57	178 <b>Hf</b> Hafnium 72	181 <b>Ta</b> Tantalum 73	184 <b>W</b> Tungsten 74	186 <b>Re</b> Rhenium 75	190 <b>Os</b> Osmium 76	195 <b>Pt</b> Platinum 78	197 <b>Au</b> Gold 79	201 <b>Hg</b> Mercury 80	204 <b>Tl</b> Thallium 81	207 <b>Pb</b> Lead 82	209 <b>Bi</b> Bismuth 83	209 <b>Po</b> Polonium 84	210 <b>At</b> Astatine 85	210 <b>Rn</b> Radon 86																					
87 <b>Fr</b> Francium	88 <b>Ra</b> Radium	226 <b>Ac</b> Actinium																																			
		*58-71 Lanthanoid series		†90-103 Actinoid series								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	167 <b>Er</b> Erbium 68	169 <b>Tm</b> Thulium 69	173 <b>Yb</b> Ytterbium 70	175 <b>Lu</b> Lutetium 71	232 <b>Th</b> Thorium 90	238 <b>Pa</b> Protactinium 91	238 <b>U</b> Uranium 92	238 <b>Np</b> Neptunium 93	238 <b>Pu</b> Plutonium 94	238 <b>Am</b> Americium 95	238 <b>Cm</b> Curium 96	238 <b>Bk</b> Berkelium 97	238 <b>Cf</b> Californium 98	238 <b>Es</b> Einsteinium 99	238 <b>Fm</b> Fermium 100	238 <b>Md</b> Mendelevium 101	238 <b>No</b> Nobelium 102	238 <b>Lr</b> Lawrencium 103

**Key**

a	<b>X</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.).

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