



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

--

CENTER  
NUMBER

--	--	--	--	--

CANDIDATE  
NUMBER

--	--	--	--

\* 9 4 6 1 2 8 5 7 2 3 \*



**CHEMISTRY (US)**

**0439/31**

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 Center 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 nonmetal 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 .....

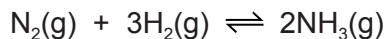
.....

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

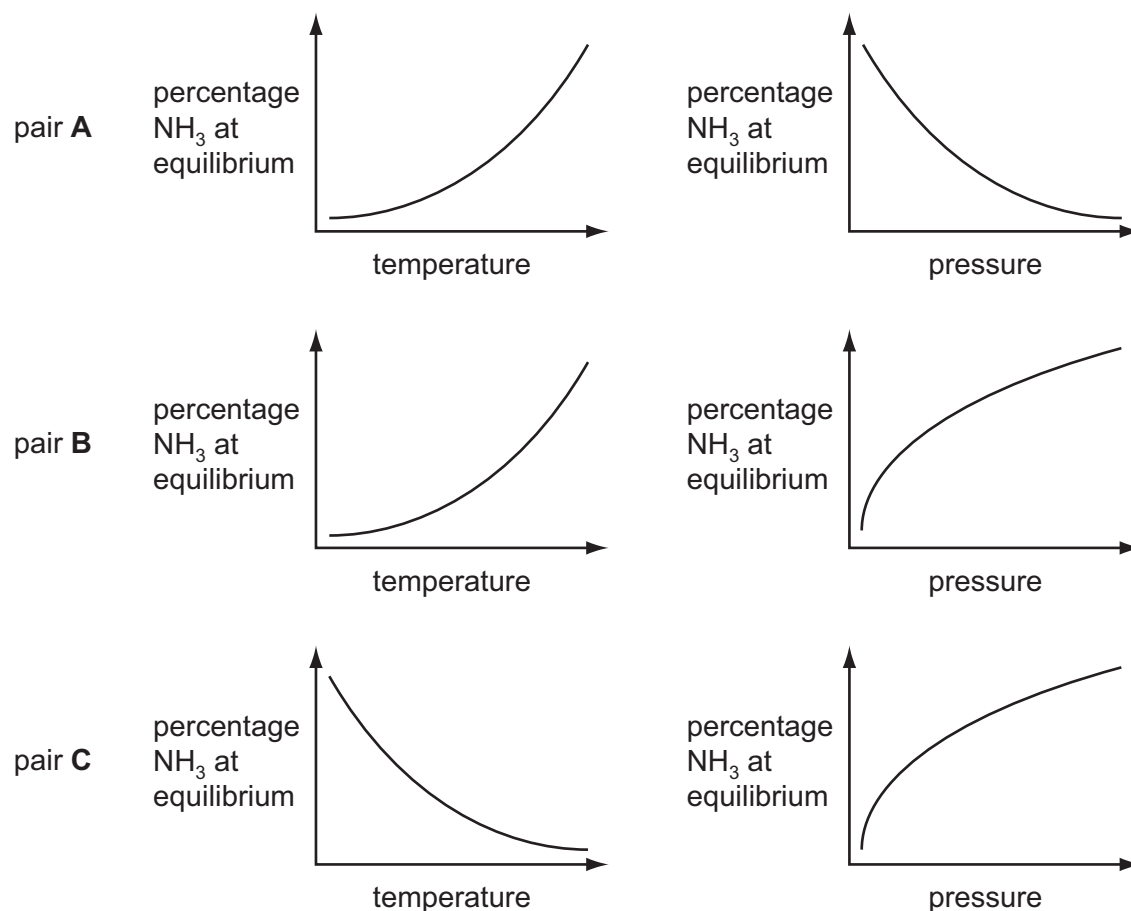
.....  
 ..... [2]

- (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.

.....

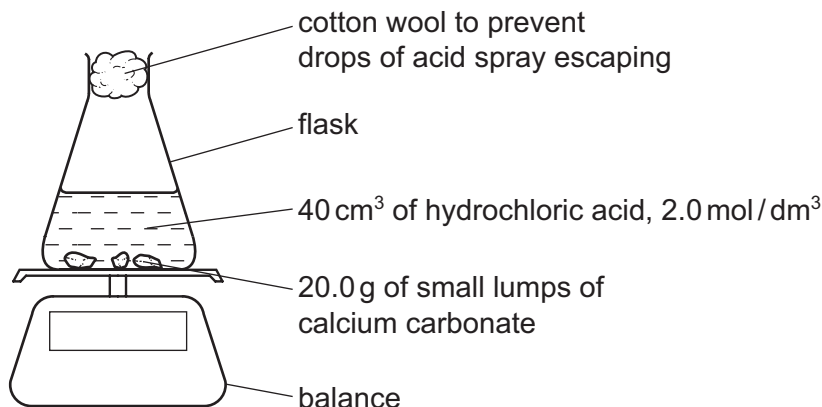
.....

.....

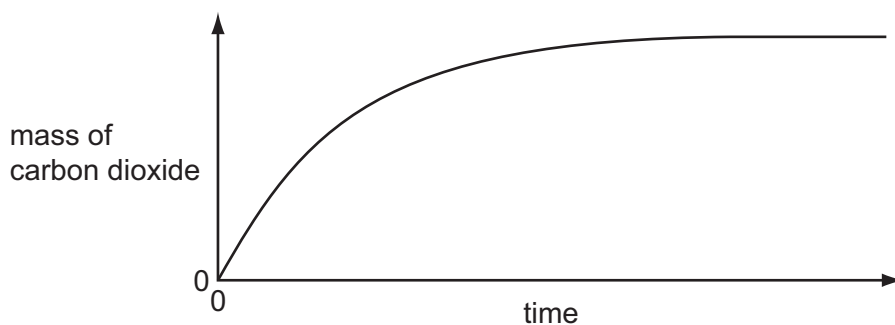
..... [2]

[Total: 14]

- 4 20.0 g 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 20.0 g 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>.



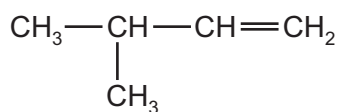
number of moles of HCl used =

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 oxidized.

(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 oxidized 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 oxidized.

ethanoic acid and propanoic acid

only ethanoic acid

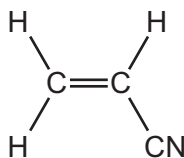
[2]

- (ii) Describe the color change you would observe when an alkene is oxidized 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 rapidly 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.

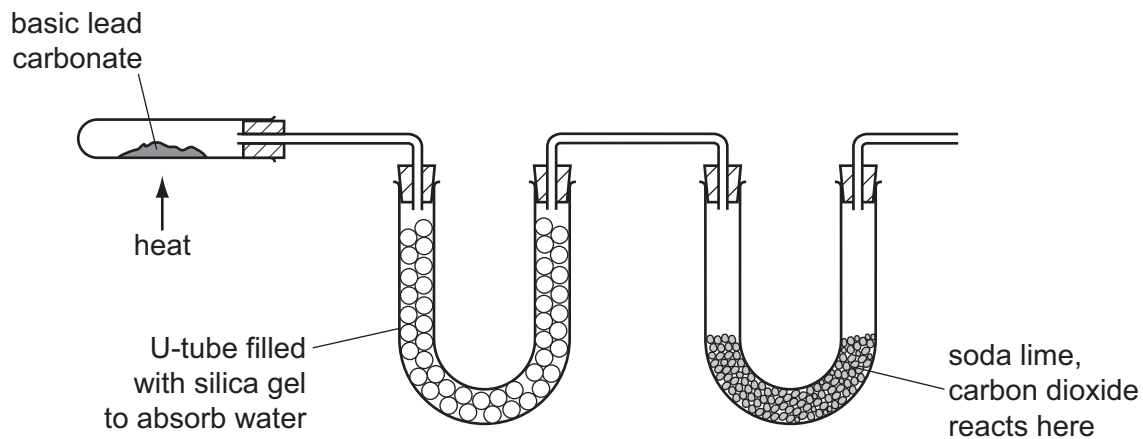
(i) Explain why there are attractive forces in a metallic structure.

.....  
..... [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?

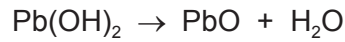
.....  
..... [2]

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

..... [2]

- (d) 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]

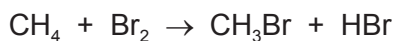
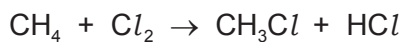
Number of moles of  $\text{H}_2\text{O}$  formed = ..... [1]

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 involving chlorine is a photochemical reaction.



- (i) Explain the phrase *substitution reaction*.

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

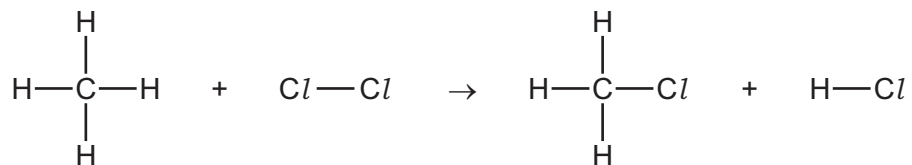
- (ii) How do photochemical reactions differ from other reactions?

.....  
..... [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
		1 <b>H</b> Hydrogen 1							4 <b>He</b> Helium 2
7 <b>Li</b> Lithium 3	9 <b>Be</b> Beryllium 4	11 <b>B</b> Boron 5	12 <b>C</b> Carbon 6	13 <b>Al</b> Aluminum 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
23 <b>Na</b> Sodium 11	24 <b>Mg</b> Magnesium 12	27 <b>Al</b> Aluminum 13	28 <b>Si</b> Silicon 14	29 <b>P</b> Phosphorus 15	30 <b>S</b> Sulfur 16	31 <b>Cl</b> Chlorine 17	32 <b>Ar</b> Argon 18	35.5 <b>Kr</b> Krypton 36	40 <b>Kr</b> Krypton 36
39 <b>K</b> Potassium 19	40 <b>Ca</b> Calcium 20	45 <b>Sc</b> Scandium 21	48 <b>Ti</b> Titanium 22	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
85 <b>Rb</b> Rubidium 37	88 <b>Sr</b> Strontium 38	89 <b>Y</b> Yttrium 39	91 <b>Zr</b> Zirconium 40	101 <b>Ru</b> Ruthenium 44	103 <b>Rh</b> Rhodium 45	106 <b>Pd</b> Palladium 46	108 <b>Ag</b> Silver 47	112 <b>Cd</b> Cadmium 48	115 <b>In</b> Indium 49
133 <b>Cs</b> Caesium 55	137 <b>Ba</b> Barium 56	139 <b>La</b> Lanthanum 57	178 <b>Hf</b> Hafnium 72	186 <b>Re</b> Rhenium 75	190 <b>Os</b> Osmium 76	192 <b>Ir</b> Iridium 77	195 <b>Pt</b> Platinum 78	201 <b>Hg</b> Mercury 80	204 <b>Tl</b> Thallium 81
226 <b>Fr</b> Francium 87	227 <b>Ra</b> Radium 88	227 <b>Ac</b> Actinium 89							
<p style="text-align: center;">*58-71 Lanthanoid series †90-103 Actinoid series</p>									
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
232 <b>Th</b> Thorium 90	232 <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
	159 <b>Tb</b> Terbium 65	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	175 <b>Lu</b> Lutetium 71	175 <b>Lu</b> Lutetium 71
	159 <b>Tb</b> Terbium 65	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	175 <b>Lu</b> Lutetium 71	175 <b>Lu</b> Lutetium 71
	159 <b>Tb</b> Terbium 65	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	175 <b>Lu</b> Lutetium 71	175 <b>Lu</b> Lutetium 71

$a$	<b>X</b>
$b$	

  
 Key  
 $a$  = 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.).

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.