



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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CHEMISTRY

0620/31

Paper 3 (Extended)

May/June 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 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.

This document consists of **12** printed pages.



1 Petroleum contains hydrocarbons which are separated by fractional distillation.

(a) (i) Complete the following definition of a hydrocarbon.

A hydrocarbon is a compound which
..... [2]

(ii) Explain what is meant by the term *fractional distillation*.

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

(b) Some of the fractions obtained from petroleum are given below.
State a use for each fraction.

bitumen

lubricating fraction

paraffin fraction

gasoline fraction [4]

[Total: 8]

2 An element, **M**, has the electron distribution 2 + 8 + 18 + 3.

(a) Which group in the Periodic Table is element **M** likely to be in?

..... [1]

(b) Predict whether element **M** is a poor or a good conductor of electricity.
Give a reason for your answer.

..... [1]

(c) Binary compounds contain two atoms per molecule, for example HCl.
Identify an element which could form a binary compound with element **M**.

..... [1]

(d) Predict the formula of the sulfate of **M**. The formula of the sulfate ion is SO_4^{2-} .

..... [1]

- (e) The hydroxide of **M** is a white powder which is insoluble in water. Describe how you could show that this hydroxide is amphoteric.

.....

 [2]

[Total: 6]

- 3 A small piece of marble, CaCO_3 , was added to 5.0 cm^3 of hydrochloric acid, concentration 1.0 mol/dm^3 , at 25°C . The time taken for the reaction to stop was measured. The experiment was repeated using 5.0 cm^3 of different solutions of acids. The acid was in excess in all of the experiments.

Typical results are given in the table.

experiment	temperature/ $^\circ\text{C}$	acid solution	time/min
1	25	hydrochloric acid 1.0 mol/dm^3	3
2	25	hydrochloric acid 0.5 mol/dm^3	7
3	25	ethanoic acid 1.0 mol/dm^3	10
4	15	hydrochloric acid 1.0 mol/dm^3	8

- (a) (i) Explain why it is important that the pieces of marble are the same size and the same shape.

.....

 [2]

- (ii) How would you know when the reaction had stopped?

..... [1]

- (b) The equation for the reaction in experiment 1 is:



Complete the following ionic equation.



[1]

- (c) (i) Explain why the reaction in experiment 1 is faster than the reaction in experiment 2.

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

- (ii) The acids used for experiment 1 and experiment 3 have the same concentration. Explain why experiment 3 is slower than experiment 1.

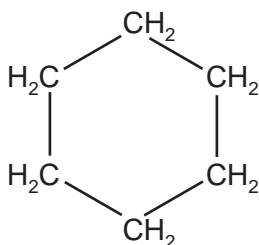
.....
.....
..... [2]

- (iii) Explain in terms of collisions between reacting particles why experiment 4 is slower than experiment 1.

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

[Total: 10]

- 4 The structural formula of cyclohexane is drawn below.



- (a) The name gives information about the structure of the compound.
Hex because there are six carbon atoms and **cyclo** because they are joined in a ring.
What information about the structure of this compound is given by the ending **ane**?

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

- (b) What are the molecular and empirical formulae of cyclohexane?

molecular formula

empirical formula

[2]

(c) Draw the structural formula of cyclobutane.

[1]

(d) (i) Deduce the molecular formula of hexene.

..... [1]

(ii) Explain why cyclohexane and the alkene, hexene, are isomers.

.....

.....

..... [2]

(e) Describe a test which would distinguish between cyclohexane and the unsaturated hydrocarbon hexene.

test

result of test with cyclohexane

.....

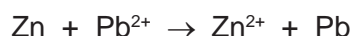
result of test with hexene

..... [3]

[Total: 11]

5 The reactivity series shows the metals in order of reactivity.

- (a) The reactivity series can be established using displacement reactions. A piece of zinc is added to aqueous lead nitrate. The zinc becomes coated with a black deposit of lead.



Zinc is more reactive than lead.

The reactivity series can be written as a list of ionic equations.

..... \rightarrow + most reactive metal: the best reductant (reducing agent)



- (i) In the space at the top of the list, write an ionic equation for a metal which is more reactive than zinc. [1]

- (ii) Write an ionic equation for the reaction between aqueous silver(I) nitrate and zinc.

..... [2]

- (iii) Explain why the positive ions are likely to be oxidants (oxidising agents).

..... [1]

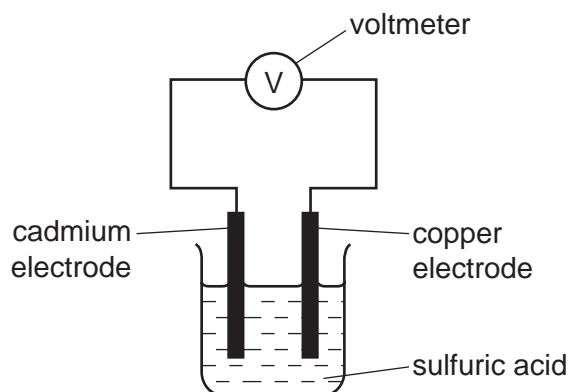
- (iv) Deduce which ion is the best oxidant (oxidising agent).

..... [1]

- (v) Which ion(s) in the list can oxidise lead metal?

..... [1]

- (b) A reactivity series can also be established by measuring the voltage of simple cells. The diagram shows a simple cell.



Results from cells using the metals tin, cadmium, zinc and copper are given in the table below.

cell	electrode 1 positive electrode	electrode 2 negative electrode	voltage / volts
1	copper	cadmium	0.74
2	copper	tin	0.48
3	copper	zinc	1.10

Write the four metals in order of increasing reactivity and explain how you used the data in the table to determine this order.

.....

 [3]

[Total: 9]

- 6 Ammonia is a compound which only contains the elements nitrogen and hydrogen. It is a weak base.

- (a) (i) Define the term *base*.

..... [1]

- (ii) Given aqueous solutions of ammonia and sodium hydroxide, both having a concentration of 0.1 mol/dm^3 , how could you show that ammonia is the weaker base?

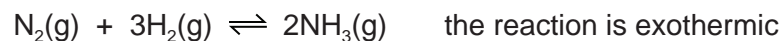
.....

 [2]

- (b)** Ammonia is manufactured by the Haber Process. The economics of this process require that as much ammonia as possible is made as quickly as possible. Explain how this can be done using the following information.

The conditions for the following reversible reaction are:

- 450 °C
- 200 atmospheres pressure
- iron catalyst



.....

.....

.....

.....

.....

.....

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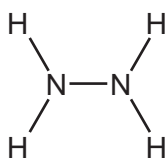
..... [5]

- (c)** Another compound which contains only nitrogen and hydrogen is hydrazine, N_2H_4 .

Complete the equation for the preparation of hydrazine from ammonia.



- (d)** The structural formula of hydrazine is given below.



Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound hydrazine.

Use x to represent an electron from a nitrogen atom.

Use o to represent an electron from a hydrogen atom.

[3]

(e) Hydrazine is a weak base and it removes dissolved oxygen from water. It is added to water in steel boilers to prevent rusting.

(i) One way it reduces the rate of rusting is by changing the pH of water. What effect would hydrazine have on the pH of water?

..... [1]

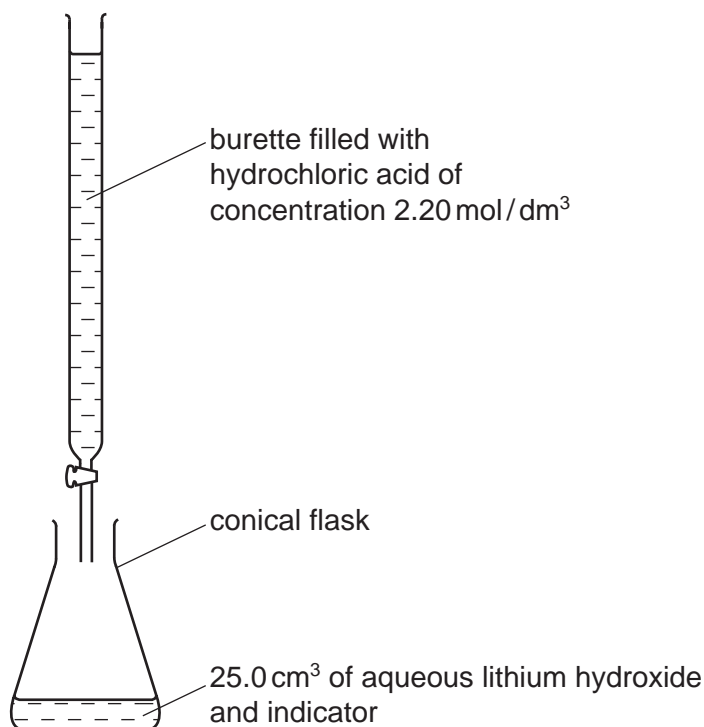
(ii) Give a reason, other than pH, why hydrazine reduces the rate of rusting.

..... [1]

[Total: 15]

7 The hydroxides of the Group I metals are soluble in water. Most other metal hydroxides are insoluble in water.

(a) (i) Crystals of lithium chloride can be prepared from lithium hydroxide by titration.



25.0 cm³ of aqueous lithium hydroxide is pipetted into the conical flask. A few drops of an indicator are added. Dilute hydrochloric acid is added slowly to the alkali until the indicator just changes colour. The volume of acid needed to neutralise the lithium hydroxide is noted.

A neutral solution of lithium chloride, which still contains the indicator, is left. Describe how you could obtain a neutral solution of lithium chloride which does **not** contain an indicator.

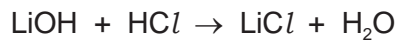
.....
..... [2]

- (ii) You cannot prepare a neutral solution of magnesium chloride by the same method. Describe how you could prepare a neutral solution of magnesium chloride.

.....

 [3]

- (b) The concentration of the hydrochloric acid was 2.20 mol / dm³. The volume of acid needed to neutralise the 25.0 cm³ of lithium hydroxide was 20.0 cm³. Calculate the concentration of the aqueous lithium hydroxide.



.....

 [2]

- (c) Lithium chloride forms three hydrates. They are LiCl.H₂O, LiCl.2H₂O and LiCl.3H₂O. Which **one** of these three hydrates contains 45.9% of water? Show how you arrived at your answer.

.....

 [3]

[Total: 10]

- 8 There are three types of giant structure - ionic, metallic and giant covalent.

- (a) In an ionic compound, the ions are held in a lattice by strong forces.

- (i) Explain the term *lattice*.

.....
 [2]

- (ii) Explain how the ions are held together by strong forces.

.....
 [1]

(b) Describe the bonding in a typical metal.

.....

 [3]

(c) The electrical conductivities of the three types of giant structure are given in the following table.

type of structure	conductivity of solid	conductivity of liquid
ionic	poor	good
metallic	good	good
giant covalent	poor	poor

Explain the differences in electrical conductivity between the three types of giant structure and the difference, if any, between the solid and liquid states of the same structure.

.....

 [5]

[Total: 11]

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											20 Ne Neon 10		
23 Na Sodium 11	24 Mg Magnesium 12	5 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9						35.5 Cl Chlorine 17	40 Ar Argon 18	
39 K Potassium 19	40 Ca Calcium 20	27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	79 Se Selenium 34	80 Br Bromine 35						131 Xe Xenon 54	
85 Rb Rubidium 37	88 Sr Strontium 38	65 Zn Zinc 30	70 Ga Gallium 31	75 As Arsenic 33	79 Se Selenium 34	128 Te Tellurium 52	127 I Iodine 53						209 Po Polonium 84	86 Rn Radon 86
133 Cs Caesium 55	137 Ba Barium 56	64 Cu Copper 29	65 Zn Zinc 30	108 Ag Silver 47	112 Cd Cadmium 48	201 Hg Mercury 80	204 Pb Lead 82						81 Tl Thallium 81	
226 Fr Francium 87	227 Ra Radium 88	59 Ni Nickel 28	59 Co Cobalt 27	106 Pd Palladium 46	103 Rh Rhodium 45	192 Ir Iridium 77	195 Pt Platinum 78						80 Hg Mercury 80	
		56 Fe Iron 26	55 Mn Manganese 25	101 Ru Ruthenium 44	103 Rh Rhodium 45	190 Os Osmium 76	195 Pt Platinum 78						201 Hg Mercury 80	
		52 Cr Chromium 24	55 Mn Manganese 25	101 Ru Ruthenium 44	103 Rh Rhodium 45	190 Os Osmium 76	195 Pt Platinum 78						201 Hg Mercury 80	
		51 V Vanadium 23	52 Cr Chromium 24	101 Ru Ruthenium 44	103 Rh Rhodium 45	190 Os Osmium 76	195 Pt Platinum 78						201 Hg Mercury 80	
		48 Ti Titanium 22	51 V Vanadium 23	101 Ru Ruthenium 44	103 Rh Rhodium 45	190 Os Osmium 76	195 Pt Platinum 78						201 Hg Mercury 80	
		45 Sc Scandium 21	48 Ti Titanium 22	101 Ru Ruthenium 44	103 Rh Rhodium 45	190 Os Osmium 76	195 Pt Platinum 78						201 Hg Mercury 80	
		89 Y Yttrium 39	91 Zr Zirconium 40	101 Ru Ruthenium 44	103 Rh Rhodium 45	190 Os Osmium 76	195 Pt Platinum 78						201 Hg Mercury 80	
		139 La Lanthanum 57	178 Hf Hafnium 72	101 Ru Ruthenium 44	103 Rh Rhodium 45	190 Os Osmium 76	195 Pt Platinum 78						201 Hg Mercury 80	
		227 Ac Actinium 89	226 Ra Radium 88	101 Ru Ruthenium 44	103 Rh Rhodium 45	190 Os Osmium 76	195 Pt Platinum 78						201 Hg Mercury 80	
		*58-71 Lanthanoid series †90-103 Actinoid series												
		a X b											175 Lu Lutetium 71	
		Key a = relative atomic mass X = atomic symbol b = proton (atomic) number										173 Yb Ytterbium 70		
												169 Tm Thulium 69		
												167 Er Erbium 68		
												165 Ho Holmium 67		
												162 Dy Dysprosium 66		
												159 Tb Terbium 65		
												157 Gd Gadolinium 64		
												152 Eu Europium 63		
												150 Sm Samarium 62		
												144 Nd Neodymium 60		
												141 Pr Praseodymium 59		
												140 Ce Cerium 58		
												238 U Uranium 92		
												232 Th Thorium 90		
												99 Es Einsteinium 99		
												100 Fm Fermium 100		
												101 Md Mendelevium 101		
												102 No Nobelium 102		
												103 Lr Lawrencium 103		

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

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