UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

8141362656

CHEMISTRY **0620/33**

Paper 3 (Extended) **October/November 2012**

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.
A copy of the Periodic Table is printed on page 16.

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.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
Total	

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

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For Examiner's Use

1 For each of the following, select an element from Period 4, potassium to krypton, which matches the description.

(a) A metal that reacts rapidly with cold water to form a compound of the type $M(OH)_2$ and hydrogen.

..... [1]

(b) Its only oxidation state is 0. ..... [1]

(c) It has a macromolecular oxide, XO_2, which has similar physical properties to those of diamond.

..... [1]

(d) This is one of the metals alloyed with iron in stainless steel. ..... [1]

(e) It can be reduced to an ion of the type X^-. ..... [1]

(f) It can form a covalent hydride having the formula H_2X. ..... [1]

(g) Its soluble salts are blue and its oxide is black. ..... [1]

(h) It is a liquid at room temperature. ..... [1]

[Total: 8]

2 **(a)** State a use for each of the following gases.

(i) chlorine ..... [1]

(ii) argon ..... [1]

(iii) ethene ..... [1]

(iv) oxygen ..... [1]

(b) Describe how oxygen is obtained from air.

.....

..... [2]

[Total: 6]

3 **(a)** A small amount of liquid bromine is added to a container which is then sealed.

$$Br_2(l) \rightarrow Br_2(g)$$

Use the ideas of the Kinetic Theory to explain why, after about an hour, the bromine molecules have spread uniformly to occupy the whole container.

.....

.....

..... [3]

(b) The diagrams below show simple experiments on the speed of diffusion of gases.

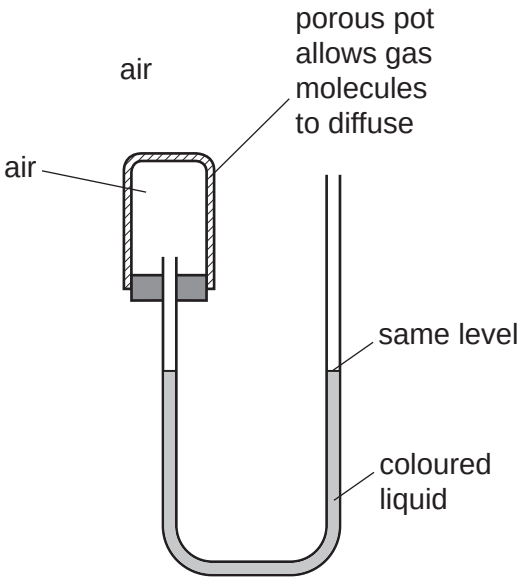


diagram 1

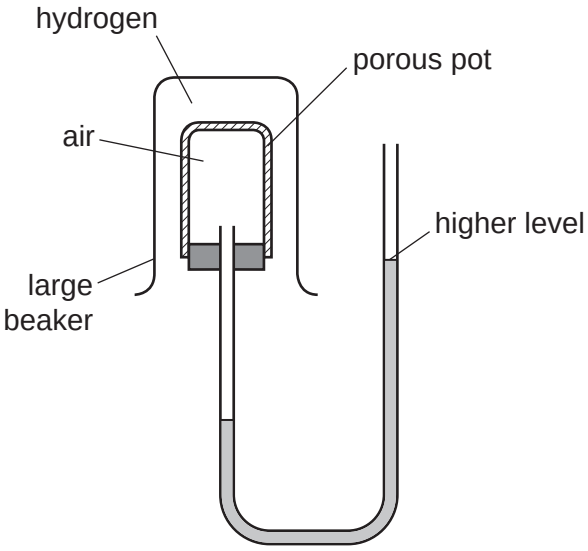


diagram 2

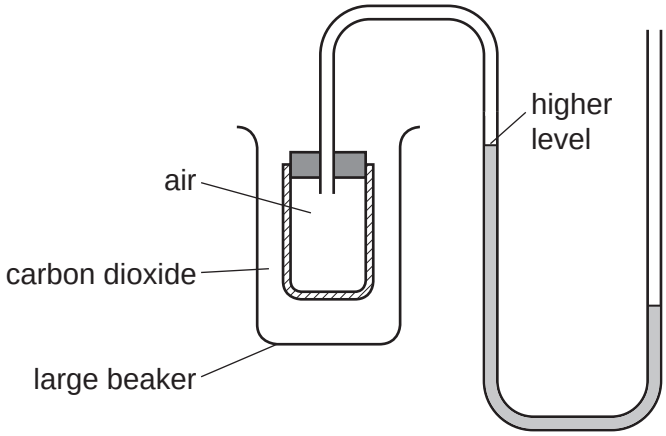


diagram 3

Complete the following explanations. Diagram 1 has been done for you.

Diagram 1

There is air inside and outside the porous pot so the rate of diffusion of air into the pot is the same as the rate of diffusion of air out of the pot. The pressure inside and outside the pot is the same so the coloured liquid is at the same level on each side of the tube.

Diagram 2

.....

.....

.....

..... [3]

Diagram 3

.....

.....

.....

..... [3]

[Total: 9]

For Examiner's Use

4 Zinc alloys have been used for over 2500 years.

(a) (i) Explain the phrase *zinc alloy*.

.....

..... [1]

(ii) Making alloys is still a major use of zinc. State **one** other large scale use of zinc.

..... [1]

(iii) Describe the bonding in a typical metal, such as zinc, and then explain why it is malleable. You may use a diagram to illustrate your answer.

.....

.....

..... [3]

(iv) Suggest why the introduction of a different atom into the structure makes the alloy less malleable than the pure metal.

.....

..... [2]

(b) Zinc metal is made by the reduction of zinc oxide. The major ore of zinc is zinc blende, ZnS. Zinc blende contains silver and lead compounds as well as zinc sulfide.
Zinc blende is converted into impure zinc oxide by heating it in air.

$$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$$

(i) Describe how zinc oxide is reduced to zinc.

..... [1]

(ii) Some of the zinc oxide is dissolved in sulfuric acid to make aqueous zinc sulfate. Write a balanced symbol equation for this reaction.

..... [2]

(iii) This impure solution of zinc sulfate contains zinc ions, silver(I) ions and lead ions. Explain why the addition of zinc powder produces pure zinc sulfate solution. Include at least one ionic equation in your explanation.

.....

.....

.....

.....

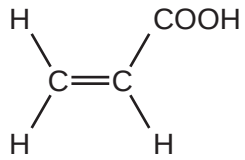
..... [4]

(iv) Describe how zinc metal can be obtained from zinc sulfate solution by electrolysis. A labelled diagram is acceptable. Include all the products of this electrolysis. The electrolysis is similar to that of copper(II) sulfate solution with inert electrodes.

[4]

[Total: 18]

5 Propenoic acid is an unsaturated carboxylic acid. The structural formula of propenoic acid is given below.



(a) (i) Describe how you could show that propenoic acid is an unsaturated compound.

test .....

result .....

..... [2]

(ii) Without using an indicator, describe how you could show that a compound is an acid.

test .....

result .....

..... [2]

(b) Propenoic acid reacts with ethanol to form an ester. Deduce the name of this ester. Draw its structural formula.

name of ester .....

structural formula showing all bonds

[3]

(c) An organic compound has a molecular formula $C_6H_8O_4$. It is an unsaturated carboxylic acid. One mole of the compound reacts with two moles of sodium hydroxide.

(i) Explain the phrase *molecular formula*.

.....

..... [2]

(ii) One mole of this carboxylic acid reacts with two moles of sodium hydroxide.
How many moles of –COOH groups are there in one mole of this compound?

..... [1]

(iii) What is the formula of another functional group in this compound?

..... [1]

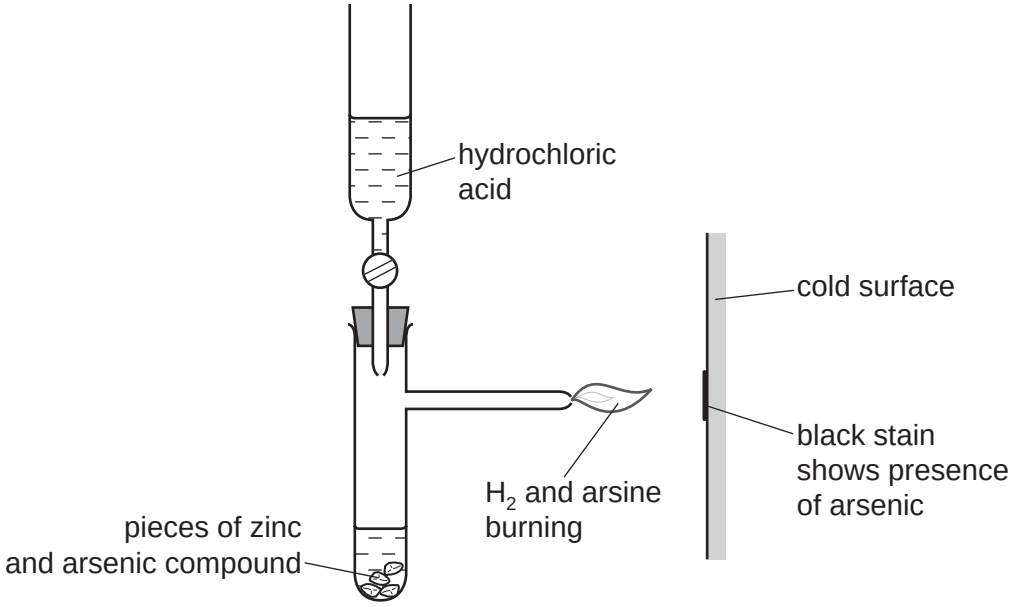
(iv) Deduce a structural formula of this compound.

[1]

[Total: 12]

6 Until recently, arsenic poisoning, either deliberate or accidental, has been a frequent cause of death. The symptoms of arsenic poisoning are identical with those of a common illness, cholera. A reliable test was needed to prove the presence of arsenic in a body.

(a) In 1840, Marsh devised a reliable test for arsenic.



Hydrogen is formed in this reaction. Any arsenic compound reacts with this hydrogen to form arsine which is arsenic hydride, AsH_3.
The mixture of hydrogen and arsine is burnt at the jet and arsenic forms as a black stain on the glass.

(i) Write an equation for the reaction which forms hydrogen.

..... [2]

(ii) Draw a diagram which shows the arrangement of the outer (valency) electrons in one molecule of the covalent compound arsine.
The electron distribution of arsenic is 2 + 8 + 18 + 5.

Use x to represent an electron from an arsenic atom.
Use o to represent an electron from a hydrogen atom.

[2]

(b) Another hydride of arsenic has the composition below.

arsenic 97.4 % hydrogen 2.6 %

(i) Calculate the empirical formula of this hydride **from the above data**. Show your working.

.....

.....[2]

(ii) The mass of one mole of this hydride is 154 g. What is its molecular formula?

..... [1]

(iii) Deduce the structural formula of this hydride.

[1]

(c) Hair is a natural protein. Hair absorbs arsenic from the body. Analysis of the hair provides a measurement of a person's exposure to arsenic. To release the absorbed arsenic for analysis, the protein has to be hydrolysed.

(i) What is the name of the linkage in proteins?

..... [1]

(ii) Name a reagent which can be used to hydrolyse proteins.

..... [1]

(iii) What type of compound is formed by the hydrolysis of proteins?

..... [1]

For Examiner's Use

(d) In the 19th Century, a bright green pigment, copper(II) arsenate(V) was used to kill rats and insects. In damp conditions, micro-organisms can act on this compound to produce the very poisonous gas, arsine.

(i) Suggest a reason why it is necessary to include the oxidation states in the name of the compound.

.....

..... [1]

(ii) The formula for the arsenate(V) ion is AsO_4^{3-}. Complete the ionic equation for the formation of copper(II) arsenate(V).

.....Cu^{2+} + ...AsO_4^{3-} $\rightarrow$ .....

[2]

[Total: 14]

7 Ammonia is made by the Haber process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(a) State **one** major use of ammonia.

..... [1]

(b) Describe how hydrogen is obtained for the Haber process.

.....

.....

..... [3]

(c) This reaction is carried out at a high pressure, 200 atmospheres.
State, with an explanation for each, **two** advantages of using a high pressure.

.....

.....

.....

.....

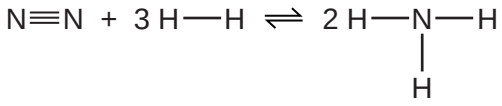
..... [5]

(d) **(i)** What is the difference between an endothermic and an exothermic reaction?

.....

..... [1]

(ii) Bond breaking is an endothermic process. Bond energy is the amount of energy needed to break or form one mole of the bond. Complete the table and explain why the forward reaction is exothermic.



bond	bond energy kJ / mol	energy change kJ	exothermic or endothermic
N≡N	944	+944	endothermic
H—H	436	3 × 436 = +1308	
N—H	388		

.....

..... [3]

[Total: 13]

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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 **X** b

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.).