



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

CENTER  
NUMBER

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**CHEMISTRY (US)**

**0439/33**

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 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 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 **11** printed pages and **1** blank page.



1 Substances can be classified as:

elements mixtures compounds

Elements can be divided into:

metals non-metals

(a) Define each of the following terms.

(i) *element*

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

(ii) *compound*

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

(iii) *mixture*

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

(b) Classify each of the following as either an element, compound or mixture.

(i) brass ..... [1]

(ii) carbon dioxide ..... [1]

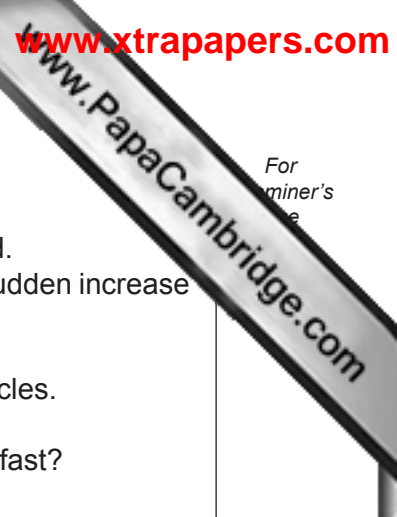
(iii) copper ..... [1]

(c) Which physical property is used to distinguish between metals and non-metals?

It is possessed by all metals but by only one non-metal.

..... [1]

[Total: 9]



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e

2 One of the factors which determine the reaction rate of solids is particle size.

(a) A mixture of finely powdered aluminum and air may explode when ignited. An explosion is a very fast exothermic reaction. This causes a large and sudden increase in temperature.

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

(i) Why is the reaction between finely powdered aluminum and air very fast?

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

(ii) Explain why for most reactions the rate of reaction decreases with time.

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

(iii) Suggest an explanation why the rate of reaction in an explosion could increase rather than decrease with time.

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

(b) (i) Give another example of a substance other than a metal which, when finely powdered, might explode when ignited in air.

..... [1]

(ii) Describe a simple test-tube reaction which shows the effect of particle size on the rate at which a solid reacts with a solution.

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

[Total: 11]

3 Iron from the blast furnace is impure. It contains 5% of impurities, mainly carbon, silicon and phosphorus. Almost all of this impure iron is converted into the alloy, mild steel.

(a) (i) State a use of mild steel.

..... [1]

(ii) Name and give a use of another iron-containing alloy.

name .....

use ..... [2]

(b) The oxides of carbon and sulfur are gases. The oxides of silicon and phosphorus are not. Explain how these impurities are removed from the impure iron when it is converted into mild steel.

.....  
.....  
.....  
.....  
..... [5]

[Total: 8]

4 Germanium is an element in Group IV. The electron distribution of a germanium atom is 2 + 8 + 18 + 4. It has oxidation states of +2 and +4.

(a) Germanium forms a series of saturated hydrides similar to the alkanes.

(i) Draw the structural formula of the hydride which contains three germanium atoms per molecule.

[1]

(ii) Predict the general formula of the germanium hydrides.

..... [1]

(b) Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound germanium(IV) chloride,  $GeCl_4$ .

Use o to represent an electron from a chlorine atom.  
Use x to represent an electron from a germanium atom.

[2]

(c) Describe the structure of the giant covalent compound germanium(IV) oxide,  $GeO_2$ . It has a similar structure to that of silicon(IV) oxide.

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

(d) Is the change  $GeCl_2$  to  $GeCl_4$  reduction, oxidation or neither? Give a reason for your choice.

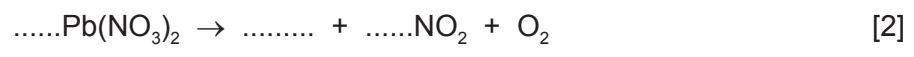
.....  
..... [2]

[Total: 9]

5 All metal nitrates decompose when heated. A few form a nitrite and oxygen. Most form the metal oxide, oxygen and a brown gas called nitrogen dioxide.

(a) (i) Name a metal whose nitrate decomposes to form the metal nitrite and oxygen.  
..... [1]

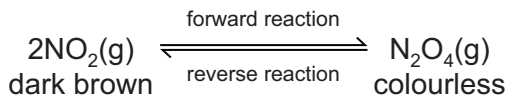
(ii) Complete the equation for the action of heat on lead(II) nitrate.



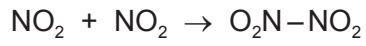
(iii) Suggest why the nitrate of the metal, named in (a)(i), decomposes less readily than lead(II) nitrate.

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

(b) Almost all samples of nitrogen dioxide are an equilibrium mixture of nitrogen dioxide, NO<sub>2</sub>, and dinitrogen tetroxide, N<sub>2</sub>O<sub>4</sub>.



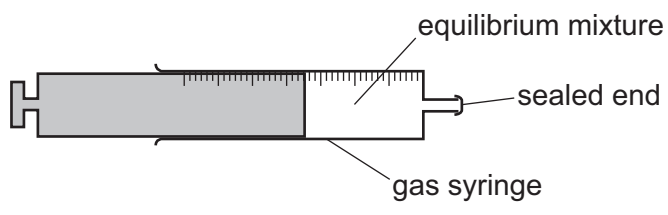
In the forward reaction, a bond forms between the two nitrogen dioxide molecules.



(i) Explain the term *equilibrium mixture*.

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

(ii) The syringe contains a sample of the equilibrium mixture. The plunger was pulled back reducing the pressure.  
 How would the color of the gas inside the syringe change? Give an explanation for your answer.



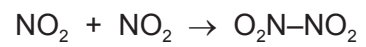
.....  
 .....  
 ..... [3]

(iii) A sealed tube containing an equilibrium mixture of nitrogen dioxide and dinitrogen tetroxide was placed in a beaker of ice cold water.  
 The color of the mixture changed from brown to pale yellow.

Is the forward reaction exothermic or endothermic? Give an explanation for your choice.

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

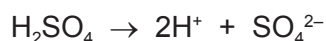
(iv) What other piece of information given in the equation supports your answer to (iii)?



..... [1]

[Total: 12]

- 6 Sulfuric acid and malonic acid are both dibasic acids. One mole of a dibasic acid can react with two moles of hydrogen ions.



Dibasic acids can form salts of the type  $\text{Na}_2\text{X}$  and  $\text{CaX}$ .

- (a) Malonic acid is a white crystalline solid which is soluble in water. It melts at  $135^\circ\text{C}$ . The structural formula of malonic acid is given below. It forms salts called malonates.



- (i) How could you determine if a sample of malonic acid is pure?

technique used .....

result if pure ..... [2]

- (ii) What is the molecular formula of malonic acid?

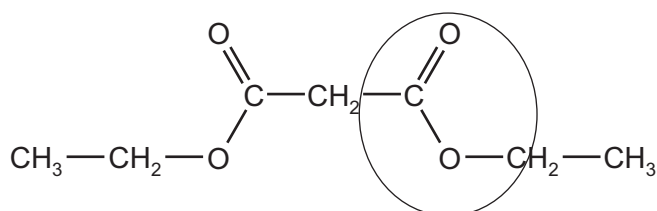
..... [1]

- (iii) When malonic acid is heated there are two products, carbon dioxide and a simpler carboxylic acid. Deduce the name and molecular formula of this acid.

.....

..... [2]

- (iv) Malonic acid reacts with ethanol to form a colorless liquid which has a 'fruity' smell. Its structural formula is given below.



What type of compound contains the group which is circled?

..... [1]

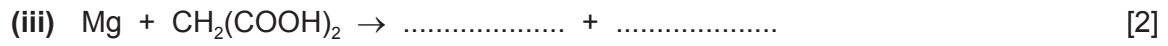
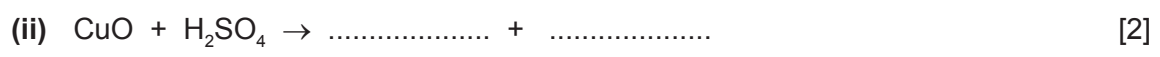
(b) (i) Suggest why a solution of malonic acid, concentration 0.2 mol / dm<sup>3</sup>, has a higher pH than one of sulfuric acid of the same concentration.

..... [1]

(ii) Describe a test, other than measuring pH, which can be carried out on both acid solutions to confirm the explanation given in (b)(i) for the different pH values of the two acids.

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

(c) Complete the following equations for reactions of these two acids.



[Total: 16]

7 Alkanes and alkenes are both series of hydrocarbons.

(a) (i) Explain the term *hydrocarbon*.  
.....  
..... [1]

(ii) What is the difference between these two series of hydrocarbons?  
.....  
..... [2]

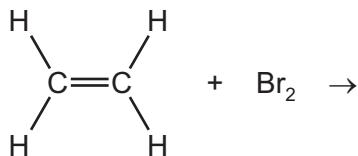
(b) Alkenes and simpler alkanes are made from long-chain alkanes by cracking. Complete the following equation for the cracking of the alkane C<sub>20</sub>H<sub>42</sub>.





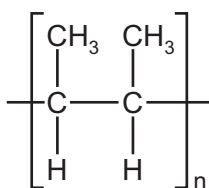
- (c) Alkenes such as butene and ethene are more reactive than alkanes. Alkenes are used in the petrochemical industry to make a range of products, which includes polymers and alcohols.

- (i) Dibromoethane is used as a pesticide. Complete the equation for its preparation from ethene.



[1]

- (ii) The structural formula of a poly(alkene) is given below.



Deduce the structural formula of its monomer.

[2]

- (iii) How is butanol made from butene,  $\text{CH}_3\text{-CH}_2\text{-CH=CH}_2$ ? Include an equation in your answer.

.....

..... [2]

- (iv) Cracking changes alkanes into alkenes. How could an alkene be converted into an alkane? Include an equation in your answer.

.....

..... [2]

(d) 20 cm<sup>3</sup> of a hydrocarbon was burnt in 175 cm<sup>3</sup> of oxygen. After cooling, the volume of the remaining gases was 125 cm<sup>3</sup>. The addition of aqueous sodium hydroxide removed the carbon dioxide leaving 25 cm<sup>3</sup> of unreacted oxygen.

(i) volume of oxygen used = ..... cm<sup>3</sup> [1]

(ii) volume of carbon dioxide formed = ..... cm<sup>3</sup> [1]

(iii) Deduce the formula of the hydrocarbon and the balanced equation for the reaction.

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

[Total: 15]



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

		Group																																																																																																																																																																																									
I	II	III	IV	V	VI	VII	0																																																																																																																																																																																				
1 <b>H</b> Hydrogen 1											2 <b>He</b> Helium 2																																																																																																																																																																																
3 <b>Li</b> Lithium 3	4 <b>Be</b> Beryllium 4											5 <b>B</b> Boron 5																																																																																																																																																																															
11 <b>Na</b> Sodium 11	12 <b>Mg</b> Magnesium 12	13 <b>Al</b> Aluminium 13	14 <b>Si</b> Silicon 14	15 <b>P</b> Phosphorus 15	16 <b>S</b> Sulfur 16	17 <b>Cl</b> Chlorine 17	18 <b>Ar</b> Argon 18					19 <b>F</b> Fluorine 9																																																																																																																																																																															
19 <b>K</b> Potassium 19	20 <b>Ca</b> Calcium 20	21 <b>Sc</b> Scandium 21	22 <b>Ti</b> Titanium 22	23 <b>V</b> Vanadium 23	24 <b>Cr</b> Chromium 24	25 <b>Mn</b> Manganese 25	26 <b>Fe</b> Iron 26	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>Ga</b> Gallium 31	32 <b>Ge</b> Germanium 32	33 <b>As</b> Arsenic 33	34 <b>Se</b> Selenium 34	35 <b>Br</b> Bromine 35	36 <b>Kr</b> Krypton 36					37 <b>Rb</b> Rubidium 37																																																																																																																																																																					
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>Sn</b> Tin 50	51 <b>Sb</b> Antimony 51	52 <b>Te</b> Tellurium 52	53 <b>I</b> Iodine 53	54 <b>Xe</b> Xenon 54					55 <b>Cs</b> Caesium 55																																																																																																																																																																							
55 <b>Cs</b> Caesium 55	56 <b>Ba</b> Barium 56	57 <b>La</b> Lanthanum 57	* 72 <b>Hf</b> Hafnium 72	73 <b>Ta</b> Tantalum 73	74 <b>W</b> Tungsten 74	75 <b>Re</b> Rhenium 75	76 <b>Os</b> Osmium 76	77 <b>Ir</b> Iridium 77	78 <b>Pt</b> Platinum 78	79 <b>Au</b> Gold 79	80 <b>Hg</b> Mercury 80	81 <b>Tl</b> Thallium 81	82 <b>Pb</b> Lead 82	83 <b>Bi</b> Bismuth 83	84 <b>Po</b> Polonium 84	85 <b>At</b> Astatine 85	86 <b>Rn</b> Radon 86					87 <b>Fr</b> Francium 87																																																																																																																																																																					
87 <b>Fr</b> Francium 87	88 <b>Ra</b> Radium 88	89 <b>Ac</b> Actinium 89	†	90 <b>Th</b> Thorium 90	91 <b>Pa</b> Protactinium 91	92 <b>U</b> Uranium 92	93 <b>Np</b> Neptunium 93	94 <b>Pu</b> Plutonium 94	95 <b>Am</b> Americium 95	96 <b>Cm</b> Curium 96	97 <b>Bk</b> Berkelium 97	98 <b>Cf</b> Californium 98	99 <b>Es</b> Einsteinium 99	100 <b>Fm</b> Fermium 100	101 <b>Md</b> Mendelevium 101	102 <b>No</b> Nobelium 102	103 <b>Lr</b> Lawrencium 103					104 <b>Rf</b> Rutherfordium 104																																																																																																																																																																					
113 <b>Bi</b> Bismuth 83	114 <b>Po</b> Polonium 84	115 <b>At</b> Astatine 85	116 <b>Rn</b> Radon 86	117 <b>Uu</b> Ununseptium 117	118 <b>Uu</b> Ununoctium 118	119 <b>Uu</b> Ununennium 119	120 <b>Uu</b> Unbinilium 120	121 <b>Uu</b> Untrium 121	122 <b>Uu</b> Unquadrium 122	123 <b>Uu</b> Unquadium 123	124 <b>Uu</b> Unpentium 124	125 <b>Uu</b> Unsexium 125	126 <b>Uu</b> Unseptemium 126	127 <b>Uu</b> Unoctium 127	128 <b>Uu</b> Unnennium 128	129 <b>Uu</b> Unnilium 129	130 <b>Uu</b> Ununnilium 130	131 <b>Uu</b> Unununium 131	132 <b>Uu</b> Unbinilium 132	133 <b>Uu</b> Unbinilium 133	134 <b>Uu</b> Unbinilium 134	135 <b>Uu</b> Unbinilium 135	136 <b>Uu</b> Unbinilium 136	137 <b>Uu</b> Unbinilium 137	138 <b>Uu</b> Unbinilium 138	139 <b>Uu</b> Unbinilium 139	140 <b>Uu</b> Unbinilium 140	141 <b>Uu</b> Unbinilium 141	142 <b>Uu</b> Unbinilium 142	143 <b>Uu</b> Unbinilium 143	144 <b>Uu</b> Unbinilium 144	145 <b>Uu</b> Unbinilium 145	146 <b>Uu</b> Unbinilium 146	147 <b>Uu</b> Unbinilium 147	148 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\*58-71 Lanthanoid series  
†90-103 Actinoid series

a	X
Key	
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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