



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
NAME

CENTRE
NUMBER

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CHEMISTRY

0620/33

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



1 Substances can be classified as:

elements mixtures compounds

Elements can be divided into:

metals non-metals

For
Examiner's
Use

(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]

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

For
Examiner's
Use

- (a) A mixture of finely powdered aluminium 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 aluminium 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, sulfur, 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]

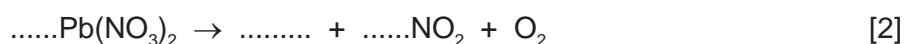
[Total: 9]

- 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]

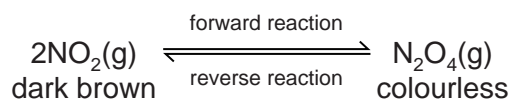
- (ii)** Complete the equation for the action of heat on lead(II) nitrate.



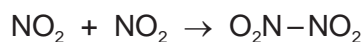
- (iii)** Suggest why the nitrate of the metal, named in **(a)(i)**, decomposes less readily than lead(II) nitrate.

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

- (b) Almost all samples of nitrogen dioxide are an equilibrium mixture of nitrogen dioxide, NO_2 , and dinitrogen tetroxide, N_2O_4 .



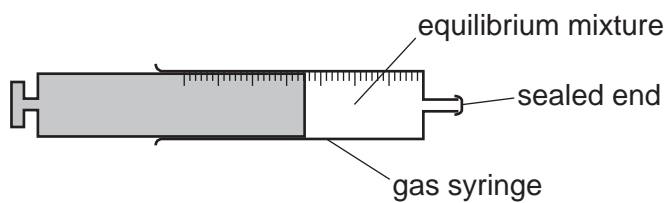
In the forward reaction, a bond forms between the two nitrogen dioxide molecules.



- (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 colour of the gas inside the syringe change? Give an explanation for your answer.



.....

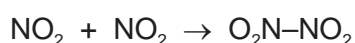
 [3]

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

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

.....
 [2]

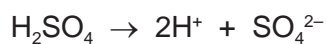
- (iv) What other piece of information given in the equation supports your answer to (iii)?



..... [1]

[Total: 12]

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



Dibasic acids can form salts of the type Na_2X and CaX .

- (a) Malonic acid is a white crystalline solid which is soluble in water. It melts at 135°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?

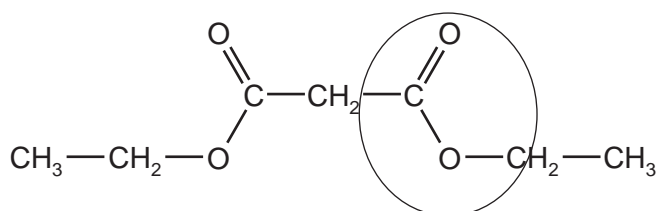
..... [1]

- (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 colourless 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^3 , has a higher pH than one of sulfuric acid of the same concentration.

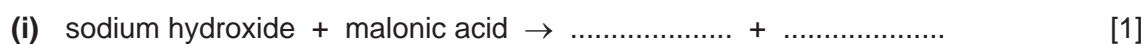
..... [1]

- (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.

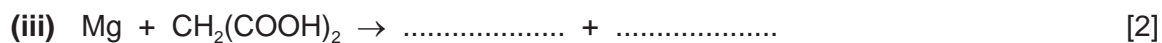
.....

..... [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]

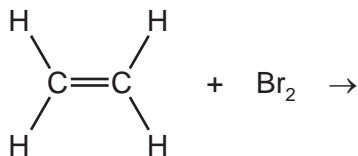
- (b) Alkenes and simpler alkanes are made from long-chain alkanes by cracking. Complete the following equation for the cracking of the alkane $\text{C}_{20}\text{H}_{42}$.



- (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.

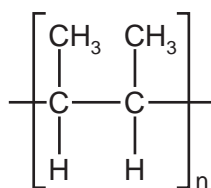
For
Examiner's
Use

- (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]

10

(d) 20 cm³ of a hydrocarbon was burnt in 175 cm³ of oxygen. After cooling, the volume of the remaining gases was 125 cm³. The addition of aqueous sodium hydroxide removed carbon dioxide leaving 25 cm³ of unreacted oxygen.

For
Examiner's
Use

(i) volume of oxygen used = cm³ [1]

(ii) volume of carbon dioxide formed = cm³ [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																																																																																																																																					
7 Li Lithium 3	9 Be Beryllium 4	1 H Hydrogen 1	11 B Boron 5	12 C Carbon 6	13 Al Aluminium 13	14 N Nitrogen 7	15 O Oxygen 8	16 F Fluorine 9	17 Ne Neon 10	18 Ar Argon 18	19 K Potassium 19	20 Ca Calcium 20	21 Sc Scandium 21	22 Ti Titanium 22	23 V Vanadium 23	24 Cr Chromium 24	25 Mn Manganese 25	26 Fe Iron 26	27 Co Cobalt 27	28 Ni Nickel 28	29 Cu Copper 29	30 Zn Zinc 30	31 Ga Gallium 31	32 Ge Germanium 32	33 As Arsenic 33	34 Se Selenium 34	35 Br Bromine 35	36 Kr Krypton 36	37 Rb Rubidium 37	38 Sr Strontium 38	39 Y Yttrium 39	40 Zr Zirconium 40	41 Nb Niobium 41	42 Mo Molybdenum 42	43 Tc Technetium 43	44 Ru Ruthenium 44	45 Rh Rhodium 45	46 Pd Palladium 46	47 Ag Silver 47	48 Cd Cadmium 48	49 In Indium 49	50 Sn Tin 50	51 Sb Antimony 51	52 Te Tellurium 52	53 I Iodine 53	54 Xe Xenon 54	55 Cs Caesium 55	56 Ba Barium 56	57 La Lanthanum 57	72 Hf Hafnium 72	73 Ta Tantalum 73	74 W Tungsten 74	75 Re Rhenium 75	76 Os Osmium 76	77 Ir Iridium 77	78 Pt Platinum 78	79 Au Gold 79	80 Hg Mercury 80	81 Tl Thallium 81	82 Pb Lead 82	83 Bi Bismuth 83	84 Po Polonium 84	85 At Astatine 85	86 Rn Radon 86	87 Fr Francium 87	88 Ra Radium 88	89 Ac Actinium 89	†	90 Th Thorium 90	91 Pa Protactinium 91	92 U Uranium 92	93 Np Neptunium 93	94 Pu Plutonium 94	95 Am Americium 95	96 Cm Curium 96	97 Bk Berkelium 97	98 Cf Californium 98	99 Es Einsteinium 99	100 Fm Fermium 100	101 Md Mendelevium 101	102 No Nobelium 102	103 Lr Lawrencium 103	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	212 Po Polonium 84	214 At Astatine 85	216 Rn Radon 86	226 Ra Radium 88	227 Ac Actinium 89	†	232 Th Thorium 90	238 U Uranium 92	238 Np Neptunium 93	238 Pu Plutonium 94	238 Am Americium 95	238 Cm Curium 96	238 Bk Berkelium 97	238 Cf Californium 98	238 Es Einsteinium 99	238 Fm Fermium 100	238 Md Mendelevium 101	238 No Nobelium 102	238 Lr Lawrencium 103	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71

*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 dm³ at room temperature and pressure (r.t.p.).

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