UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTER NUMBER

CANDIDATE NUMBER

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.

UNIVERSITY of CAMBRIDGE International Examinations

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]

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 ste

(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 mole 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.

$$\text{.....}Pb(NO_3)_2 \rightarrow \text{.....} + \text{.....}NO_2 + O_2$$ [2]

(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.

$$2NO_2(g) \underset{\text{reverse reaction}}{\overset{\text{forward reaction}}{\rightleftharpoons}} N_2O_4(g)$$

dark brown — colourless

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

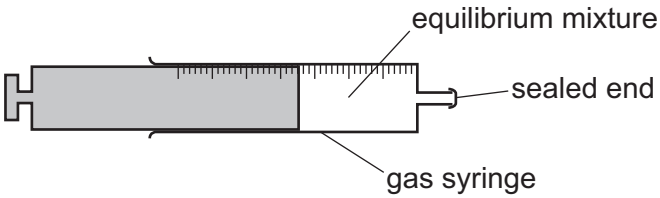
$$NO_2 + NO_2 \rightarrow O_2N–NO_2$$

(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)**?

$$NO_2 + NO_2 \rightarrow O_2N–NO_2$$

..... [1]

[Total: 12]

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

$$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$$

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.

$$CH_2(COOH)_2 \text{ or } HOOC-CH_2-COOH$$

(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?

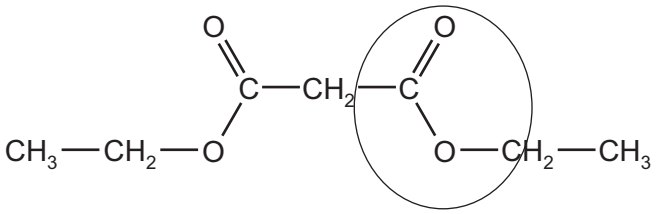
..... [1]

(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^3, has a hig
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.

(i) sodium hydroxide + malonic acid → ..... + ... [1]

.....

(ii) $CuO + H_2SO_4 \rightarrow$ ..... + ... [2]

(iii) $Mg + CH_2(COOH)_2 \rightarrow$ ..... + ... [2]

(iv) $K_2CO_3 + H_2SO_4 \rightarrow$ ..... + ... + ... [2]

[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?

.....

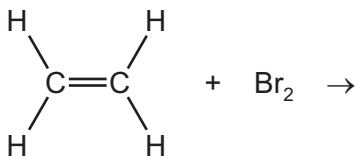
..... [2]

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

$$C_{20}H_{42} \rightarrow 2C_4H_8 + 2C_2H_4 + ...$$ [1]

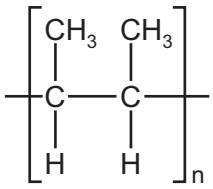
(c) Alkenes such as butene and ethene are more reactive than alkanes.
Alkenes are used in the petrochemical industry to make a range of products, w
includes polymers and alcohols.

(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, $CH_3-CH_2-CH=CH_2$? 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^3 of a hydrocarbon was burnt in 175 cm^3 of oxygen. After cooling, the vo the remaining gases was 125 cm^3. The addition of aqueous sodium hydroxide rem carbon dioxide leaving 25 cm^3 of unreacted oxygen.

(i) volume of oxygen used = ... cm^3 [1]

(ii) volume of carbon dioxide formed = ... cm^3 [1]

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

.....

.....

.....

..... [2]

[Total: 15]

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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 Aluminum 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 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

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

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.).