OCR
RECOGNISING ACHIEVEMENT

H

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE CHEMISTRY A

A323/02

Unit 3: Ideas in Context plus C7 (Higher Tier)

Candidates answer on the question paper.
A calculator may be used for this paper.

OCR supplied materials:
- Insert (inserted)

Other materials required:
- Pencil
- Ruler (cm/mm)

Friday 27 May 2011
Morning

Duration: 60 minutes

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The insert will be found in the centre of this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Answer **all** the questions.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **55**.
- Where you see this icon you will be awarded a mark for the quality of written communication in your answer.
- The Periodic Table is printed on the back page.
- This document consists of **12** pages. Any blank pages are indicated.

Answer **all** the questions.

1 This question is based on the article "**Bolivian Bonanza**".

(a) The article says 'the green-car revolution could make lithium one of the planet's most sought after elements'.

Explain why the demand for lithium will increase greatly.

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

(b) **Describe and explain** one impact on the environment that may be caused by the extraction, use or disposal of lithium used in lithium-ion batteries.

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

(c) **(i)** Vehicles powered by petrol or diesel release carbon dioxide into the air. This causes global warming.

Cars powered using lithium-ion batteries do not release carbon dioxide.

However, large scale use of cars powered by lithium-ion batteries would still result in global warming.

Explain why.

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

(ii) What further developments would be needed to prevent cars powered by lithium-ion batteries contributing to global warming?

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

(d) (i) Lithium is extracted from lithium chloride, LiC*l*, by electrolysis, but iron is extracted from iron oxide by reduction with carbon.

What is the reason for this difference?

.....

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

(ii) During the electrolysis, lithium metal is formed at the negative electrode (cathode) and chlorine gas is released at the positive electrode (anode).

Write equations to show how the ions react at the electrodes.

Use e^- to represent an electron.

cathode

.....

anode

.....

[2]

(iii) A factory produces 50 tonnes of lithium from lithium chloride, LiC*l*.

What mass of lithium chloride would be used to produce this lithium?

Give your answer to the nearest tonne.

(Relative atomic masses: C*l*, 35.5; Li, 7.)

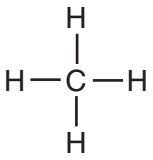
Show your working.

mass of lithium chloride = ... tonnes **[2]**

[Total: 13]

2 The alkanes are a family of chemical compounds.

(a) Complete the table to show names, molecular formulae and structural formulae of three alkanes.

name of alkane	molecular formula	structural formula
methane	CH_4	
ethane		
	C_3H_8	

[4]

(b) Alkanes burn in a plentiful supply of air to give two products.

Balance this equation for the burning of an alkane.

C_3H_8 + …… O_2 → …… CO_2 + …… H_2O **[1]**

(c) The burning of an alkane in air is an exothermic reaction.

Use ideas about the energy involved in the making and breaking of bonds to explain this.

One mark is for a clear ordered answer.

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..... **[3+1]**

[Total: 9]

3 Most esters have sweet, fruity smells.

Esters can be made by reacting a carboxylic acid with an alcohol.

carboxylic acid + alcohol $\rightleftharpoons$ ester + water

(a) The reaction to make an ester takes place in the presence of sulfuric acid.

State and explain the job of the sulfuric acid.

.....

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

(b) Octyl ethanoate, $CH_3COOC_8H_{17}$, has the smell of oranges.

Octyl ethanoate can be made by heating a mixture of ethanoic acid, CH_3COOH, and octanol, $C_8H_{17}OH$.

Write a balanced equation for the reaction used to make octyl ethanoate.

..... $\rightleftharpoons$ ..... **[1]**

(c) The $\rightleftharpoons$ sign shows that this is a reversible reaction that reaches a state of equilibrium.

At equilibrium the concentrations of each of the reactants and the products are constant.

Use ideas about dynamic equilibrium to explain how the reaction mixture reaches a state of equilibrium.

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..... **[4]**

[Total: 7]

4 Lime scale can build up in kettles.

A company makes a lime scale remover that contains solid phosphoric acid, H_3PO_4, together with other ingredients. When dissolved in water the phosphoric acid reacts with and removes the lime scale.

The batch of lime scale remover that has been made each day is analysed to measure how much phosphoric acid it contains.

(a) The amount of phosphoric acid in 10.0 g samples of the lime scale remover is measured using titration against standard sodium hydroxide solution.

A rough titration is carried out first, then several accurate titrations.

Describe the key stages of an accurate titration.

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

(b) The titration is repeated with several other samples of the lime scale remover.

Give **two** reasons for analysing several samples of the lime scale remover.

1 .....

.....

2 .....

.....

[2]

(c) A best estimate from the analysed samples is used to work out the phosphoric acid content of the lime scale remover.

How can the degree of uncertainty of this result be assessed?

.....

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

(d) Why is it important for the company to know how much phosphoric acid the lime scale remover contains?

.....

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

(e) The result of the analysis shows that 25.0 cm^3 of standard sodium hydroxide solution reacts with the phosphoric acid in 10.0 g of the lime scale remover.

(i) The standard sodium hydroxide solution contains 60.0 g/dm^3 of sodium hydroxide.

What is the mass of sodium hydroxide in 25.0 cm^3 of this standard solution?

(1 dm^3 contains 1000 cm^3)

mass of sodium hydroxide in 25.0 cm^3 standard solution = ... g **[1]**

(ii) Work out the relative formula mass of phosphoric acid, H_3PO_4.

(relative atomic masses: H, 1; O, 16; P, 31.)

relative formula mass of phosphoric acid = ...**[2]**

(iii) Phosphoric acid reacts with sodium hydroxide according to this equation.

$$H_3PO_4 + 3NaOH \rightarrow Na_3PO_4 + 3H_2O$$

The relative formula mass of sodium hydroxide is 40.

Work out the mass of phosphoric acid in 10.0 g of lime scale remover.

Show your working.

mass of phosphoric acid H_3PO_4 in 10.0 g lime scale remover = ... g **[3]**

[Total: 12]

5 The chemical industry produces thousands of different chemicals. Some of these are classed as bulk chemicals and others as fine chemicals.

(a) Steps in the production of sulfuric acid, H_2SO_4, are shown below.

Step 1 Liquid sulfur is burned in air to produce sulfur dioxide.

Step 2 Sulfur dioxide is reacted with more oxygen to make sulfur trioxide.

Step 3 Sulfur trioxide is dissolved in concentrated sulfuric acid.

Step 4 Water is added to produce sulfuric acid of the required concentration.

(i) Write a symbol equation with state symbols for the formation of sulfur dioxide in **Step 1**.

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

(ii) Vanadium oxide speeds up the reaction in **Step 2**.

This vanadium oxide is not used up in the reaction.

Explain how vanadium oxide speeds up this reaction.

Use ideas about activation energy in your answer.

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.....

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

(b) The Government has strict regulations to control the manufacture, transport and storage of sulfuric acid.

What is the purpose of these regulations?

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

[Total: 7]

6 Details of three methods used to produce ethanol are given below.

method	starting material (feedstock)	process
1	ethene	react with steam
2	corn starch	ferment with yeast
3	waste biomass	ferment with E. coli bacteria

(a) (i) **In terms of feedstock**, which of these three methods is least sustainable?

Explain why this method is less sustainable than the other two.

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

(ii) The sustainability of a chemical process depends on a number of factors.

Choose one of these factors, other than the type of feedstock, and explain how it may affect the sustainability of a chemical process.

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

(b) Ethanol can be used instead of petrol as a fuel in cars. This would greatly increase the demand for ethanol.

Producing much larger amounts of ethanol could result in an increase in food prices.

Using **method 3** rather than **method 2** may overcome this problem.

Explain why.

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.....

.....

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

[Total: 7]

END OF QUESTION PAPER

PLEASE DO NOT WRITE ON THIS PAGE

The Periodic Table of the Elements

1	2											3	4	5	6	7	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	63.5 **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	[98] **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	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.