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**OXFORD CAMBRIDGE AND RSA EXAMINATIONS
GENERAL CERTIFICATE OF SECONDARY EDUCATION**

A323/02

**TWENTY FIRST CENTURY SCIENCE
CHEMISTRY A**

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

FRIDAY 27 MAY 2011: Morning

DURATION: 60 minutes

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

**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)

READ INSTRUCTIONS OVERLEAF

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes on the first page. 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.

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 provided.

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.

[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.

[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.

[2]

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

[2]

- (d) (i) Lithium is extracted from lithium chloride, LiCl , 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, LiCl .

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

Give your answer to the nearest tonne.

(Relative atomic masses: Cl , 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	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$
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) 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.

[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.

[2]

(b) Octyl ethanoate, $\text{CH}_3\text{COOC}_8\text{H}_{17}$, has the smell of oranges.

Octyl ethanoate can be made by heating a mixture of ethanoic acid, CH_3COOH , and octanol, $\text{C}_8\text{H}_{17}\text{OH}$.

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.

[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.

[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 cm³ 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/dm³ of sodium hydroxide.

What is the mass of sodium hydroxide in 25.0 cm³ of this standard solution?

(1 dm³ contains 1000 cm³)

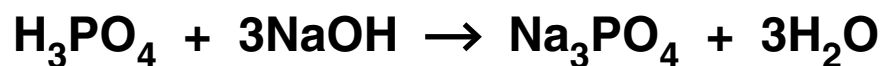
mass of sodium hydroxide in 25.0 cm³ standard solution = _____ g [1]

(ii) Work out the relative formula mass of phosphoric acid, H₃PO₄.

(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.



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.

[2]

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

What is the purpose of these regulations?

[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.

[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.

[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.

[2]

[Total: 7]

END OF QUESTION PAPER

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The Periodic Table of the Elements

	1	2	3	4	5	6	7	0										
	7 Li lithium 3	9 Be beryllium 4	11 Na sodium 11	12 Mg magnesium 12	13 Al aluminium 13	14 Si silicon 14	15 P phosphorus 15	16 S sulfur 16	17 Cl chlorine 17	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
	[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						

1	H hydrogen 1
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relative atomic mass
atomic symbol
name
atomic (proton) number

Key

* 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.