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A323/02

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

CHEMISTRY A

Unit 3 Ideas in Context plus C7 (Higher Tier)

FRIDAY 23 MAY 2008

Afternoon

Time: 60 minutes

Candidates answer on the question paper.
Additional materials (enclosed):
Insert

Calculators may be used.
Additional materials: Pencil
Ruler (cm/mm)

CUP/T48796

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided.

INFORMATION FOR CANDIDATES

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

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	13	
2	12	
3	10	
4	9	
5	11	
TOTAL	55	

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Answer **all** the questions.

1 This question is based on the article 'The Periodic Table'.

(a) Johann Dobereiner put the elements lithium, sodium and potassium in a Triad because they have similar chemical properties.

Use ideas about the electron arrangement of these elements to explain why they have similar chemical properties.

.....

.....

.....

..... [2]

(b) Mendeleev arranged elements in order of increasing relative atomic mass. He found a repeating pattern in their properties.

Use examples of the properties of **three** of the first 20 elements to describe this pattern.

.....

.....

.....

..... [2]

(c) Mendeleev said that some elements had not yet been discovered.

He predicted the properties of these elements.

Explain how these predictions helped his ideas to be accepted by other chemists.

.....

.....

..... [2]

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(d) Many chemists suggested different patterns for the elements.

They all used the **same** data.

Suggest why these chemists could not agree.

.....

.....

.....

..... [2]

(e) Argon has proton number 18 and relative atomic mass 40.

Potassium has proton number 19 and relative atomic mass 39.

(i) This caused a problem for Mendeleev when arranging elements in his Periodic Table.

Explain why.

.....

.....

..... [2]

(ii) Why does this problem not occur in the modern Periodic Table?

.....

..... [1]

(f) Mendeleev placed copper in Group 1 of his Periodic Table.

Copper is a fairly unreactive metal with a high melting point.

In the modern Periodic Table copper is placed in the central block of transition elements.

Explain why copper should not be in Group 1.

.....

.....

..... [2]

[Total: 13]

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2 Manufacturers around the world are trying to find alternative fuels to petrol and diesel. This will stop drivers using up the world's fossil fuels. One alternative fuel is bio-ethanol, made by the fermentation of wheat or beet sugar.

Bio-ethanol can be mixed with petrol. When burned, this produces less carbon dioxide and other pollutants. Bio-ethanol also provides more energy and is a renewable energy source.

(a) Fermentation of carbohydrates by yeast produces a solution that is distilled to produce bio-ethanol.

(i) Balance the equation for this fermentation reaction.

$$C_6H_{12}O_6 \rightarrow \ldots\ldots\ C_2H_5OH + \ldots\ldots\ CO_2$$ [1]

(ii) The process is carried out at an optimum temperature.

Explain why higher temperatures are not used and why lower temperatures are not used.

One mark is for correct use of scientific terms.

.....

.....

.....

..... [2+1]

(iii) Fermentation produces a dilute solution of ethanol. This is distilled to produce pure ethanol.

Explain why fermentation cannot be used to produce a concentrated solution of ethanol.

.....

..... [1]

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(b) Ethanol can also be made from ethane obtained from natural gas.

Ethane is first cracked to form ethene.

Ethanol is then made by the addition of steam to ethene.

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

(i) What mass of ethanol can be made from one tonne of ethene?

(Relative atomic mass: C = 12, H = 1, O = 16.)

mass of ethanol = ... tonne [2]

(ii) Making ethanol by fermentation is more sustainable than making ethanol from ethane.

Explain why.

.....

.....

..... [2]

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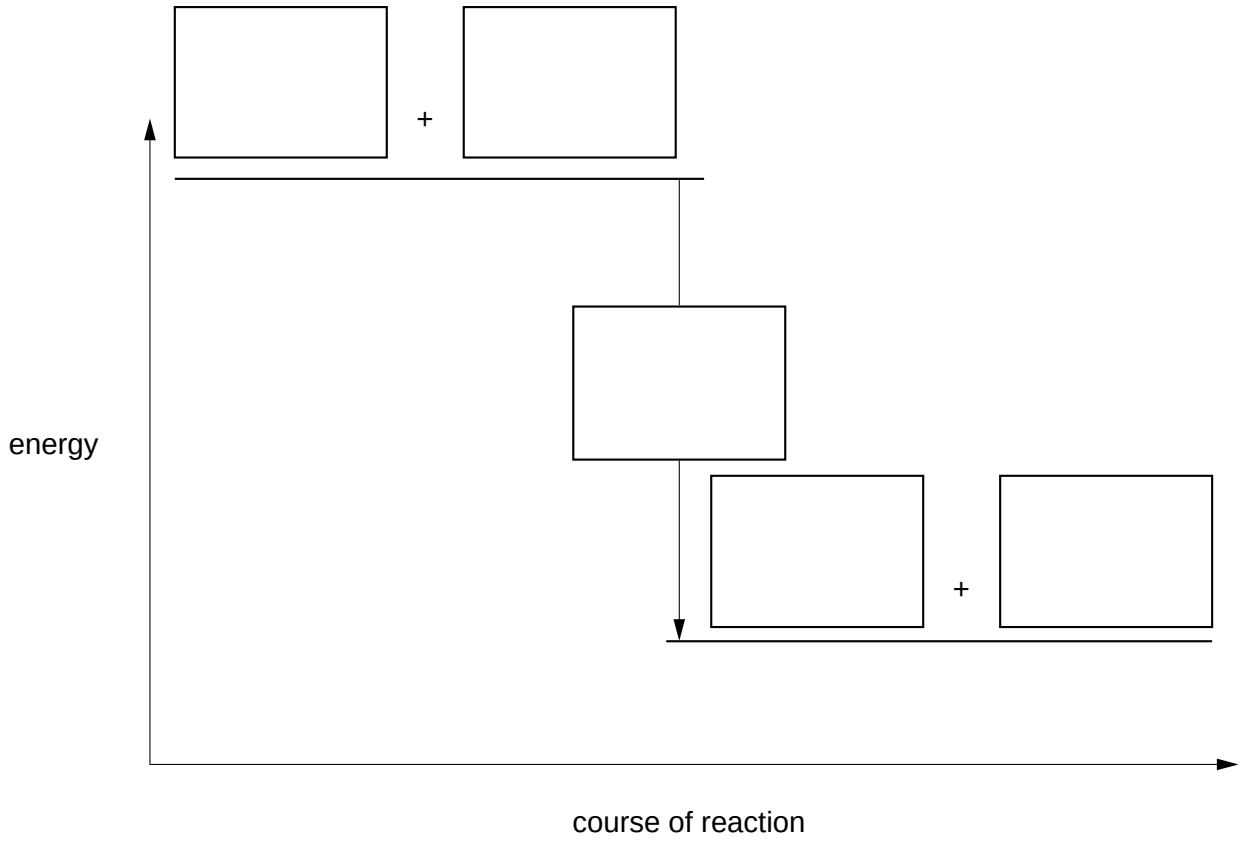
(c) The burning of ethanol is an exothermic reaction.

Finish the energy level diagram for this reaction by writing the correct terms from the list in the boxes.

carbon dioxide **energy released** **energy absorbed** **ethanol** **oxygen** **water**



[3]

[Total: 12]

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3 **(a)** Ethanoic acid is a weak acid.

In a solution of ethanoic acid there is a dynamic equilibrium.

$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

(i) What does the $\rightleftharpoons$ sign show about this reaction?

..... [1]

(ii) Ethanoic acid is a **weak** acid, but hydrochloric acid is a **strong** acid.

Use ideas about ion formation and dynamic equilibrium to explain this difference.

.....

.....

.....

.....

..... [4]

(b) Ethanoic acid reacts with ethanol, C_2H_5OH, to produce an ester called ethyl ethanoate, $CH_3COOC_2H_5$, and water.

This reaction also involves a dynamic equilibrium.

(i) Write a balanced equation for this reaction.

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

(ii) A small quantity of strong acid is used as a catalyst for this reaction.

Explain why only a small quantity is needed.

.....

..... [1]

(iii) A mixture of ethanoic acid, ethanol and a strong acid are heated **under reflux**.

Describe and explain the use of this technique.

.....

.....

.....

..... [3]

[Total: 10]

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4 Gemma works for a company making vinegar.

She measures the amount of ethanoic acid in 25 cm^3 samples of the company's product.

She carries out a titration using a standard solution of sodium hydroxide and an indicator.

(a) Gemma makes her standard solution of sodium hydroxide to use for her titration.

The statements describe how she makes up this solution. They are in the wrong order.

A Rinse all of the solution from the beaker using more distilled water.

B Place a stopper in the graduated flask and shake it.

C Dissolve the sodium hydroxide in a small volume of distilled water in a beaker.

D Accurately weigh 1.0 g of sodium hydroxide.

E Transfer the solution to a 250 cm^3 graduated flask.

F Add more distilled water up to the volume mark on the graduated flask.

(i) Write the letters of these statements in the boxes to show the correct order.

The first and last have been done for you.

D					B

[3]

(ii) Calculate the concentration of her sodium hydroxide solution in g / dm^3.

concentration of sodium hydroxide solution = ... g / dm^3 [1]

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(b) Gemma carries out six titrations in the morning and six more in the afternoon.

All of the samples she tests are from the same vinegar.

Her results are shown in the table.

	volume of sodium hydroxide solution / cm^3					
morning	12.9	12.2	12.5	12.8	12.9	12.1
afternoon	12.4	12.6	12.5	12.5	12.4	12.6

Gemma decides to use the results she obtained in the afternoon to calculate the concentration of ethanoic acid in the vinegar.

(i) Explain why she chose the afternoon set of results.

.....

.....

..... [2]

(ii) Ethanoic acid and sodium hydroxide react according to this equation.

$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$$

Gemma used 25 cm^3 of vinegar for each titration.

The average of the results from Gemma's afternoon titrations is 12.5 cm^3.

Use this average, and the concentration of sodium hydroxide you gave in **(a)(ii)**, to calculate the mass of ethanoic acid in each dm^3 of the vinegar.

(Relative formula mass: CH_3COOH = 60, NaOH = 40.)

mass of ethanoic acid = ... g [3]

[Total: 9]

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5 Phosphoric acid, H_3PO_4, is manufactured in large quantities.

The most common process uses a feedstock of phosphate rock. The rock is first crushed and then reacted with concentrated sulfuric acid.

calcium phosphate + sulfuric acid $\longrightarrow$ phosphoric acid + calcium sulfate

The insoluble calcium sulfate is separated from the phosphoric acid by filtration.

Calcium sulfate is a useful by-product. It is dried and crushed into powder ready to be sold.

The dilute phosphoric acid formed is concentrated by evaporation.

The final concentrated acid is analysed to find its concentration and measure any impurities.

(a) Write a balanced equation for the reaction between calcium phosphate, $Ca_3(PO_4)_2$, and sulfuric acid, H_2SO_4.

..... [3]

(b) The process involves the following stages:

- feedstock preparation
- synthesis
- separation of products
- handling of by-products and acidic wastes
- analysis of the acid.

(i) Suggest what problems might be involved in disposal of liquid waste from the process.

.....

.....

..... [2]

(ii) Suggest reasons why the final concentration of acid is measured.

.....

.....

..... [2]

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(c) The Government has strict regulations to control the storage and transport of chemicals.

Suggest and explain the precautions that should be used for the transport of concentrated phosphoric acid.

.....

.....

..... [2]

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

List **two** things which affect the sustainability of a chemical manufacturing process.

1 .....

2 ..... [2]

[Total: 11]

END OF QUESTION PAPER

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The Periodic Table of the Elements

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

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						

** 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.

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