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 28 May 2010
Morning

Duration: 60 minutes

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use 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. Additional paper may be used if necessary but you must clearly show your Candidate Number, Centre Number and question number(s).

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 **16** pages. Any blank pages are indicated.

Answer **all** the questions.

1 This question is based on the article 'Which nappy is best for the environment?'

(a) Both disposable and reusable 'terry' nappies contain cellulose fibres from cotton. Cotton is generally considered to be a renewable material.

Some people say that although cotton is a renewable material its use is not really sustainable because of the way that we grow it.

What information in the article supports this argument?

....

....

.... **[2]**

(b) Many parents think that reusable nappies cause less environmental damage than disposable nappies.

Despite this, most parents use disposable nappies.

Suggest a reason why they do this.

....

.... **[1]**

(c) The article says that a Life Cycle Assessment (LCA) follows the lifetime of a product 'from cradle to grave'.

Explain what this means.

....

.... **[1]**

(d) Use information from the article to describe and explain **one** environmental impact that is greater for reusable nappies than disposable nappies.

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.... **[2]**

(e) It might be possible to use the recycling process mentioned in the article to recycle materials from **all** of the disposable nappies used in the UK.

Suggest why this would be difficult to achieve.

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.... **[3]**

(f) Disposable nappies contain the polymers polyethene and polypropene.

(i) These polymers melt at low temperatures. This enables the recycled polymers to be melted and made into new products.

Use ideas about forces and energy to explain why these polymers melt at low temperatures.

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.... **[2]**

(ii) A polymer with a lower melting point than polyethene might be easier to recycle.

Describe one method that may be used to produce a polymer with a lower melting point and explain how it does this.

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.... **[2]**

[Total: 13]

2 A teacher drops a small piece of sodium into a dish of ethanol.

The teacher repeats this demonstration with sodium and water, and then with sodium and the liquid alkane, hexane.

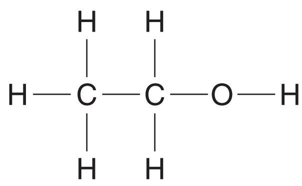
(a) The table below is to record the observations made by a student watching the demonstration.

Complete the table by writing in each empty box **what the student sees**.

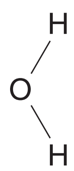
sodium + ethanol	**sodium + water**	**sodium + hexane**

[4]

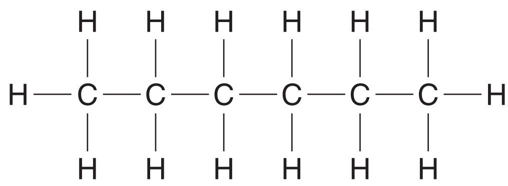
(b) The diagrams show the structural formulae of ethanol, water and hexane.



ethanol



water



hexane

Explain the similarities and differences in the reactions of these three compounds with sodium.

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....

.... **[2]**

(c) A dilute solution of ethanol can be made by fermentation of grape juice using yeast.

(i) Why is it not possible to make a concentrated solution of ethanol by fermentation?

....

.... **[1]**

(ii) Name the method used to separate ethanol from the solution, and explain how it works.

method: ....

explanation: ....

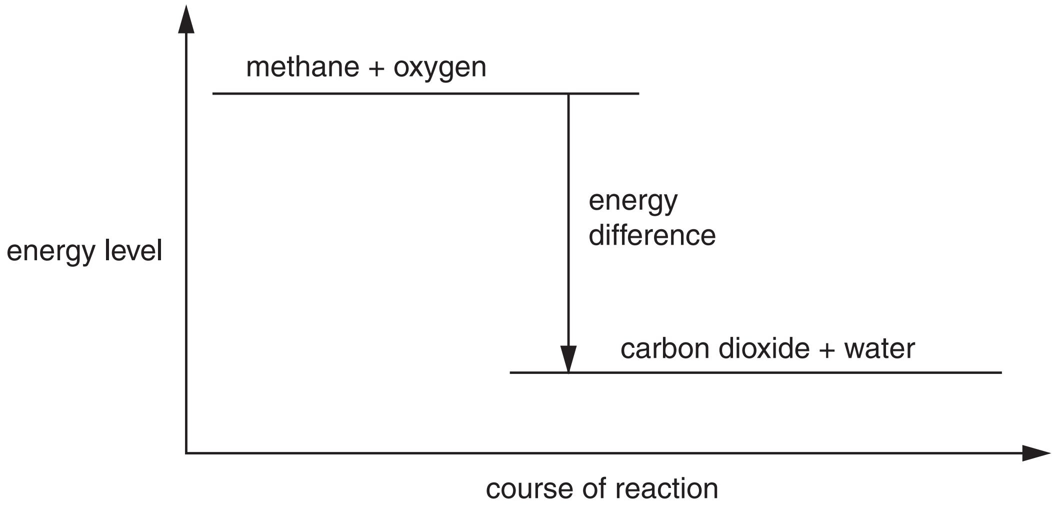
....

....

.... **[3]**

[Total: 10]

3 Look at this energy level diagram for the complete combustion of methane in air.



(a) The complete combustion of methane in air is an exothermic reaction.

How does the energy level diagram show that this reaction is exothermic?

....

....

.... **[2]**

(b) A mixture of methane and oxygen at room temperature does not react.

When a lighted match is applied the mixture burns.

The lighted match supplies the activation energy for the reaction.

Explain what is meant by the term **activation energy**.

....

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.... **[2]**

(c) Methane burns in air according to this equation.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

The table shows the energy required to break each of the bonds involved in this reaction.

bond	**energy in kJ/mol**
C–H	435
O=O	498
C=O	805
H–O	464

The energy used when the bonds in this reaction are broken can be calculated as follows.

4 × C–H = 4 × 435 = 1740 kJ/mol

2 × O=O = 2 × 498 = 996 kJ/mol

energy used = 1740 + 996 = 2736 kJ/mol

(i) Calculate the energy released as new bonds are made in this reaction.

energy released = ... kJ/mol **[3]**

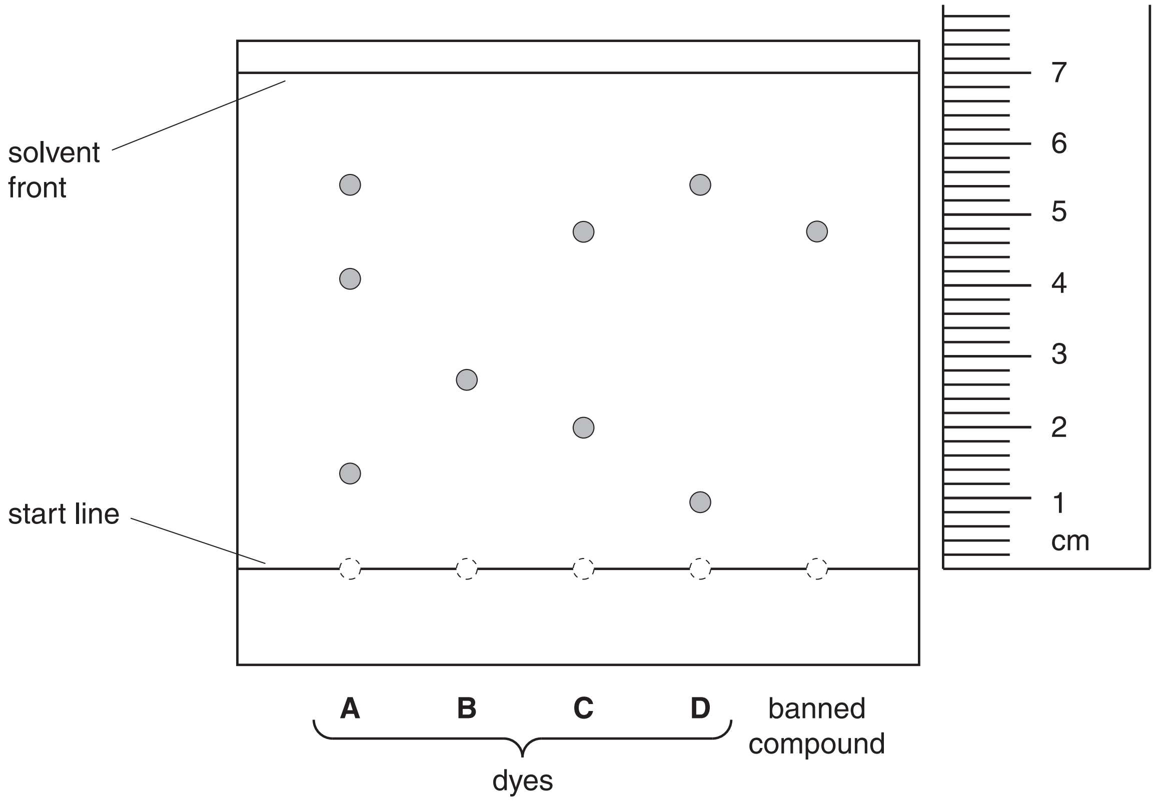
(ii) Calculate the overall energy change for the reaction.

overall energy change = ... kJ/mol **[1]**

[Total: 8]

4 A scientist employed by the Food Standards Agency uses paper chromatography. He tests samples of water-soluble food dyes to see if they contain a banned compound.

The resulting chromatogram is shown below.



(a) The chromatogram shows that dye **C** contains the banned compound.

The identity of this substance can be confirmed using its published R_f value.

(i) Calculate the R_f value for the banned compound.

You must show your working.

$$R_f \text{ value} = \frac{\text{distance travelled by solute}}{\text{distance travelled by solvent}}$$

R_f value = ... **[2]**

(ii) Suggest why R_f values are sometimes a better way to compare spots on different chromatograms than a simple visual comparison.

....

....

.... **[2]**

(b) Describe how compounds in the dyes are separated during the chromatography.

Use the terms **stationary phase**, **mobile phase** and **dynamic equilibrium** in your answer.

....

....

....

....

.... **[3]**

[Total: 7]

5 A student uses a titration with nitric acid to find the concentration of a solution of sodium hydroxide.

(a) The student has a stock solution of nitric acid containing 63 g in each dm^3.

She uses this to make up 250 cm^3 of a standard solution containing 6.3 g in each dm^3.

Describe how she makes up this standard solution.

(1 dm^3 = 1000 cm^3)

....

....

.... **[2]**

(b) The student adds the standard nitric acid solution from a burette into sodium hydroxide solution in a flask.

She uses five 25.0 cm^3 samples of the sodium hydroxide solution.

She obtains the following titration results.

titration number	**1**	**2**	**3**	**4**	**5**
volume of nitric acid in cm^3	28.3	28.2	28.2	28.1	28.2

(i) The student uses the average of her titration results, 28.2 cm^3, as the best estimate of the volume of nitric acid used.

Show by calculation that the mass of nitric acid in 28.2 cm^3 of the standard solution is 0.178 g.

[1]

(ii) Nitric acid and sodium hydroxide react according to the following equation.

$$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$$

The relative formula mass of nitric acid is 63 and the relative formula mass of sodium hydroxide is 40.

Calculate the mass of sodium hydroxide in 25.0 cm^3 of the sodium hydroxide solution, and hence find the concentration of the sodium hydroxide solution in g/dm^3.

You should show your working.

mass of the sodium hydroxide in 25 cm^3 solution = ... g

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

(iii) Use the titration results to assess the degree of uncertainty in your value for the concentration of the sodium hydroxide solution.

....

....

.... **[2]**

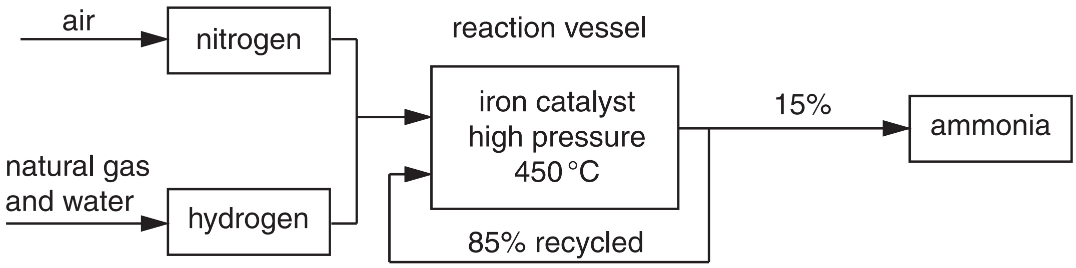
[Total: 8]

6 Ammonia is a bulk chemical made by the reaction of nitrogen with hydrogen.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

The reaction is reversible, forming a dynamic equilibrium.

The diagram shows a flow chart of the Haber process for the manufacture of ammonia.



(a) Air and natural gas are used to make ammonia.

Suggest how each of these raw materials affects the sustainability of the process.

air ....

....

natural gas ....

.... **[4]**

(b) The process uses an iron catalyst. A catalyst speeds up the rate of conversion of reactants to products.

Use ideas about energy to explain how a catalyst works.

One mark is for using the correct scientific terms.

....

....

.... **[2+1]**

(c) Although the reaction is reversible, all of the nitrogen and hydrogen are eventually converted to ammonia.

Use the flow chart to explain how this is achieved.

....

....

.... **[2]**

[Total: 9]

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.