OCR
RECOGNISING ACHIEVEMENT

H

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE CHEMISTRY A

A321/02

Unit 1 Modules C1 C2 C3
(Higher Tier)

Candidates answer on the question paper
Electronic calculators may be used

OCR Supplied Materials:
None

Other Materials Required:
- Pencil
- Ruler (cm/mm)

Thursday 15 January 2009
Afternoon

Duration: 40 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, however additional paper may be used if necessary.

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 **42**.
- The Periodic Table is printed on the back page.
- This document consists of **16** pages. Any blank pages are indicated.

FOR EXAMINER'S USE		
Qu.	**Max**	**Mark**
1	9	
2	7	
3	7	
4	5	
5	9	
6	5	
TOTAL	42	

Answer **all** the questions.

1 Three technicians test the hardness of samples of the **same** type of rubber. They use identical apparatus and method.

A metal cylinder is pushed into a rubber sample. The depth it sinks into the rubber is measured.

Their results are shown in the table.

technician	depth in rubber for each sample in mm				
	sample 1	**sample 2**	**sample 3**	**sample 4**	**sample 5**
A	12	17	15	10	13
B	11	13	12	11	13
C	12	12	13	7	11

(a) The laboratory supervisor uses results from technician **B** to find the best estimate of the depth.

(i) Why did he **not** use results from technician **A** to calculate a best estimate?

Put a tick (✓) in the box next to the correct answer.

The results are too high. ☐

The results are too low. ☐

The range of the results is too large. ☐

The results contain an outlier. ☐

[1]

(ii) If the laboratory supervisor calculates the mean (average) from the results from technician **C** to get a best estimate of the depth, what value will he get?

Best estimate of depth from **C** = ... mm **[2]**

(iii) Each technician tested five samples of rubber.

Why did they each test more than one sample of rubber?

Put ticks (✓) in the boxes next to the **two** best answers.

Taking more measurements reduces the effects of random errors.	☐
The technicians were learning how to take the measurements.	☐
A number of measurements are needed to give fair testing.	☐
If they take more measurements the technicians will make fewer errors.	☐
There may be small variations between different samples of the same type of rubber.	☐

[2]

(b) The laboratory supervisor decides that there is not a **real difference** between the results from each of the three technicians.

Which statements give correct reasons for this conclusion?

Put ticks (✓) in the boxes next to the **two** best answers.

The mean for the results from technician B is within the range of the results for technician C.	☐
The results from technicians A, B and C all contain the value 12.	☐
The results from technicians A, B and C all have the same mean.	☐
The mean for the results from technician B is within the range of the results for technician A.	☐
Each of the technicians A, B and C tested five samples of rubber.	☐

[2]

(c) Natural rubber is made from liquid sap from rubber trees.

Synthetic rubber is made from chemicals from crude oil.

Which of these statements explain why the production, use and disposal of natural rubber are more **sustainable** than that of synthetic rubber?

Put ticks (✓) in the boxes next to the **two** best answers.

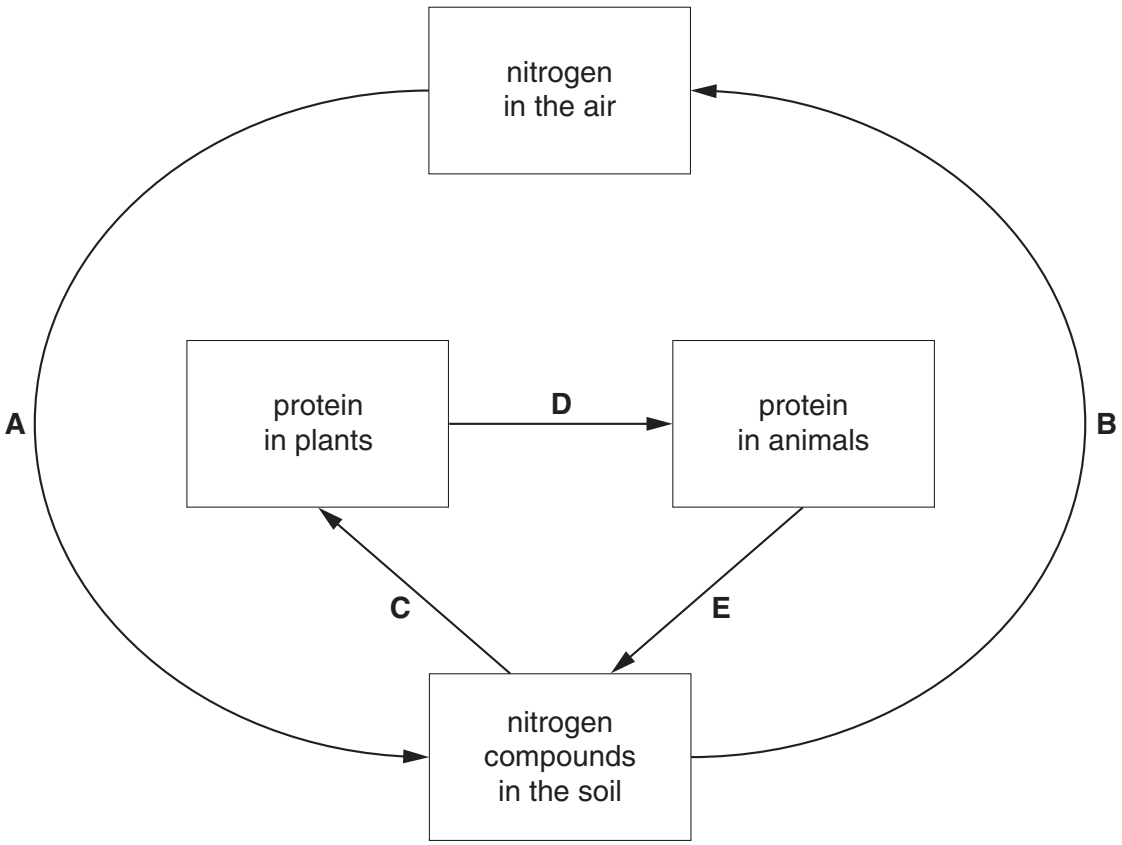
Liquid sap can be taken from the same rubber tree each year.	☐
Only one type of tree produces sap that can be made into rubber.	☐
It is easier to make rubber from liquid sap than from crude oil.	☐
Crude oil is used to make many products other than rubber.	☐
Crude oil is a finite resource.	☐

[2]

[Total: 9]

2 The diagram shows part of the nitrogen cycle.

Changes are labelled **A**, **B**, **C**, **D** and **E**.



(a) Choose the correct letter, **A**, **B**, **C**, **D** or **E**, to answer each of the following questions.

You may use each letter **once**, **more than once or not at all**.

(i) Which change involves decay?

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

(ii) Which change involves bacteria in the roots of plants?

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

(iii) Which change involves lightning in thunder storms?

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

(b) Proteins contain nitrogen and carbon.

What are the other two main elements in proteins?

answer ..... and ..... **[2]**

(c) When crops are grown and harvested essential elements are removed and lost from the soil.

Nitrogen is one of the three most important elements lost from soil in this way. Name the other two.

answer ..... and ..... **[2]**

[Total: 7]

3 The food that we eat may sometimes contain toxic chemicals.

(a) The first list below gives sources of toxic chemicals in foods. The second list describes how foods can be contaminated with these toxic chemicals.

Draw a line from each **source of toxic chemical** to the correct description of **contamination**.

source of toxic chemical	contamination
used by farmers	produced as food is cooked
produced by plants	used to improve taste or appearance of food
produced by micro organisms	contained in pesticides sprayed onto crops
made by reactions at high temperatures	remain in food that has not been cooked properly
used illegally as food additives	released when food goes mouldy

[3]

(b) Aspartame is an artificial sweetener added to many foods. In a research project large doses of aspartame were fed to rats. Some of these rats developed cancer. There is no direct evidence that aspartame has a similar effect on humans.

(i) Which of these statements best describe what people should know so that they can decide whether they should accept the risk of eating food containing aspartame?

Put ticks (✓) in the boxes next to the **two** best answers.

- The chance of aspartame causing them harm. ☐
- The names of other artificial sweeteners that are added to foods. ☐
- The number of people who are diagnosed with cancer each year. ☐
- The consequences of the harm that aspartame may do to them. ☐
- Details of how aspartame is made. ☐

[2]

(ii) Some people may use the **precautionary principle** to decide that they should not eat food containing aspartame.

Which two statements describe this use of the precautionary principle?

Put ticks (✓) in the boxes next to the **two** best answers.

Aspartame causes cancer in rats. ☐

We do not know whether aspartame causes serious harm to humans. ☐

Scientists should carry out more research on aspartame. ☐

All food additives are harmful and should be avoided. ☐

If you are not sure about the outcome of an action it is better to avoid it. ☐

[2]

[Total: 7]

4 This question is about the combustion of hydrocarbon fuels.

(a) When the hydrocarbons in petrol burn in a car engine the carbon atoms form pollutants that are released from the car exhaust.

Which three statements help to explain how these pollutants are formed?

Put ticks (✓) in the boxes next to the **three** correct statements.

Because there is not enough oxygen for all of the carbon atoms to form carbon dioxide, some form carbon monoxide.	☐
Petrol does not contain enough oxygen to react with all of the atoms in the hydrocarbon.	☐
When a hydrocarbon burns, only the hydrogen atoms are reactive enough to join with oxygen atoms.	☐
Some of the carbon atoms join with oxygen atoms to form carbon dioxide.	☐
Nitrogen in the air prevents some of the oxygen reacting with the atoms in the petrol.	☐
Some of the carbon atoms do not react with oxygen at all.	☐

[3]

(b) Propane, C_3H_8, is a fuel used for central heating in some homes.

Each molecule of propane contains three carbon atoms and eight hydrogen atoms.

When propane burns in a plentiful supply of air, complete combustion takes place, forming carbon dioxide, CO_2, and water, H_2O.

One molecule of propane burns in a plentiful supply of air.

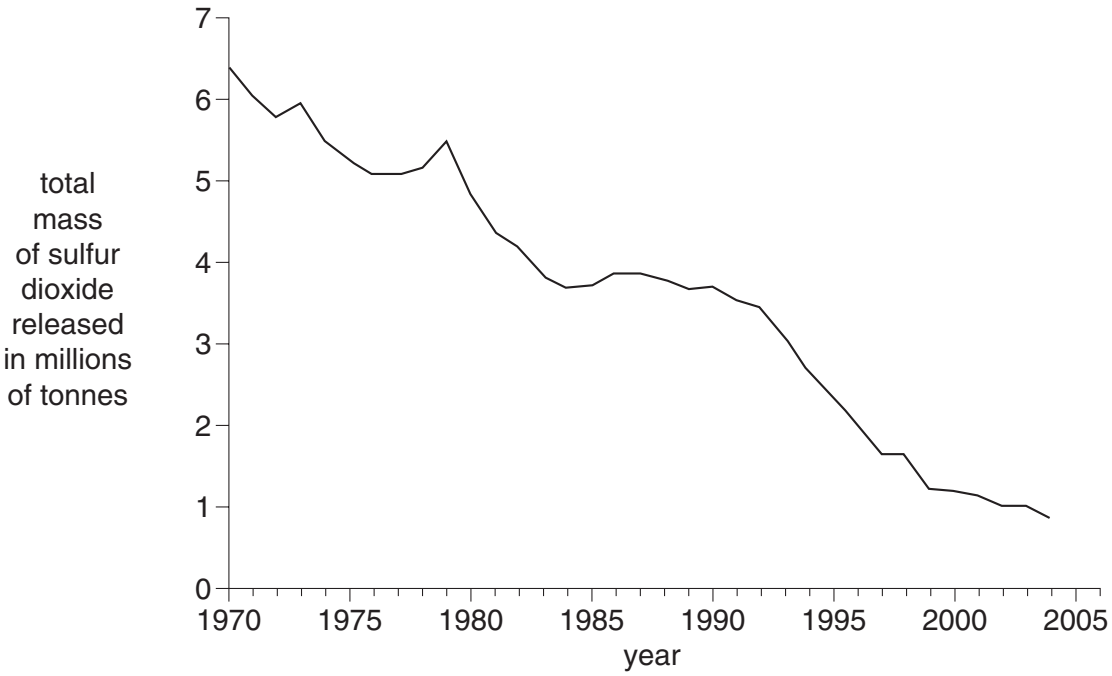
Complete the table to show the **total** number of atoms of carbon, hydrogen and oxygen in **all** of the molecules of each of the products formed.

product from one molecule of propane	total number of carbon atoms	total number of hydrogen atoms	total number of oxygen atoms
carbon dioxide			
water			

[2]

[Total: 5]

5 Sulfur dioxide is a pollutant gas. The graph shows how the total mass of sulfur dioxide released into the air in the United Kingdom changed from 1970 to 2004.



Source: Department for Environment, Food and Rural Affairs, www.defra.gov.uk

Sulfur dioxide is released when fossil fuels are burned in power stations. Burning coal releases more sulfur dioxide than burning oil or natural gas.

Since 1970 many coal-burning power stations have been replaced by those burning oil or natural gas.

(a) Use these statements to answer the following questions.

A	Some of the compounds in fossil fuels contain sulfur.
B	Coal contains a higher proportion of sulfur compounds than natural gas or oil.
C	Sulfur in compounds can be oxidised to produce sulfur dioxide at high temperatures.
D	Over the years many coal-burning power stations have been replaced by those burning oil or natural gas.
E	From 1970 to 2004 the mass of sulfur dioxide released into the air each year decreased.

(i) Which statement describes how sulfur dioxide is formed in a power station?

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

(ii) Which two statements, when put together, suggest that there is a correlation between the number of coal-burning power stations and the mass of sulfur dioxide released into the air?

answer ..... and ..... **[1]**

(iii) Which two statements, when put together, explain how the decrease in the number of coal-burning power stations has caused a change in the mass of sulfur dioxide released into the air?

answer ..... and ..... **[1]**

(iv) What other changes may have caused a **decrease** in the sulfur dioxide released into the air?

Put ticks (✓) in the boxes next to the **two** best answers.

People used more electricity.	☐
Low-sulfur petrol and diesel fuels were introduced for use in motor vehicles.	☐
The number of motor vehicles increased.	☐
Devices were fitted to remove sulfur dioxide from the flue gases released by coal-burning power stations.	☐
Some nuclear power stations were closed down.	☐

[2]

(b) Nitrogen dioxide, NO_2, is a pollutant of air.

Six of the seven statements in the box describe how this pollutant forms.

The statements are in the wrong order.

A	At high temperature nitrogen and oxygen react together.
B	Nitrogen monoxide and oxygen react together.
C	Nitrogen and oxygen in air enter a car engine
D	Nitrogen monoxide is released from the car exhaust into the air.
E	Nitrogen and oxygen react to make nitrogen dioxide.
F	Nitrogen monoxide is formed.
G	Nitrogen dioxide is formed.

Write **five** of the letters **A** to **F** in the boxes to show the correct order in which nitrogen dioxide forms.

The last one has been done for you.

					G

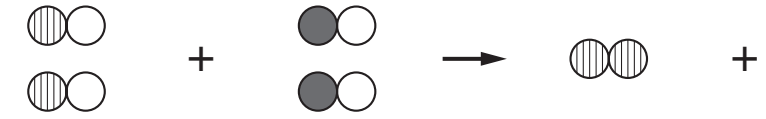
[2]

(c) Catalytic converters reduce the amount of nitrogen monoxide released from car engines.

The following reaction takes place.

nitrogen monoxide + carbon monoxide ⟶ nitrogen + carbon dioxide

Finish the diagram to show this reaction.



nitrogen monoxide | carbon monoxide | nitrogen | carbon dioxide

[2]

[Total: 9]

6 Propene is a hydrocarbon obtained from crude oil.

Propene can be polymerised to make poly(propene). This is also known as propylene.

(a) Propylene can be used to make many different products such as ropes, carpets and chairs.

How will the life cycle assessment (LCA) be different for the same propylene when used to make each of these products?

Put ticks (✓) in the boxes next to the **two** best answers.

There will be a difference in the …

… energy needed to make the propylene from crude oil. ☐

… sustainability of making the propylene from crude oil. ☐

… environmental impact of making the product from propylene. ☐

… environmental impact of using the product. ☐

… pollution caused by disposing of the propylene. ☐

[2]

(b) Complete these sentences about propylene.

Use words from this list.

atoms **burns** **catalyst** **chains**

energy **melts** **monomer** **plasticizer**

Propylene can be made more flexible by adding a …… This reduces the forces between the polymer …… so that less …… is needed for the molecules to slide past each other. This modification of the polymer also changes the temperature at which the polymer …… . **[2]**

(c) The properties of a polymer can be modified in a number of ways.

Which of the following will **decrease** the melting point of the polymer?

Put a tick (✓) in the box next to the correct answer.

Increasing the crystallinity of the polymer. ☐

Making the chain length of the polymer shorter. ☐

Heating and then cooling the polymer. ☐

Cross-linking the polymer chains. ☐

[1]

[Total: 5]

END OF QUESTION PAPER

PLEASE DO NOT WRITE ON THIS PAGE

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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.