

Candidate Forename						Candidate Surname					
Centre Number							Candidate Number				

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

A321/02

**TWENTY FIRST CENTURY SCIENCE
CHEMISTRY A**

Unit 1: Modules C1 C2 C3 (Higher Tier)

MONDAY 18 JANUARY 2010: Morning

DURATION: 40 minutes

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

Candidates answer on the Question Paper

A calculator may be used for this paper

OCR SUPPLIED MATERIALS:

None

OTHER MATERIALS REQUIRED:

Pencil

Ruler (cm/mm)

READ INSTRUCTIONS OVERLEAF

INSTRUCTIONS TO CANDIDATES

- **Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes on the first page.**
- **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.**
- **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.**

BLANK PAGE

Answer ALL the questions.

1 (a) (i) Nitrogen dioxide is a pollutant gas. One source is the exhaust gases of vehicles using petrol as a fuel.

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

Nitrogen from petrol reacts with oxygen from the air to make nitrogen monoxide.

Nitrogen from the air reacts with oxygen from the air to make nitrogen monoxide.

Nitrogen from the air reacts with oxygen from petrol to make nitrogen monoxide.

Nitrogen monoxide reacts with water vapour to make nitrogen dioxide.

Nitrogen monoxide reacts with oxygen from the air to make nitrogen dioxide.

Nitrogen from the air reacts with oxygen from the air to make nitrogen dioxide.

[2]

(ii) Nitrogen dioxide does not stay in the atmosphere.

Explain how nitrogen dioxide is removed from the air and why the result may be harmful.

[3]

(iii) New petrol-driven cars sold in the UK must be fitted with a catalytic converter.

This reduces the amount of nitrogen oxides and carbon monoxide given out by car exhausts.

Which statements explain how catalytic converters do this?

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

Carbon monoxide is converted to carbon dioxide.

Nitrogen dioxide reacts with carbon monoxide to produce nitrogen and carbon dioxide.

Nitrogen monoxide is decomposed into nitrogen and oxygen.

Carbon monoxide is decomposed into carbon and oxygen.

Nitrogen monoxide reacts with nitrogen dioxide to produce nitrogen and oxygen.

[2]

(b) When petrol burns completely in air, carbon dioxide and water are formed.

One of the hydrocarbons in petrol is heptane, C_7H_{16} .

Complete the boxes to show how many molecules of oxygen are used, and how many molecules of water are formed, when one molecule of heptane burns completely.



molecules of heptane	molecules of oxygen	molecules of carbon dioxide	molecules of water
1		7	

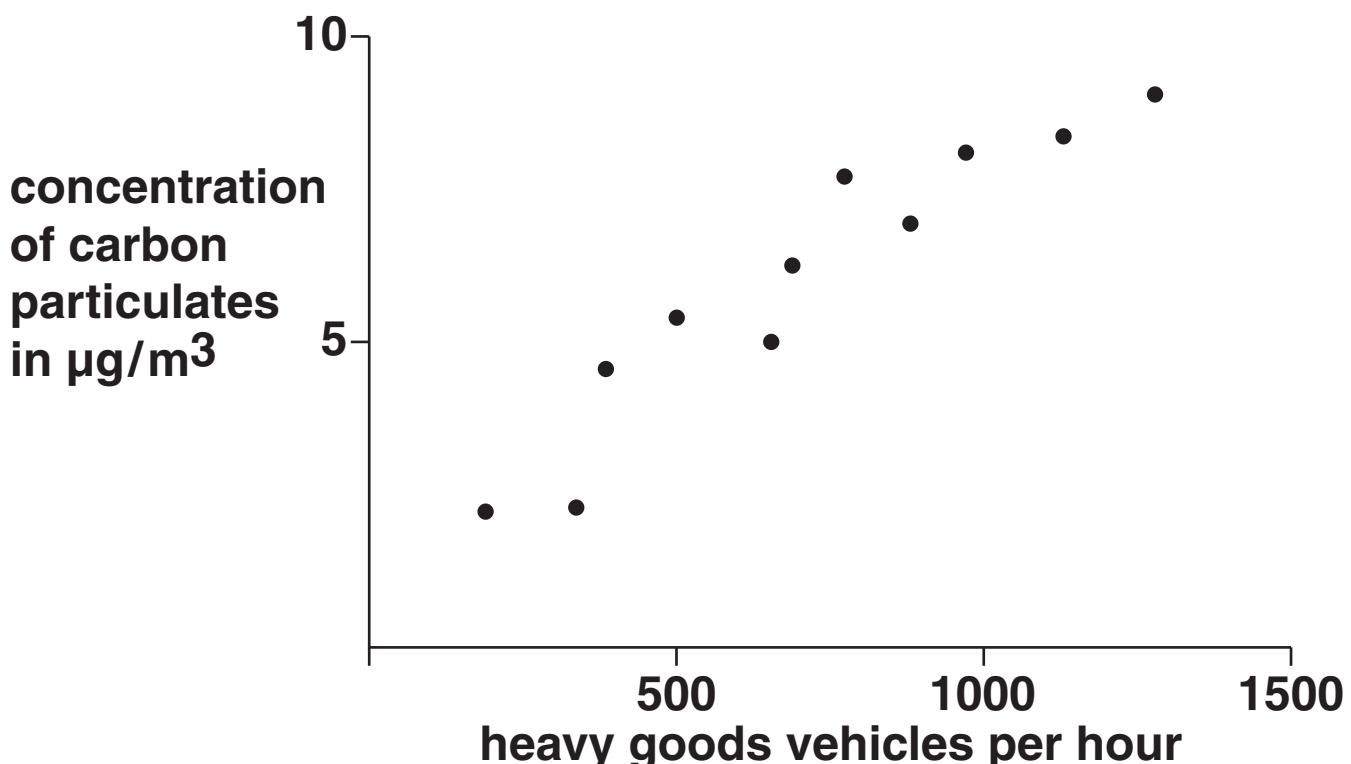
[2]

[Total: 9]

2 Black carbon pollution is caused by very small carbon particulates in the air.

Scientists measure the concentration of carbon particulates in the air beside a motorway. They also count the number of heavy goods vehicles passing along the motorway.

Their results are shown on this scatter graph.



(a) What trend is shown by the scatter graph?

[1]

(b) The scientists suggest that the carbon particulates come from diesel-fuelled heavy goods vehicles.

(i) Which of these statements support this suggestion?

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

Diesel fuel is used by all heavy goods vehicles but only a small proportion of cars.

Other scientists report similar results from investigations next to other roads.

Vegetation next to the motorway is covered with a layer of black soot.

When burned in a restricted supply of air, diesel fuel produces a smoky flame.

The number of heavy goods vehicles using the motorway at this time was higher than the number of cars.

[2]

(ii) The scientists suggest that black carbon pollution could be reduced by transporting goods using railways instead of roads.

Which of these statements, taken together, support their claim?

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

Some trains are powered by electric motors.

Some trains burn diesel fuel.

Coal-burning power stations produce carbon particulates.

Goods have to be taken to railway stations by road.

Particulates can be removed from the flue gases of coal-burning power stations.

[2]

[Total: 5]

BLANK PAGE

3 **Vulcanisation is a process that has been used for many years to make natural rubber harder.**

Scientists develop a new process for hardening rubber.

They test the hardness of this rubber by measuring the force needed to push a metal pin through several samples.

They use the same test on samples of natural rubber, vulcanised rubber and new process rubber.

All of the rubber samples are the same shape and size.

Their results are shown in the table opposite.

TYPE OF RUBBER	FORCE NEEDED TO PUSH PIN THROUGH SAMPLE IN kN				
	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 4	SAMPLE 5
natural rubber	4	6	8	7	2
vulcanised rubber	24	21	24	23	22
new process rubber	28	11	24	27	26
					25

(a) The scientists conclude that there is a REAL DIFFERENCE between the hardness of vulcanised rubber and new process rubber.

How do their results show this?

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

The value 26 kN is not in the range for vulcanised rubber.

The value 23 kN is not in the range for new process rubber.

The ranges for vulcanised rubber and new process rubber do not overlap.

The mean for new process rubber is higher than the mean for vulcanised rubber.

The range for new process rubber is larger than the range for vulcanised rubber.

[2]

(b) The scientists make sure that all measurements are taken at the same temperature using the same equipment.

Explain why these factors are controlled.

[2]

(c) (i) Natural rubber is a polymer.

During vulcanisation, sulfur reacts with the polymer chains in the rubber.

Suggest how this reaction with sulfur increases the hardness of rubber.

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

It makes the polymer chains shorter.

1

It lowers the melting point.

1

It pushes the polymer chains further apart.

1

It forms strong bonds between the polymer chains.

1

[1]

(ii) The new process for making natural rubber harder works in a different way to vulcanisation.

Which of these statements could explain how the new process makes natural rubber harder?

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

It decreases the cross-linking between polymer chains.

It adds plasticizer to the polymer chains.

It increases the length of the polymer chains.

It changes the small molecules used to make the polymer chains.

[1]

[Total: 6]

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4 Different materials are used to make bags to carry food.

(a) What features of the Life Cycle Assessment for a paper bag are different from those for a plastic bag?

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

The energy used to make the material.

The energy used to make bags from the material.

The energy used to transport the same mass of bags.

The environmental impact of using the bags.

The environmental impact of disposing of the bags.

[2]

(b) Ten years ago it was thought that using plastic bags to carry food home from a supermarket was a good idea. Now it is thought to be bad.

Suggest explanations for this CHANGE IN ATTITUDE.

[3]

(c) Most plastic supermarket bags are made from poly(ethene).

Poly(ethene) is also used to make plastic buckets.

Parts of the Life Cycle Assessment for a plastic supermarket bag are different from those for a plastic bucket.

Which of these statements explain these differences?

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

Plastic buckets are used for longer than supermarket bags before they are thrown away.

More supermarket bags are made than plastic buckets.

There is less poly(ethene) in a supermarket bag than in a plastic bucket.

Plastic buckets and supermarket bags are made from different polymers.

Supermarket bags are more likely to be dropped as litter than plastic buckets.

Plastic buckets have a higher density than supermarket bags.

[3]

[Total: 8]

5 Two hundred years ago all farmers in the UK used organic growing methods that included use of animal waste as a fertiliser.

Now most UK farmers use intensive farming methods that include use of synthetic fertiliser, though some farmers still use organic growing methods.

(a) Which statements suggest reasons why it would be difficult for farmers to produce enough food if they all used organic farming methods today?

Put ticks (✓) in the boxes next to the TWO best statements.

Synthetic fertiliser supplies essential elements needed by crops that are not contained in animal waste.

The population in the UK is much larger now than it was two centuries ago.

More land is used for farming now than two centuries ago.

People now eat different food to that eaten two centuries ago.

Crops grown using intensive farming methods produce higher yields for the same area of land used.

Animal waste has an unpleasant smell, but synthetic fertiliser does not.

[2]

(b) Some people think that all food grown in the UK should be produced using organic methods.

Which **TWO** statements, when put together, suggest why this idea is a good idea but not technically feasible?

Put a tick (✓) in the box next to the correct statement in each column.

one
tick
(✓)

one
tick
(✓)

	Organic farming is more sustainable	but	animal waste contains toxic chemicals.	
	Organic food has more vitamins		synthetic fertiliser improves soil condition.	
	Organic food looks better		there is not enough animal waste to provide sufficient fertiliser.	
	Organic food is cheaper to produce		synthetic fertiliser kills pests.	

[2]

(c) The statements give reasons why some people may prefer to buy carrots grown using organic methods rather than intensive methods.

Which statements are good reasons why?

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

Organically grown carrots are bigger.

Organically grown carrots always contain more essential minerals.

Organically grown carrots have been produced with less damage to the environment.

Intensively grown carrots may contain toxic pesticide residues.

Intensively grown carrots may contain toxic residues from synthetic fertiliser.

Intensively grown carrots always contain fewer vitamins.

[2]

[Total: 6]

6 Sodium benzoate is added to many soft drinks, such as cola, as a preservative.

(a) Sodium benzoate has the number E211. What does this mean?

Put ticks (✓) in the boxes next to the TWO correct answers.

Sodium benzoate should not be used in food products.

Sodium benzoate has passed a safety test.

Sodium benzoate has been approved for use in the EU.

Sodium benzoate is safe to use at any concentration.

Sodium benzoate can only be used in drinks.

[2]

(b) Some people are worried about soft drinks that contain sodium benzoate.

Which TWO of these statements suggest that sodium benzoate in soft drinks does NOT pose a significant health risk?

Put ticks (✓) in the boxes next to the TWO BEST statements.

Little research has been carried out on the effects of sodium benzoate on health.

Sodium benzoate is found naturally in some fruits.

Soft drinks contain much lower concentrations of sodium benzoate than some food.

Sodium benzoate has been added to soft drinks for many years.

You would have to drink about ten litres of soft drinks to exceed the maximum recommended dose of sodium benzoate in one litre of drinking water.

[2]

(c) People have to make a choice whether to drink products containing sodium benzoate or not.

(i) What two pieces of information do people need in order to choose whether to take the risk of being harmed by sodium benzoate?

_____ [2]

(ii) A family has decided to take a precautionary approach to the food and drinks that they buy.

Explain why this family might decide NOT to buy soft drinks containing sodium benzoate.

[2]

[Total: 8]

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 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	4 He helium 2
23 Na sodium 11	24 Mg magnesium 12	27 Al aluminum 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	20 Ne neon 10
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
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
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
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[268] Bh bohrium 107	[271] Ds darmstadtium 109
						[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.