

**Advanced Subsidiary GCE  
CHEMISTRY B (SALTERS)**

**F332 QP**

Unit F332: Chemistry of Natural Resources

**Specimen Paper**

Candidates answer on the question paper.

Time: 1 hour 45  
minutes

Additional Materials:

Data Sheet for Chemistry B (Salters) (Inserted)  
Advance Notice article (Inserted)  
Scientific calculator

Candidate  
Name

Centre  
Number

--	--	--	--	--


Candidate  
Number

--	--	--	--

**INSTRUCTIONS TO CANDIDATES**

- Write your name, Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED.

**INFORMATION FOR CANDIDATES**

- The number of marks is given in brackets [] at the end of each question or part question.
-  Where you see this icon you will be awarded marks for the quality of written communication in your answer.
- You may use a scientific calculator.
- The insert 'Getting tired with chemistry!' is provided for use with question 5.
- A copy of the *Data Sheet for Chemistry B (Salters)* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **100**.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	18	
2	10	
3	28	
4	24	
5	20	
<b>TOTAL</b>	<b>100</b>	

This document consists of **13** printed pages, **3** blank pages, a *Data Sheet for Chemistry B (Salters)* and an *Advance Notice insert 'Getting tired with chemistry!'*.

Answer **all** the questions.

1 Chlorine,  $Cl_2$ , can be used as a disinfectant for water. Chlorine is transported in pressurised containers.

(a) Explain, in terms of intermolecular bonds, why chlorine is a gas at room temperature and pressure.

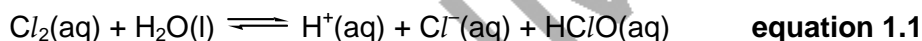
 *In your answer, you should use appropriate technical terms, spelled correctly.*

.....  
 .....  
 ..... [2]

(b) In the event of an accident when chlorine is being transported, people living near the accident site are evacuated. Give **two** properties of chlorine that makes this necessary.

1.....  
 .....  
 2.....  
 ..... [2]

(c) A student bubbled some chlorine through water. The chlorine reacted with the water as shown below.

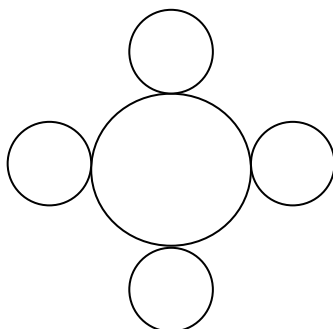


(i) The student added some solid sodium chloride to the solution of chlorine in water. Use le Chatelier's principle to describe and predict what would happen to the concentration of  $Cl_2(aq)$ .

.....  
 .....  
 .....  
 .....  
 .....  
 .....  
 ..... [3]

- (ii) The diagram below shows part of a layer of a sodium chloride lattice.

Label each type of particle and complete the diagram with enough particles to show the structure of the layer clearly.



[2]

- (iii) Sodium, like other elements in Group I, readily forms 1+ ions. Explain, in terms of ionisation enthalpies, why this is so and why sodium is unlikely to form compounds containing  $\text{Na}^{2+}$  ions.

.....  
 .....  
 .....  
 .....

[2]

- (d) (i) Give the oxidation states of chlorine in  $\text{Cl}_2$  and  $\text{HClO}$ .

$\text{Cl}_2$ .....

$\text{HClO}$ ..... [2]

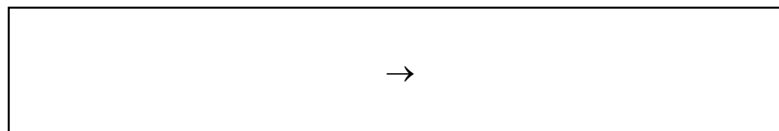
- (ii) Give the name of the process in which  $\text{Cl}_2$  is changed into  $\text{HClO}$ .

..... [1]

- (iii) Explain your choice of answer in (ii).

..... [1]

- (iv) Write a **half-equation** that shows what happens to the chlorine molecules in **equation 1.1** that are converted into chloride ions.



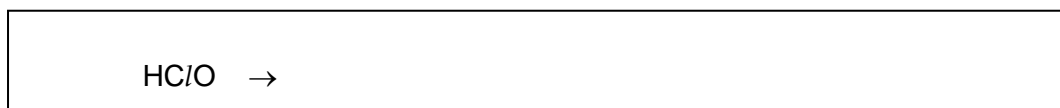
[1]

- (e) When a solution of chlorine in water behaves as a disinfectant, the active chemical is  $\text{HClO}$ .

The disinfecting power decreases when the solution is exposed to sunlight because  $\text{HClO}$  decomposes to form oxygen and a solution of hydrochloric acid.

Complete the balanced chemical equation for this reaction below.

[2]



[Total: 18]


[Turn over]

2 There is considerable concern over rising carbon dioxide levels that most scientists think are causing global warming. This concern has prompted the British Government to charge less in road fund tax for cars that produce less carbon dioxide.

- (a) Cars are now more fuel efficient than they used to be and so they produce less carbon dioxide. Suggest **one** design feature that has made cars more fuel efficient.

.....  
 ..... [1]

- (b) Greenhouse gases like carbon dioxide absorb infrared radiation in the troposphere. Explain the source of this infrared radiation and suggest what happens to a molecule of carbon dioxide when it absorbs this radiation.

 *In your answer you should make clear how your explanation links with the chemical theory.*

.....  
 .....  
 .....  
 .....  
 ..... [5]

- (c) The Earth's oceans act in a way that regulates the increase in carbon dioxide levels in the troposphere. An equilibrium is set up between gaseous and aqueous carbon dioxide.

- (i) Suggest and explain why the balance between gaseous and aqueous carbon dioxide is not a true equilibrium.

.....  
 ..... [1]

- (ii) Suggest **two** possible methods that could be used for the capture and storage of carbon dioxide, to prevent its build-up in the atmosphere.

1.....  
 .....  
 2.....  
 ..... [2]

- (iii) For **one** of your methods in (ii), suggest an environmental impact that could arise from its use.

..... [1]

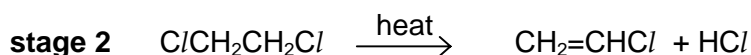
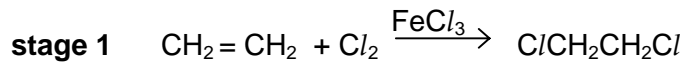
[Total: 10]

3 The polymer commonly known as PVC exists in two forms. Plasticised PVC is used where flexibility is required. Unplasticised PVC, uPVC, is rigid at room temperature and is used to make things such as guttering for houses.

(a) Suggest **one** other use for uPVC in the construction of a house.

..... [1]

(b) PVC is manufactured by polymerising chloroethene. Chloroethene is produced in a two stage synthesis as outlined below.



(i) Underline **two** of the following words to describe the reaction in **stage 1**.

**addition electrophilic elimination nucleophilic radical substitution**

[2]

(ii) Select **one** word from the list to describe the reaction in **stage 2**.

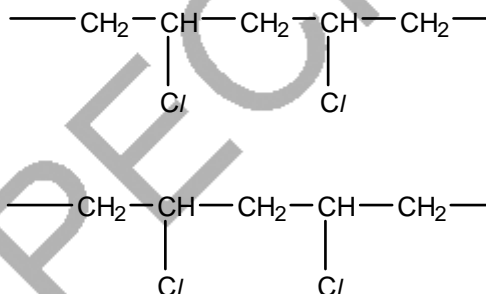
..... [1]

(c) PVC owes many of its properties to the intermolecular bonds between the polymer chains.

(i) Name the strongest type of intermolecular bond that is present in PVC.

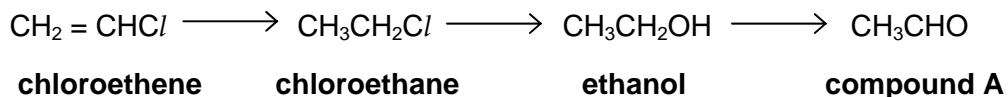
..... [1]

(ii) Use the diagram below to show how these intermolecular bonds hold the PVC chains together.



[2]

(d) Chloroethene will also undergo the following sequence of reactions.



(i) Name the reagent and conditions needed to turn **chloroethene** into **chloroethane**.

.....  
 ..... [2]

(ii) Classify **ethanol** as primary, secondary or tertiary, giving a reason.

.....  
 ..... [2]

(iii) Name the functional group in **compound A**.

..... [1]

(iv) Give the reagents and conditions for the conversion of **ethanol** to **compound A** in the laboratory.

.....  
 .....  
 ..... [3]

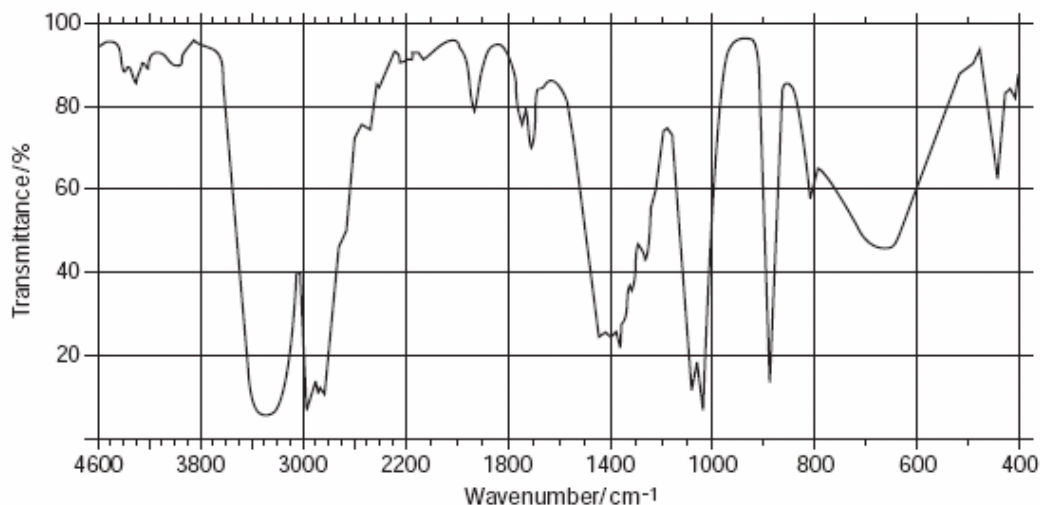
(e) In a laboratory experiment, 10 g of chloroethene,  $\text{CH}_2\text{CHCl}$ , produced 1.5 g of ethanol,  $\text{CH}_3\text{CH}_2\text{OH}$ .

Work out the percentage yield of the conversion of chloroethene to ethanol.

Give your answer to **two** significant figures.

yield = .....% [5]

- (f) Infrared spectroscopy was carried out on the product formed in the reaction of chloroethene to give ethanol. The spectrum that was produced is shown below.



- (i) Use information from this spectrum to explain how it confirms that an alcohol had been produced.

..... [1]

- (ii) Suggest how you would be able to confirm, using infrared spectroscopy, that the product was ethanol.

.....  
 .....  
 ..... [2]

- (g) Much of the ethanol is made industrially from ethene.

- (i) Give the reagents and conditions by which ethanol is made from ethene in industry.

.....  
 ..... [2]

- (ii) The reaction in which ethanol is produced from ethene involves attack by an electrophile. Explain what is meant by the term *electrophile*.

.....  
 ..... [2]

- (iii) Suggest a reason, other than cost, why ethanol is **not** manufactured from chloroethene.

.....  
 ..... [1]

[Total: 28]

[Turn over

4 Hydrofluorocarbons, HFCs, have replaced CFCs for many of their uses. They are broken down in the troposphere before they have time to reach the stratosphere.

(a) (i) Give the formula of a CFC.

..... [1]

(ii) CFCs were used as the refrigerant in domestic fridges. The presence of CFCs makes disposing of old fridges difficult. Give **one** property of CFCs that made them suitable as refrigerants.

.....  
..... [1]

(b) CFCs cause depletion of the ozone layer. Describe how they do this.

.....  
.....  
.....  
.....  
..... [4]

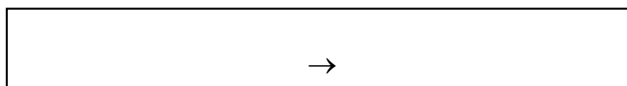
(c) Initially, studies of changes in the Earth's atmosphere did not reveal the problem of ozone depletion. Explain why the information about ozone depletion was overlooked.

.....  
.....  
..... [2]

(d) Other atmospheric pollutants can contribute to a build-up in tropospheric ozone. For example, hydrocarbons can interfere with the normal reactions for the formation and breakdown of ozone. The reaction for the breakdown of ozone involves naturally occurring  $\text{NO}_2$  and  $\text{NO}$ .



(i) Combine **two** of these equations to show how ozone is broken down.



[1]



- (ii) Hydrocarbons lead to reactions in which NO is converted into NO<sub>2</sub>. Explain how this leads to a build-up of ozone.

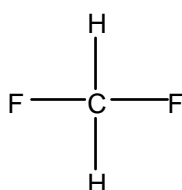
.....  
.....  
..... [2]

- (iii) Suggest **one** disadvantage of a build-up of tropospheric ozone.

.....  
..... [1]

- (e) One example of an HFC is CH<sub>2</sub>F<sub>2</sub>. The C–F bond is polar.

- (i) Mark partial charges on the C and F atoms in the structure below.



[1]

- (ii) Explain what determines where the partial charges are placed on this molecule.

.....  
.....  
..... [2]

- (iii) Does the whole molecule have a dipole? Explain your answer.

.....  
..... [2]

(f) If molecules of  $\text{CH}_2\text{F}_2$  reach the stratosphere, they do not break down to produce F radicals.

(i) Suggest why C–F bonds are not broken in the stratosphere.

.....  
..... [2]

(ii) The bond enthalpy of the C–F bond is  $+467 \text{ kJ mol}^{-1}$ .

Calculate the minimum energy (in joules) needed to break a single C–F bond.

Avogadro constant,  $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$

minimum energy = ..... [2]

(iii) Calculate the minimum frequency of radiation needed to break a C–F bond.

Give the appropriate units for your answer.

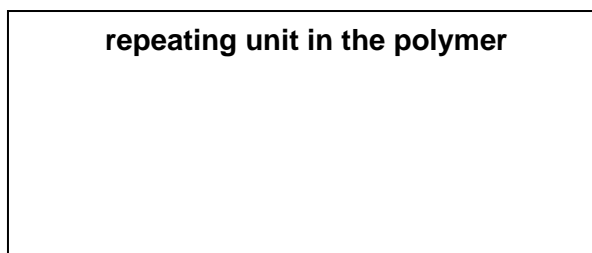
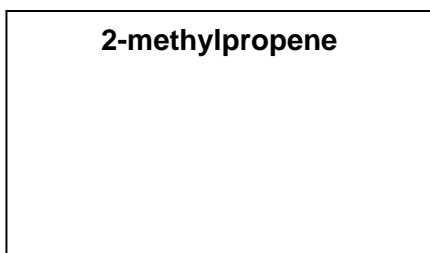
Planck constant,  $h = 6.63 \times 10^{-34} \text{ J Hz}^{-1}$ .

minimum frequency = .....  
units..... [3]

[Total: 24]

5 This question is based on the Advance Notice article 'Getting tired with chemistry!' which is provided as an insert to this paper.

- (a) (i) Draw the structural formula of 2-methylpropene and the formula of the repeating unit of the rubber formed from it.



[3]

- (ii) Suggest the formula of the repeating unit of the rubber formed from butadiene and styrene that has one double bond per butadiene remaining (**Fig. 2**). Include one unit of butadiene and one unit of styrene.

[2]

- (iii) Describe a simple chemical test that might enable you to distinguish between the rubbers in parts (i) and (ii).

.....  
 .....  
 ..... [3]

- (b) Draw the structure of the repeating unit of *trans* poly(isoprene).

[1]

- (c) Explain why *trans* poly(isopropene) cannot be rotated to give *cis* poly(isopropene).

.....  
 ..... [1]

- (d) Explain the meaning of the term *thermoplastic*.

.....  
 .....  
 ..... [1]

[Turn over]

(e) Suggest how ultraviolet light might affect rubber.

.....  
.....  
.....  
..... [3]

(f) Vulcanisation improves the properties of rubber and accelerator molecules catalyse the process.

Use information from the article about polymer structures and your knowledge of catalysts to explain this.

*In your answer you should make clear how your explanation links with the chemical theory.*

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
..... [6]

[Total: 20]

Paper Total [100]

SPECIMEN

END OF QUESTION PAPER

SPECIMEN

*Copyright Acknowledgements:*

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (OCR) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest opportunity.

OCR is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2007

Advanced Subsidiary GCE  
**CHEMISTRY B (SALTERS)**

**F332**

Advance Notice

**Specimen**



### Information for Candidates

- 1 This leaflet contains an article, which is needed in preparation for Question 5 in the externally assessed examination **F332**.
- 2 You will need to read the article carefully and also have covered the learning outcomes for unit F332 (Chemistry of Natural Resources).
- 3 You will be expected to apply your knowledge and understanding of the work covered in the unit to answer this question. There are 20 marks available on the paper for this question.
- 4 You can seek advice from your teacher about the content of the article and you can discuss it with others in your class. You may also investigate the topic yourself using any resources available to you.
- 5 You will not be able to bring your copy of the article, or other materials, into the examination. The examination paper will contain a fresh copy of the article as an insert.
- 6 You will not have time to read this article for the first time in the examination if you are to complete the examination paper within the specified time. However, you should refer to the article when answering the questions.

This document consists of 4 printed pages.

## Getting tired with chemistry!

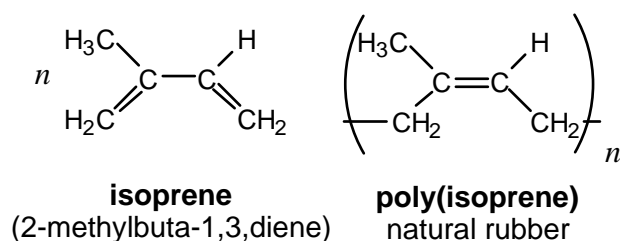
Adapted from © Chris Ferguson, *Chemistry Review*, 2002, Volume 11, Issue 4, 'Getting Tired with Chemistry'.

Next time you are out on a mountain bike, in a car or even an aeroplane, stop and think about the chemistry involved in the tyres you are travelling on. Those tyres are pneumatic tyres containing compressed air and, on your vehicle, they perform a variety of functions. Since the Scotsman, Robert William Thompson, filed the first patent for a pneumatic tyre in 1845, tyre technology has developed a huge amount – and many of these improvements are due to chemistry.

Typically, a rubber tyre is composed of rubbers (both natural and synthetic), carbon black, oils and resins, curing agents and anti-ageing chemicals. No tyre is complete without all of these components and each one has a varied and interesting chemistry.

**Natural rubber** Natural rubber can be obtained from bushes from many parts of the world (e.g. Brazil, Sri Lanka and Malaysia). However, by far the best and most widely used source is the *Hevea brasiliensis* tree originating from South America. The rubber is obtained as **latex**, a colloidal dispersion of nanoscale rubber particles in water. At the beginning of the twentieth century, C. D. Harries showed that natural rubber consists of repeating units. It was initially believed that the structural units were joined to form rings, but it was soon established that they are joined in long chains. These chains have the structure shown in **Fig. 1** – and can be produced synthetically by joining isoprene (2-methylbuta-1,3-diene) units to give a polymer structure.

In natural rubber, the configuration across the double bond is 98% *cis*. This *cis* arrangement gives rise to rubber's property of increasing in strength when stretched, by allowing the chains to form **crystalline regions**. Notice that the addition polymerisation of natural rubber is not a simple reaction, such as happens when ethene polymerises. *Two* double bonds in isoprene open to form a polymer that contains *only one* double bond in its



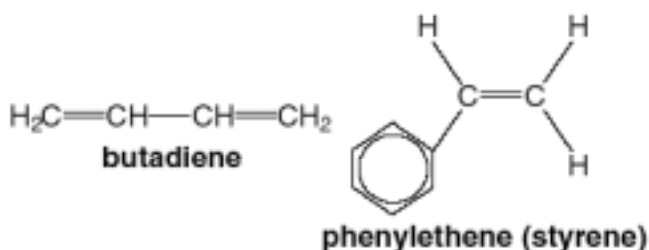
**Fig. 1** The structure of the isoprene monomer and natural rubber

repeating unit. Natural rubber has many limitations. It cannot be used on its own to make tyres due to its thermoplastic nature. It would become very hard in the winter and during the summer it would melt into a sticky, smelly mess. Imagine riding a bicycle that would stick to the road in summer! Fortunately the problem of its thermoplastic nature is overcome by 'curing' natural rubber by heating with sulfur, as described in a later paragraph.

**Synthetic rubber** Synthetic rubber was first produced by carrying out the polymerisation of dienes (alkenes containing two double bonds) in the laboratory. Since it is impossible to recreate the exact conditions for natural rubber synthesis, the laboratory-based syntheses initially gave poor quality products. For example, early attempts at polymerising isoprene in the laboratory gave synthetic rubber as a mixture of *cis* and *trans* isomers. The best synthetic rubber is a **co-polymer**, obtained by combining a diene and an alkene. Thus polymerisation of butadiene with phenylethene (styrene) gives the copolymer, styrene-butadiene rubber (SBR), **Fig. 2**.

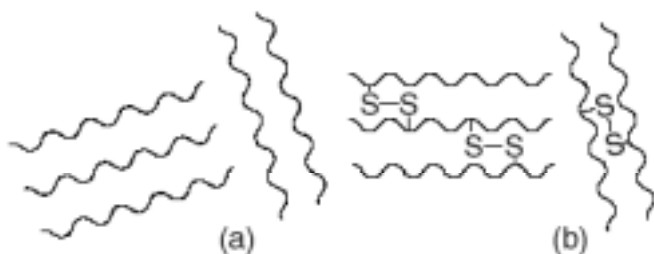
To produce this 'natural-like' synthetic rubber, a process called emulsion polymerisation is used. In this process, butadiene and styrene are polymerised in water with a surfactant to give a colloidal dispersion of the polymer in water. This process is often done at 5 °C (rather than above 50 °C, as is more normal for an emulsion polymerisation) to give the desired rubber properties. Another variety of synthetic rubber is known as butyl rubber and is produced by polymerising

2-methylpropene. The polymer in this case is a saturated hydrocarbon. Nowadays, many types of synthetic rubber are available for use in tyres.



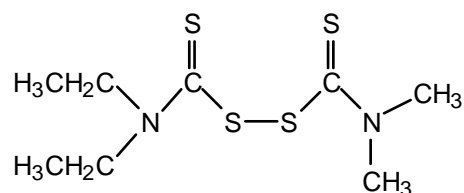
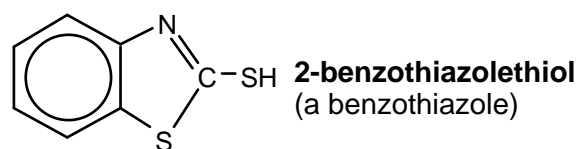
**Fig. 2** Structures of monomeric building blocks

**Curing agents** In 1839, Charles Goodyear discovered, accidentally, that heating rubber and sulfur together produced a new version of rubber that did not flow or become sticky at higher temperatures. This process of sulfur curing is called **vulcanisation** after Vulcan, the Roman God of fire. The chemical process of vulcanisation is called **cross-linking** and it changes the property of rubber to the hard, durable material we associate with car and bike tyres. **Fig. 3** shows a schematic diagram of cross-linking.



**Fig. 3** Sulfur

This produces a more rigid structure, which limits the movement of polymer chains. Unfortunately, vulcanisation with sulfur is a slow process, taking about 8 hours for the rubber to cure. A typical car tyre is cured for 15 minutes at 150 °C. However, the time can be reduced by the addition of accelerators such as those shown in **Fig. 4**.



**Fig. 4** Accelerator molecules

Accelerators increase the rate of cure by catalysing the addition of sulfur chains to the rubber molecules.

**Anti-ageing chemicals** A tyre is subjected to quite harsh operating conditions. Factors such as heat, fatigue, weathering and exposure to ultraviolet light all reduce the life of a tyre. You will probably be aware of the effect sunlight has on a rubber band. Therefore, various chemicals are added to prevent tyre degradation.

**Tyred out!** Tyres are very important in all our lives and it is likely that they will continue to be so for the foreseeable future. An important question is 'where do all the used tyres go?' Tyres are inherently strong and this makes them almost impossible to destroy after use. In the USA, 250 million used tyres are produced each year and at the moment most (about 75%) are simply buried in landfill. But this and other methods of disposal can have a serious impact on the environment. Some tyres are recycled to make products such as cushioned surfaces for childrens' playgrounds. An exciting project for chemists of the future would be to develop an environmentally friendly tyre.



## Information for Teachers

- 1 This Advance Notice material should be issued to candidates on or after the date shown on the front cover of the candidate instructions sheet at the discretion and convenience of the Centre. Candidates can be given the material at any point, but it is suggested that this should be **at least four weeks** before the examination date.
- 2 Candidates will need to read the article carefully. Time can be built into the teaching programme to introduce the article content. Candidates should be able to discuss the article freely and be given support and advice in the interpretation of the content so that they are able to answer the question based on the article in the externally assessed examination. Candidates should also be encouraged to investigate the topics covered in the article for themselves.
- 3 Candidates will be expected to apply their knowledge and understanding of unit F332 to the question based on the article. There are 20 marks available on the paper for this question.
- 4 The Advance Notice material **must not** be taken into the examination. The examination paper will contain a fresh copy of the article, as an insert to the paper. Candidates should be reminded that they do not have sufficient time during the examination to read the article for the first time. They should, however, refer to the article printed in the insert in the examination paper to help them to answer the questions.

SPECIMEN

### *Copyright Acknowledgements:*

#### *Sources*

*Adapted from © Chris Ferguson, Chemistry Review, 2002, Volume 11, Issue 4, 'Getting Tyred with Chemistry'.*

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (OCR) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest opportunity.

OCR is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.