# Advanced Subsidiary GCE Subject Chemistry B (Salters)

## Unit F332: Chemistry of Natural Resources - Medium banded Candidate style answer

**Introduction**

OCR has produced these candidate style answers to support teachers in interpreting the assessment criteria for the new GCE specifications and to bridge the gap between new specification release and availability of exemplar candidate work.

This content has been produced by senior OCR examiners, with the input of Chairs of Examiners, to illustrate how the sample assessment questions might be answered and provide some commentary on what factors contribute to an overall grading. The candidate style answers are not written in a way that is intended to replicate student work but to demonstrate what a "good" or "excellent" response might include, supported by examiner commentary and conclusions.

As these responses have not been through full moderation and do not replicate student work, they have not been graded and are instead, banded "medium" or "high" to give an indication of the level of each response.

Please note that this resource is provided for advice and guidance only and does not in any way constitute an indication of grade boundaries or endorsed answers.

**1(a) question Chlorine, $Cl_2$, can be used as a disinfectant for water. Chlorine is transported in pressurised containers.**
**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, spelt correctly. [2]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *There are id-id bonds between the molecules. These are weak.* | The candidate is close to scoring both marks but does not give enough detail in either case. 'id-id' must always be expanded to 'instantaneous dipole-induced dipole' and the second marking point should be related to the boiling point, for example by adding after 'weak bonds' 'so little energy is needed to break them'. |

**(b) In the event of an accident when chlorine is being transported, people living near the accident site are evacuated. Give <u>two</u> properties of chlorine that make this necessary. [2]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *it is toxic and is thus dangerous* | This is partially correct but it really says the same thing twice, so it scores one mark out of two. The second mark was for saying that chlorine is a gas (and thus likely to spread). |

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

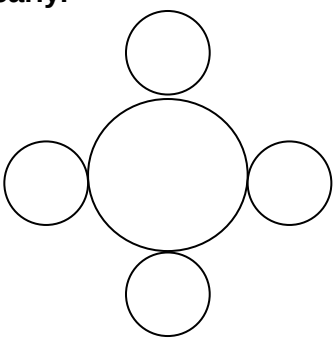
$Cl_2$ (aq) + $H_2O$ (l) $\rightleftharpoons$ $H^+$ (aq) + $Cl^-$ (aq) + HClO (aq) ***equation 1.1***

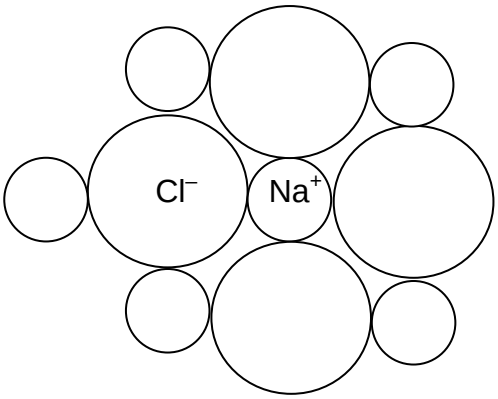
**(i)** **The student added some solid sodium chloride to the solution of chlorine in water. Use Le Chatelier's principle to describe and predict what would happen to the concentration of $Cl_2$(aq).** **[3]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *the reaction moves to the left so that more chlorine is formed.* | The answer to part **(i)** lacks detail. The first mark was for saying why the equilibrium moved (increased chloride concentration) and this is not given. The second mark must refer to the equilibrium moving to the left to score. . |

**(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]**



| *Candidate style answer* | *Examiner's commentary* |
|---|---|
|  | Part **(ii)** is correct. |

| **(iii) Sodium, like other elements in Group I, readily forms 1+ ions. Explain why this is so and why sodium is unlikely to form compounds containing $Na^{2+}$ ions. [2]** | |
|---|---|
| *Candidate style answer* | *Examiner's commentary* |
| *sodium has a very high second ionisation energy, as this involves breaking into a full shell* | Part **(iii)** is a partial answer, answering the second part of the question well but ignoring the first (why sodium forms 1+ ions). The candidate should have added "the first ionisation enthalpy is low" to score this mark. |

| **(d)(i) Give the oxidation states of chlorine in $Cl_2$ and HClO. [2]** | |
|---|---|
| *Candidate style answer* | *Examiner's commentary* |
| *0 +1* | The first two parts are correct and score full marks. |
| **(ii) Give the name of the process in which $Cl_2$ is changed into HClO. [1]** | |
| *Candidate style answer* | *Examiner's commentary* |
| *oxidation* | Correct answer. |
| **(iii) Explain your choice of answer in (ii). [1]** | |
| *Candidate style answer* | *Examiner's commentary* |
| *gain of electrons* | Part **(iii)** is the wrong way round, gain of electrons is reduction. The candidate would have done better to have related the answer to the oxidation state change here rather than trying to remember a definition (and getting it the wrong way round). |
| **(iv) Write a half-equation that shows what happens to the chlorine molecules in equation 1.1 that are converted into chloride ions. [1]** | |
| *Candidate style answer* | *Examiner's commentary* |
| *$Cl + e^- \rightarrow Cl^-$* | In part **(iv)**, the candidate has shown chlorine atoms not molecules reacting and thus does not score. |

**(e) When a solution of chlorine in water behaves as a disinfectant, the active chemical is HC*l*O.**

**The disinfecting power decreases when the solution is exposed to sunlight because HC*l*O decomposes to form oxygen and a solution of hydrochloric acid.**

**Complete the balanced chemical equation for this reaction below. [2]**

HClO $\rightarrow$

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *HClO → HCl + O2* | This has the correct species but is not balanced. |

**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]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *use of lean burn engines* | This is one of many possible correct answers. |

**(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. [5]**

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

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *The Sun warms the Earth which emits IR which causes the bonds in the carbon dioxide to vibrate.* | The candidate is on the right track but has not always given the required detail. To score the first mark, the radiation from the Sun needs to be named (mainly uv). The warm Earth emitting IR scores one mark, and the reference to the bonds vibrating scores another. The 'quality of written communication' mark is scored for the link between the warm Earth, the IR and the bonds vibrating. Thus three marks have been scored. The last mark was for saying that the bonds vibrate <u>more</u> when they absorb IR. |

**(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]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *CO2 gas can move away from the surface* | Correct answer |

**(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. [2]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *pump it underground; pump it on to the Ocean floor* | Correct answer |

**(iii) For <u>one</u> of your methods in (ii) suggest an environmental impact that could arise from its use. [1]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *react with rocks to form carbonates* | All these are acceptable answers. |

**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 <u>one</u> other use for uPVC in the construction of a house. [1]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *windows* | This is vague and does not score the mark. Window <u>frames</u> would have scored, though. |

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

**stage 1** $CH_2 = CH_2 + Cl_2 \xrightarrow{FeCl_3} ClCH_2CH_2Cl$

**stage 2** $ClCH_2CH_2Cl \xrightarrow{heat} CH_2 = CHCl + HCl$

**(i) Underline two of the following words to describe the reaction in <u>stage 1</u>. [2]**

**addition electrophilic elimination nucleophilic radical substitution**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *nucleophilic addition* | Part **(i)** should be 'electrophilic addition'. |

**(ii) Select <u>one</u> word from the list to describe the reaction in <u>stage 2</u>. [1]**

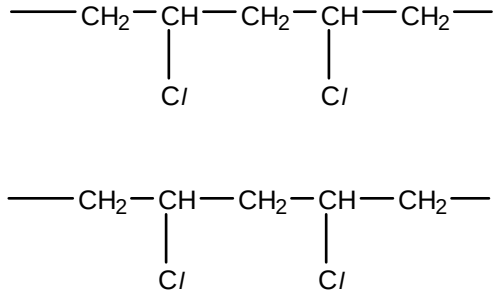
| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *radical* | Part **(ii)** should be 'elimination' so it does not score. |

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

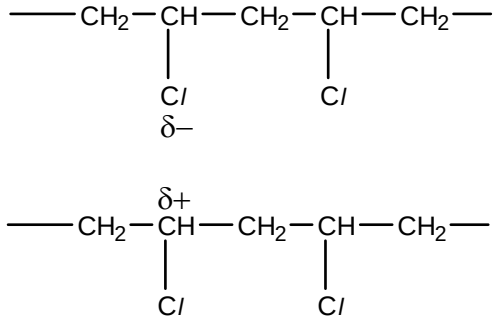
**(i) Name the strongest type of intermolecular bond that is present in PVC. [1]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *permanent dipole permanent dipole bonds* | Part **(i)** is correct. The candidate has not abbreviated here as was done for 'instantaneous dipole-induced dipole' above. |

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



**[2]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
|  | The diagram in part **(ii)** shows the correct polarities but does not show clearly where the attraction occurs. A dotted line is needed between the δ+ and δ–. |

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

**$CH_2 = CHCl \longrightarrow CH_3CH_2Cl \longrightarrow CH_3CH_2OH \longrightarrow CH_3CHO$**

**chloroethene chloroethane ethanol compound A**

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

**[2]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *hydrogen chloride and heat* | Part **(i)** does not score, as a more careful examination of the substances would indicate that <u>hydrogen</u> needs to be added |

**(ii) Classify <u>ethanol</u> as primary, secondary or tertiary, giving a reason.** **[2]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *primary, since it has CH2OH* | Part **(ii)** is correct. |

**(iii) Name the functional group in <u>compound A</u>.** **[1]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *aldehyde* | Part **(iii)** is correct. |

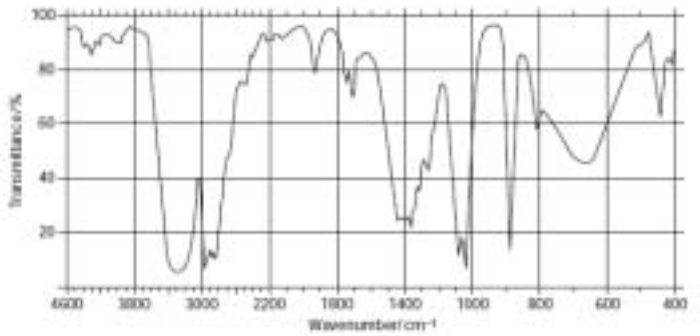
**(iv) Give the reagents and conditions for the conversion of <u>ethanol</u> to <u>compound A</u> in the laboratory. [3]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *heat with potassium dichromate(VI)* | Part (**iv)** scores one for the reagent but *distillation* is needed here not 'heat' (which is too vague). Also the reagent needs to be acidified. |

**(e) In a laboratory experiment, 10g of chloroethene, $CH_2CHCl$, produced 1.5g of ethanol, $CH_3CH_2OH$.**
**Work out the percentage yield of the conversion of chloroethene to ethanol.**
**Give your answer to <u>two</u> significant figures. [5]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *% = 1.5x100/10 = 15%* | This answer is based on a misconception. To calculate the percentage yield, the expected mass of ethanol must be calculated by a mole calculation and then the percentage evaluated. This answer scores one mark for manipulating the percentage correctly. It scores another for the correct number of significant figures. |

**(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]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *There is a peak which shows the presence of an O–H group.* | The answer to part **(i)** does not score as the peak has not been identified, either by pointing it out on the spectrum or by giving its value. |

**(ii) Suggest how you would be able to confirm, using infrared spectroscopy, that the product was ethanol. [2]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *Compare with spectrum of known sample of ethanol.* | Part **(ii)** scores one mark but more detail is needed for the second – for example and indication that the 'fingerprint' region below 1400 $cm^{-1}$ is the important area to compare. |

**(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]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *water with a catalyst of phosphoric acid* | Part **(i)** is correct. |

**(ii) The reaction in which ethanol is produced from ethene involves attack by an electrophile. Explain what is meant by the term *electrophile*. [2]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *an electron lover* | Part **(ii)** is too informal and does not score. An electrophile is best explained as a reagent that attacks a negative area and then accepts a pair of electrons form it to form a bond. |

**(iii) Suggest a reason, other than cost, why ethanol is not manufactured from chloroethene. [1]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *low yield* | Part **(iii)** is correct. |

**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]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *CCl2F2* | Correct answer |

**(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]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *they are non-toxic* | Correct answer |

**(b) CFCs cause depletion of the ozone layer. Describe how they do this. [4]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *CFCs break down to form Cl radicals that cause the breakdown of ozone* | This answer is vague and misses several of the marking points. It is necessary to say that the breakdown is <u>in the stratosphere</u> and is caused by <u>high-energy uv</u> to score the first two marks. 'Cl radicals' score the third marking point, but, to score the fourth, it is necessary to say that they <u>catalyse</u> the breakdown of ozone. |

**(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]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *the readings were so low the computers ignored them* | This answer is essentially correct and scores two marks. |

**(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 $NO_2$ and NO.**

**$NO_2 \xrightarrow{hv} NO + O$** **equation 4.1**

**$NO + O_3 \rightarrow NO_2 + O_2$** **equation 4.2**

**$O + O_2 \rightarrow O_3$** **equation 4.3**

**(i) Combine two of these equations to show how ozone is broken down. [1]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *$O3 + NO \rightarrow O2 + NO2$* | |

**(ii) Hydrocarbons lead to reactions in which NO is converted into $NO_2$. Explain how this leads to a build-up of ozone. [2]**

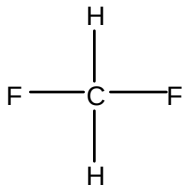
| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *less ozone is broken down as hydrocarbons provide an alternative to equation 4.2* | |

**(iii) Suggest one disadvantage of a build-up of tropospheric ozone. [1]**

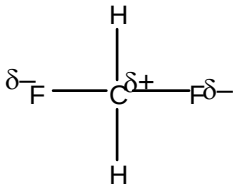
| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *people with asthma have breathing difficulties* | Part **(i)** is incorrect and does not score the mark. If the top two equations are added together, all the NO and $NO_2$ molecules cancel and we are left with $O_3 \rightarrow O_2 + O$. Part **(ii)** is a good answer and scores two marks. Part (**iii**) is correct and scores the mark. |

**(e) One example of an HFC is $CH_2F_2$. The C-F bond is polar.**

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




**[1]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
|  | Part (i) is correct and scores the mark. |



**(ii) Explain what determines where the partial charges are placed on this molecule. [2]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *electronegativity* | Part (**ii**) is an incomplete answer. It scores one mark for mentioning electronegativity but does not score the second mark for saying that fluorine is more electronegative than carbon. |

**(iii) Does the whole molecule have a dipole? Explain your answer. [2]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *no, because the two C–F polarities cancel out.* | Part (**iii**) is based on a misconception and does not score. The structure is tetrahedral, not flat, so the two C–F bonds are not 'opposite' and do not cancel out. Thus the molecule does have a dipole. |

**(f) If molecules of $CH_2F_2$ 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]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *they are too strong* | The answer to part **(i)** does not give enough detail. The bonds are strong but it also needs to be stated that even the high-energy uv in the stratosphere is unable to break them. |

**(ii) The bond enthalpy of the C-F bond is +467 KJ $mol^{-1}$.**
**Calculate the minimum energy (in joules) needed to break a single C–F bond. [2]**

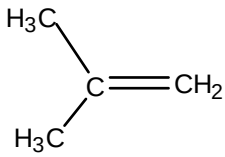
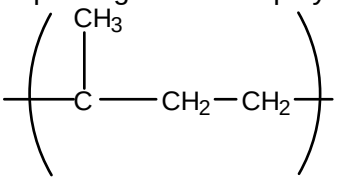
| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *Avogadro constant, NA = 6.02 x 1023 mol-1*<br>*467 x 1000/NA = 7.76 x 10–19* | Part **(ii)** is correct and scores two marks. |

**(iii) Calculate the minimum frequency of radiation needed to break a C-F bond.**
**Give the appropriate units for your answer. [3]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *Planck constant, h = 6.63 x 10-34 J Hz-1.*<br>*Thus: 8.54 x 10–16 Hz* | In part **(iii)**, the candidate has produced a wrong answer with *no working*. In fact, *h* has been divided by the frequency, as opposed to the other way up. So the numerical answer scores nothing, though the unit mark is scored. |

**5 This question is based on the article *Getting tyred 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 (line 44) [3]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| 2-methylpropene   Repeating unit in the polymer   | In part **(i)**, the monomer is correct and scores two marks. This has not been correctly polymerised, however, so the third mark is not scored. It should be like poly(ethene) with two methyl groups on every alternate carbon. |

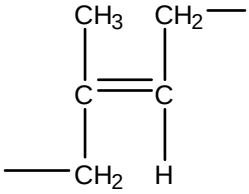
**(ii) Suggest the formula of the repeating unit of the rubber formed from butadiene and styrene that has one double bond per butadiene remaining. (Fig 4). Include one unit of butadiene and one unit of styrene. [2]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *–CH2–CH2–CH2–CH2–C(C6H5)=CH–* | The candidate has become muddled in part **(ii)** and only scores one for giving the 'residues' of the two alkenes correctly. More careful examination of Figure 2 in the Article might have helped here. |

**(iii) Describe a simple chemical test that might enable you to distinguish between the rubbers in parts** (i) **and** (ii)**. [3]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
| *add bromine water and it will go from brown to colourless* | In part **(iii)**, however, the candidate has given the correct test but has not said how each rubber will react to the test . |

**(b) Draw the structure of the repeating unit of *trans* polyisoprene. (line 20). [1]**

| *Candidate style answer* | *Examiner's commentary* |
|---|---|
|   | This is correct and scores the mark |

| **(c) Explain why *trans* (polyisopropene) cannot be rotated to give *cis* (polyisopropene). [1]** | |
|---|---|
| *Candidate style answer* | *Examiner's commentary* |
| *because the structure is rigid* | This is not the correct answer, which involves lack of free rotation about C=C, and thus it does not score. |

| **(d) Explain the meaning of the term *thermoplastic* (line 29). [1]** | |
|---|---|
| *Candidate style answer* | *Examiner's commentary* |
| *softens when heated* | This scores the mark. |

| **(e) Suggest how ultraviolet light might affect rubber (line 62). [3]** | |
|---|---|
| *Candidate style answer* | *Examiner's commentary* |
| *it breaks the bonds* | The answer omits the points that it is the high energy of the uv that breaks the bonds and that the structure breaks down when bonds are broken. |

| **(f) Vulcanisation improves the properties of rubber and accelerator molecules catalyse the process**<br>**Use information from the article about polymer structures and your knowledge of catalysts to explain this.**<br>**✎ In your answer you should make it clear how your explanation links with the chemical theory. [6]** | |
|---|---|
| *Candidate style answer* | *Examiner's commentary* |
| *Vulcanisation causes strong –S-S- bonds to form between the rubber chains. Accelerator molecules are catalysts containing S atoms. They speed up a reaction by lowering the activation enthalpy.* | This answer scores some of the points. It scores one mark for the formation of –S-S- bonds but does not then explain why these are important (they stop the chains sliding over each other). The 'cause and effect' mark for linking explanation and theory is also missed here. A mark is scored for saying that the catalysts molecules contain sulfur. However, the fact that these form intermediates has not been mentioned. Also pathway of lower activation enthalpy is required for the catalyst mark. |

## Overall standard:

The candidate clearly knows some chemistry. Some answers lack detail, however, and in several places more marks could have been scored if the candidate had looked more carefully at the number of marks available and matched these with detail.