CHEMISTRY

Paper 0439/13
Multiple Choice

Question Number	*Key*	*Question Number*	*Key*
1	**B**	21	**C**
2	**C**	22	**D**
3	**D**	23	**C**
4	**C**	24	**D**
5	**D**	25	**C**
6	**C**	26	**B**
7	**D**	27	**D**
8	**B**	28	**C**
9	**A**	29	**D**
10	**B**	30	**C**
11	**D**	31	**B**
12	**C**	32	**B**
13	**B**	33	**D**
14	**D**	34	**A**
15	**B**	35	**B**
16	**C**	36	**C**
17	**A**	37	**C**
18	**A**	38	**A**
19	**D**	39	**D**
20	**C**	40	**A**

Candidates performed well on this paper. **Questions 1**, **9**, **10**, **11**, **19**, **24**, **26** and **37** proved to be particularly straightforward with a large majority selecting the correct answer.

Questions 2, **28**, **31** and **40** proved to be the most difficult with less than half the candidates selecting the correct answer.

Comments on Specific Questions

The following responses were popular wrong answers to the questions listed:

Question 2

Response **A**. Candidates chose this response because they knew a burette was used in a titration for accurate measurement but did not consider the other responses fully.

Question 4

Response **B**. Candidates did not appreciate that filtration would be needed to remove an substance.

Question 6

Response **A**. Candidates realised that two further electrons were required, but appeared not to have read all the responses.

Question 8

Response **A**. Candidates found a total which corresponded to 78 but did not realise that argon does not form compounds of this formula.

Question 13

Response **A**. Candidates did not realise that hydrogen is always formed at the negative electrode.

Question 16

Response **D**. Candidates knew that alternative 3 was correct but did not know that (II) referred to the oxidation state of copper.

Question 20

Response **B**. Candidates knew that one piece of litmus paper would change colour, but chose the wrong one, not knowing the test for ammonium ions.

Question 22

Response **B**. Candidates chose the first alternative which had a high melting point without taking into account the coloured nature of transition metal compounds.

Question 36

Response **D** Candidates knew that answer 1 was wrong but then, not knowing sufficient about carbonate chemistry chose the wrong one of the remaining alternatives.

Question 38

Response **B** Candidates correctly knew that ethene decolourised bromine water and that ethane did not. They did not realise that ethene is a gas.

Question 40

The topic of ethanol production was not well understood. All responses were chosen by a significant number of candidates with response **D** being slightly more popular than the correct response and response **C** being the least popular.

CHEMISTRY

Paper 0439/23
Core Theory

Key Messages

- Questions about atomic structure were often done well as were questions relating to graphical work.
- Some candidates may need further practice at questions involving practical procedures, e.g. separation techniques using chromatography and filtration.
- Some candidates need more practice at answering questions requiring extended answers, e.g. **Question 3(a)**.
- It is important that candidates read the question carefully in order to understand exactly what is being asked.
- Many candidates need more practice at answering questions on particle theory, e.g. **Question 3(a)**, and qualitative analysis tests for specific ions and molecules.
- Some candidates need more practice in aspects of organic chemistry, e.g. homologous series and structure of functional groups such as carboxylic acids.

General comments

Some candidates tackled this paper well, showing a good knowledge of core chemistry. Good answers were seen to many parts of **Questions 1** and **3**. Nearly all candidates were entered at the appropriate level. In **Question 3(b)** some candidates wrote about chemical properties instead of physical properties, whilst in **Question 4(e)** many candidates tried to write a symbol equation instead of a word equation. A considerable number of candidates did not attempt to answer **Questions 4(c)(i)** and **7(a)(i)**. The extraction of information from tables of data was generally well done. Candidates performed less well on questions about particles. For example, in **Question 3(a)** a considerable number of candidates thought that the particles in liquids are well separated and that particles in solids move slightly. The standard of English was good. A few candidates wrote their answers in the form of short phrases or bullet points; candidates are less likely to write vague statements or contradict themselves if this is done. As in previous sessions, quantitative tests for specific groups were not well known. For example, a considerable number of candidates were challenged by **Question 4(b)** where the test for water was required. Few candidates knew the test for iodide ions in **Question 7(c)(iii)**. In organic chemistry, few candidates could write the formula for ethanoic acid or explain the term 'homologous series'.

Comments on specific questions

Question 1

Most candidates were able to interpret the atomic structures in part **(a)** and select the correct words to fill in the gaps in part **(c)**. Fewer were able to write the atomic structure showing the correct mass number and atomic number.

(a) Many candidates scored most of the available credit. Most parts were well answered, parts **(iii)** and **(iv)** being invariably correct. The most common incorrect answers were **B** and **D** (helium isotopes) in part **(i)**, and **A** and **D** in part **(ii)**.

(b) A minority of candidates correctly identified atom **D** as helium. The commonest errors were to suggest helium-2 or helium-4. A significant number of candidates gave elements other than helium, hydrogen and lithium being the commonest of these incorrect answers. A considerable number of candidates drew structures showing electron shells.

(c) The majority of candidates correctly identified the words to be placed in the gaps. The were 'atoms' placed in the first gap, and 'protons' and 'neutrons' being reversed. Nearly candidates correctly identified 'radioactive' and 'energy'.

Question 2

Parts **(b)** and **(c)**, involving interpretation of the figures from a table, were done well by a minority of candidates. About half knew the colour of chlorine. Few could explain why iodine does not react with potassium bromide. The parts that were answered best related to the electronic structure of chlorine and the balancing of the equation between chlorine and potassium bromide.

(a) (i) About half of the candidates gave a convincing explanation as to why chlorine is a gas at room temperature. Common errors were vague statements such as 'has a low boiling point', or references to the melting point rather than the boiling point.

(ii) Only a minority of candidates realised that a reference needed to be made to both melting and boiling points. The best answers suggested that room temperature is between the melting point and the boiling point. Common errors included reference to melting point alone, reference to boiling point alone or just stating that the melting point is lower than the boiling point.

(b) Many candidates identified the general trend in atomic radius. Some gave unnecessarily long answers or tried to link the atomic radius to the boiling point.

(c) A minority of candidates estimated the atomic radius of fluorine correctly from the data provided. Many gave values above 0.08 nanometres, 0.084 being the commonest answer outside the range accepted.

(d) Many of the candidates gave the correct colour of chlorine, but a significant number stated bluish-green or blue. A number suggested that chlorine is either colourless or orange, the latter arising through confusion with the colour of bromine.

(e) Most candidates drew the electronic structure of chlorine correctly. Some incorrectly drew five outer shell electrons and ten middle shell electrons, or drew a single electron in the overlap area rather than a pair of electrons. Few candidates drew chlorine molecules. A minority of candidates did not answer the question.

(f) (i) A significant number of candidates realised that bromine is a diatomic molecule and consequently wrote the correct formula and balanced the equation correctly. Other candidates balanced the equation with 2 and 2Br and a small number of candidates wrote H or H_2O instead of Br_2.

(ii) The majority of candidates did not realise that a comparison of the reactivity of iodine and bromine was required. Many compared incorrect species, e.g. bromine is more reactive than potassium, or bromine is more reactive than potassium bromide. Other candidates gave vague answers such as 'iodine is unreactive'.

Question 3

Although many candidates scored partial credit on this question, few scored highly. Parts **(c)** and **(d)** were particularly well done. The candidates' comparisons of solids and liquids in part **(a)** were often written in a confused manner. Many did not know the structure of liquids in terms of arrangement or proximity of particles.

(a) Many candidates scored credit for comparing the structures of solids and liquids. Few compared the arrangement of the particles, but more compared the motion and closeness. Comments about the changes which occur when a solid changes into a liquid were occasionally seen. Common incorrect answers suggested that liquid particles are some distance from each other, particles in solids move (rather than vibrate), omitted mentioning particles, or described bulk properties of solid and liquids rather than particle properties.

(b) Some candidates gave chemical properties instead of physical properties. Others gave properties of transition elements which were not relevant, e.g. coloured compounds or Group I elements.

(c) Many candidates gave the correct molecular formula for gallium chloride. The [illegible] incorrect formulae were $GaCl_3$ and Ga_2Cl_3.

(d) (i) Most candidates extracted the relevant information from the table correctly to expla[illegible] aluminium is used because it has a lower density than tungsten. The commonest error was to [illegible] a comparison, e.g. 'aluminium has a low density' rather than 'aluminium has a lower density'.

(ii) Most candidates correctly deduced from the table that steel, rather than copper, is used as a core for overhead power cables because it is stronger. Some omitted to give a comparison and just stated that 'steel is strong'.

(iii) Most candidates correctly stated that aluminium is used because it has a lower density or is cheaper than copper. The commonest error was to omit a comparison, e.g. 'aluminium has a low density' rather than 'aluminium has a lower density'.

(e) Most candidates were able to give a correct use of aluminium. Those who did not gave vague answers such as sheets, foils or in buildings.

Question 4

Many candidates gave good answers to parts **(a)** and **(d)**. Fewer could describe the test for water or understood 'dot-and-cross' diagrams and covalent bonding.

(a) (i) A significant number of candidates gave a suitable explanation of the reason for filtering water and wrote about chlorine killing bacteria. The main errors were vague explanations, such as 'purifying the water' or 'removing impurities', and suggesting that chlorination is used as part of the filtration process.

(ii) This part was very well answered. Very few gave industrial uses.

(b) A minority of candidates gave a correct chemical test for water. Most suggested incorrectly that litmus or pH measurement should be used. Some suggested adding sodium hydroxide or even potassium. Others, following on from part **(a)**, suggested filtration or sedimentation.

(c) (i) Fewer than half the candidates completed the 'dot-and-cross' diagram for water correctly. The commonest errors were to put extra non-bonded electrons around the oxygen or hydrogen or to draw a single bonding electron rather than a pair of electrons.

(ii) A minority of the candidates linked covalent bonding to pairs of shared electrons. Some incorrectly suggested covalent bond formation because of the combination of non-metals, wrote 'covalent' but did not give a reason, or suggested that electrons are shared in ionic bonding.

(d) Most candidates identified pH 7 as being neutral. A few incorrectly suggested pH 0.

(e) Fewer than half the candidates were able to answer this correctly even though all the information was given in the stem of the question. Some candidates gave symbol equations (almost invariably incorrect), attempted to write an equation without the arrow or + signs, e.g. 'sodium and water gives sodium hydroxide plus hydrogen', or failed to read the stem of the question properly and suggested that water is formed instead of hydrogen.

Question 5

Most candidates gained some credit for this question. Most were able to plot a graph correctly, knew the term 'exothermic' and identified a use of gasoline. Very few knew the conditions for cracking or could explain the term 'homologous series'.

(a) Most candidates gave the correct name for a reaction which releases energy. The commonest incorrect answer was 'combustion'. Only a few candidates suggested 'endothermic'.

(b) Over half the candidates realised that oxygen is a diatomic molecule and consequently wrote the correct formula and balanced the equation correctly. Other candidates balanced the equation with 2 and 2O, while a small number wrote O or H_2O instead of O_2.

(c) (i) Almost all candidates answered this correctly although a few gave the incorrect answ

(ii) The majority of candidates answered this correctly. Incorrect answers suggested fuel for h industry, or just gave 'fuels' or 'cars' without further qualification.

(d) (i) The majority of candidates plotted the graph correctly. A significant number did not draw the line between the points or drew a series of straight lines between each point with a ruler. A small number drew a single straight line. Some candidates did not extend the line to the *y*-axis.

(ii) Most candidates deduced the value for the boiling point of the 7 carbon hydrocarbon from the line they had drawn in part **(i)**. Candidates who did not draw a line in part **(i)** were not awarded credit because the question clearly stated that the information had to be obtained from the graph.

(e) (i) Very few candidates explained the meaning of the term 'homologous series'. Some suggested that 'they belong to the same group', or named particular groups, e.g. 'alkenes' or 'all alkanes belong to the same series'. Of those who mentioned functional groups, very few stated that the functional group was the same. Similarly, the few candidates who mentioned general formulae, did not gain credit because they were not specific enough, e.g. 'they all have a general formula' rather than 'they have the same general formula'.

(ii) The conditions required for cracking were not well known. Many just suggested enzymes or large alkanes.

Question 6

Many candidates were able to interpret information from a chromatogram. Fewer were able to explain the process of chromatography convincingly. The majority of candidates were able to interpret the structure of an unfamiliar compound in terms of counting the number of atoms of particular types, but few were familiar with the structure of the carboxylic acid group.

(a) Some candidates drew clear, well-labelled diagrams to explain chromatography. The majority, however, did not explain the procedure sufficiently or drew diagrams which were confusing, e.g. a cross between filtration and chromatography. A large number of candidates suggested using coffee filters as chromatography paper. Incorrect answers suggested placing the mixture to be chromatographed in the bottom of the beaker, placing the chromatography paper with the spot below the solvent level, or omitted to state or show that the chromatography paper should be dipped into the solvent. Few candidates mentioned the solvent moving up the paper and separating the spots, although some showed this on the diagram.

(b) (i) This was almost invariably answered correctly. Some incorrectly chose **E**.

(ii) Most candidates identified **G** as containing none of the dyes.

(iii) Most candidates correctly identified **G** as having the greatest number of different dyes, although some chose **F** or **D**.

(c) A minority of candidates drew the correct structure of the carboxylic acid group. Some incorrect answers put O or OH in place of COOH, showed an aldehyde group, or omitted oxygen atoms from the structure.

(d) A minority of the candidates explained the term 'solvent' correctly. Many confused the term with either solution or solute. Others gave vague or confused answers for which credit could not be given, e.g. 'a substance which makes another soluble when it dissolves in it'. Some candidates just gave the name of a solvent, 'water' being the commonest of these.

(e) (i) The majority of candidates identified the number of different types of atom correctly. The commonest errors were to suggest 2, 6 or 10 instead of 4.

(ii) Many candidates counted the number of carbon atoms correctly. The commonest incorrect answers suggested six or larger numbers such as 15.

Question 7

A few candidates performed well on this question. Others did not score highly because they wro statements in parts **(a)** and **(d)**.

(a) (i) A minority of candidates were able to explain the term 'enzyme'. Most answers referred to substances which decompose others. Many gave 'biological' answers and described types of enzymes rather than focusing on their function as catalysts.

(ii) Most candidates balanced the equation successfully. Incorrect answers either placed a 2 in front of the oxygen molecule on the right (despite the lack of a dotted line here) or balanced the hydrogen peroxide with the number 3 rather than 2.

(b) (i) Most candidates did not refer to rate, but just to volume of oxygen produced or time taken. Those who wrote a straightforward answer such as 'rate increases as concentration increases' were generally awarded credit. Some candidates did not refer to concentration increase (or decrease).

(ii) Most candidates drew the graph correctly. A few drew a line above the line for the 0.4 mol / dm^3 level.

(iii) Many candidates read the volume and time from the graph correctly. Some gave the volume as 20 cm^3 rather than 26 cm^3, or the time as 350 s or 100 s.

(c) (i) Some candidates realised that *reduction* is loss of oxygen or gain of electrons. Others gave simplistic answers referring just to reducing or lowering something.

(ii) A minority of candidates completed the equation correctly. The commonest incorrect answers gave calcium hydroxide, hydrogen or hydrogen peroxide instead of water, products containing completely different elements from those in the reactants, e.g. iodine, or compounds with guessed names, e.g. sulfuric hydroxide

(iii) Very few candidates remembered the test for iodide ions. Incorrect answers used universal indicator or pH paper, sodium hydroxide, or limewater. Of those who suggested that silver nitrate can be used for the test, most gave an incorrect colour for the precipitate. The commonest incorrect colours were cream and brown.

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Paper 0439/33

Extended Theory

Key Messages

- It is important that candidates learn the chemistry as specified in the current syllabus. This is best achieved by a steady acquisition throughout the course. Learning should be an active process; just reading notes or a text book is an inefficient method of acquiring knowledge. There should be an element of self-assessment or testing. Without a secure base of relevant material, a creditable examination grade will not be achieved.

- The acquisition of the required skills is the next step. These would include the various types of calculation specified in the syllabus, writing formulae and equations. These skills need to be practised.

- The final element of this preparative phase is examination technique. It is a lack of competence in this attribute which is a major cause of disappointing grades. Proficiency in this technique can only be acquired through practice on past papers, using published mark schemes and seeking guidance from teachers.

Even if these three elements are securely in place, there is still one crucial skill, and that is the ability to communicate. This deserves a lot more attention during the actual examination and currently it is a major reason why credit cannot be awarded. The problems range from poor quality handwriting and diagrams, to ambiguities and not directing the response to the requirements of the question. Most of these shortcomings could be rectified by more care and attention.

General Comments

Candidates who were well-prepared for the examination were able to tackle all of the questions. There was no evidence that the candidates had insufficient time to complete the paper.

Candidates are reminded of the importance of careful reading of the question before they attempt an answer.

Centres should advise candidates about the consequences of poor or illegible handwriting. Examiners will make every reasonable effort to determine the meaning, but if it cannot be read then it cannot be marked.

This report should be read in conjunction with the published mark scheme for this paper.

Comments on Specific Questions

Question 1

(a) (i) Candidates generally answered this question well. A typical error was from those candidates who described the structure of an atom.

(ii) Many candidates were able to give the correct definition.

(iii) Quite a few candidates failed to recognise that a mixture contains substances that are not chemically joined together.

(b) Many candidates gained full credit here. The most common error was stating that brass is a compound.

(c) Many candidates answered this correctly.

Question 2

(a) (i) Most candidates correctly identified that using powdered aluminium would lead to an inc surface area, although many candidates did not explain this effect in terms of collisions.

(ii) Many candidates gained some credit here for recognising that the amount of reactants decreases. However, only a small minority of candidates correctly stated that there is a decrease in the concentration of reactants.

(iii) Candidates generally answered this question well, although a number did not explain the effect of an explosion in terms of collisions.

(b) (i) The most common correct answers were carbon, flour and sugar. However, a number of candidates incorrectly stated a metal or phosphorus.

(ii) This answer required planning to give a coherent method. Although stronger candidates gave two reactions involving a named solution with a named solid with two different particle sizes, weaker candidates omitted some or all of these. A small number of candidates who suggested sodium and potassium for use in chemical experiments should be aware that these are dangerous substances and would not be allowed for routine experiments in schools.

Only the more able candidates gave an expected result for their test.

Question 3

(a) (i) Most candidates gave a correct response. The most popular answers were car bodies and bridges.

(ii) Many candidates gained credit here. The most common answers given were stainless steel and cutlery.

(b) This was not a question about the extraction of iron, but was concerned with the conversion of impure iron into pure iron. A number of candidates identified that oxygen and limestone were added to the impure iron but did not link them correctly to the removal of the relevant oxides.

Question 4

(a) (i) This proved to be a difficult question for many, and only a small proportion of candidates gave the correct structure.

(ii) Only the more able candidates gave the correct answer Ge_nH_{2n+2}. A common error was to quote a molecular formula in this series, for example Ge_3H_8.

(b) Examiners had to be able to count the dots and crosses in order to mark this question, and candidates should be reminded to draw clear, large diagrams. Candidates generally answered this question well, although a number of candidates omitted the non-bonded electrons from chlorine.

(c) This caused problems for a significant number of candidates who were unable to draw upon knowledge of the structure of SiO_2. Many candidates were able to recall that GeO_2 had a tetrahedral structure. Only a small number stated that four oxygen atoms are around each germanium atom and that two germanium atoms are around each oxygen atom.

(d) A wide variety of answers to this question were seen. Only the more able candidates identified that this was an oxidation reaction due to the germanium losing electrons (increasing their oxidation number).

Question 5

Many candidates found this question difficult.

(a) (i) A variety of different metals were seen. Only Group I elements were given credit.

(ii) Only the stronger candidates gained any credit here. Most candidates incorrectly identified lead, Pb, as the unknown product, instead of PbO.

(iii) This question was marked independently of the answer given to **(a)(i)**. However, only a small number of candidates gained any credit.

(b) (i) The expected answer was that at equilibrium, the rate of the forward reaction is equal to the rate of the back reaction. Many candidates omitted the reference to rate.

(ii) Candidates were expected to comment that the mixture would turn darker and explain this in terms of the position of equilibrium moving to the left since the reactant has more moles of gas. This question was marked consequentially, for consistency, and almost half the candidates stated that the gas would go colourless, so gained no credit. Only the more able candidates managed to gain full credit; weaker candidates usually omitted that reactants have more moles of gas.

(iii) Many candidates identified the reaction as exothermic, although only the stronger candidates stated that low temperatures favour the exothermic reaction.

(iv) Some very good answers were seen. Many candidates recognised that the reaction was exothermic due to the fact that a bond is being formed.

Question 6

(a) (i) Candidates generally answered this question well. The most common incorrect answers suggested chromatography and solubility in water.

(ii) This was usually answered correctly.

(iii) Most candidates gained some credit here, usually for the correct formula of ethanoic acid. The correct formula, incorrectly named as methanoic acid, was a common error.

(iv) The most common mistakes were carboxylic acid and alcohol.

(b) (i) This caused problems for a significant number of candidates. Only stronger candidates gave an answer in terms of relative acid strength relating to the degree of dissociation or splitting up into ions. Common errors were answers stating that malonic acid is more acidic and a stronger acid than sulfuric acid.

(ii) Some candidates ignored the statement in the question about giving a test other than measuring pH. Many candidates gained some credit here for a valid test, although only the more able candidates gave the expected result of the test.

(c) (i) This caused problems for a significant number of candidates. Only the stronger candidates identified the correct names of the two products. Sodium malonide was a common incorrect answer.

(ii) Most candidates were able to identify the correct formulae of the products.

(iii) This proved to be one of the most difficult questions on the paper. A number of candidates identified that H_2 was formed as a product. However, only a minority of candidates gave the correct formula of the carboxylate salt.

(iv) Most candidates were able to identify the correct formulae of the products.

Question 7

(a) (i) Hydrocarbons are defined as a compound/molecule containing carbon and hydrogen on was the only acceptable answer.

(ii) Most candidates gained some credit here. Candidates lost credit for imprecise answers, for example statements that alkanes contain single bonds and alkenes contain double bonds scored partial credit only.

(b) C_8H_{18} was the only acceptable answer. A common error seen was $2C_4H_9$.

(c) (i) This question required any unambiguous structure of $C_2H_4Br_2$. The formula $C_2H_4Br_2$ was not sufficient.

(ii) Many candidates achieved full credit.

(iii) Most candidates were awarded partial credit, but only a few gave the correct structure of the alcohol product. Both butan-1-ol and butan-2-ol were credited.

(iv) Candidates generally answered this question well. The hydrogenation of ethene was the most popular response seen.

(d) Most candidates gained some credit here. However, only the more able candidates deduced a formula of a hydrocarbon with a balanced equation for the reaction. Candidates were expected to deduce that the molar ratio of oxygen used : carbon dioxide formed is 3 : 2. Since water is the only other product, this would indicate that the hydrocarbon was either an alkene or a cycloalkane.

CHEMISTRY

Paper 0439/04
Coursework

General comments

Most of the Centres that entered for this unit had not done so previously. Many of these Centres experienced some problems both with the selection of appropriate tasks for use in assessment and with the application of appropriate standards in the awarding of marks. These problems were not common across all Centres; some clearly had more difficulties than others.

Those who had entered last year had clearly taken account of the feedback from the Moderator and showed significant improvement. It is recommended that other Centres take account of the detailed feedback given in the reports on this year's submission.

There was some evidence of sharing of resources between Centres which is to be encouraged. Sharing tasks which work successfully and comparing marking standards is a good way to ensure that Centres meet the standards necessary to comply with standards established internationally.

In general there were more problems with the application of the criteria than with the selection of appropriate tasks. Just over half of the Centres who entered chose tasks which were fit for purpose and some other Centres chose some tasks which were suitable. Criteria were often applied rather too generously and guidance on how this can avoided will be found in the specific comments which follow and in the individual Centre reports.

Comments on specific skills

Skill C1 Using and Organising Techniques, Apparatus and Materials

Since this task assesses the ability of the candidate to follow instructions, it is essential that the instructions provided by the Centre are appropriate. To gain the highest credit, the instructions should include a number of separate steps which the candidates must follow in sequence. In addition there should be a point in the investigation where the candidate has to decide what to do next as a result of an observation made.

This instruction sheet, together with a mark scheme explaining how the candidate is to be assessed, must be included in the sample of work sent to the Moderator. This mark scheme must be linked to the assessment criteria, but should not simply be a copy of them.

Skill C2 Observing, Measuring and Recording

The tasks set should allow candidates to both take measurements and to make other observations, although not necessarily in the same task. Visual observation should be detailed and complete. Measurements should be as accurate as is feasible using the apparatus available to the candidate. Simple single observations or measurement do not give sufficient justification for high credit. There should always be a range of data values or a number of observations as part of the task.

Observations and measurements should be recorded appropriately, (usually in a table), in a manner designed by the candidate. The provision of an outline table or detailed instruction on how to record results limits the maximum credit available.

Again the instruction sheet given to the candidates should be included with the sample, along with a mark scheme.

Skill C3 Handling Experimental Observations and Data

In this skill processing is important. This is easier to assess where the tasks include some numer The most straightforward way to assess this skill is by incorporating a graph into the assessment. S arithmetical processes do not usually provide sufficient evidence, although more complex calculations m do so. Graphs should be accurately drawn and fill at least half of an A4 sheet.

If the candidate has only undertaken tasks which involve observation rather than data measurements it is difficult to justify the highest credit.

Where calculations are involved, e.g. in titration exercises, any assistance given decreases the credit available.

Conclusions given in answer to leading questions are rarely worth high credit, although a question prompting the candidate to give a conclusion is fair.

At the highest level conclusions should describe and explain patterns/trends found in the results and should comment on any results which do not fit the pattern.

Skill C4 Planning, Carrying Out and Evaluating Investigations.

This is the skill where the selection of an appropriate task is most important. To gain access to the higher credit it is essential that a number of variables are involved, as part of the skill is the ability to control variables. Very simple investigations are, therefore, unlikely to give access to the highest credit.

The most obvious examples are concerned with rate of reaction where a number of variables could affect the rate. Explaining how these variables will be controlled, varied, or measured is the key to performing well. Another good example would be comparing the amount of heat produced by different fuels.

It is also essential that candidates perform the investigation which they have planned as indicated in the title for this skill. A candidate who has not carried out the investigation has not fully complied with the criteria for minimal credit.

Another part of the assessment criteria is the evaluation of the method, and suggestions of improvements. This clearly cannot be done if the investigation has not been attempted.

This is the most difficult skill on which to score well. It is not recommended that C4 tasks should be the only way of assessing C2 and C3.

In a well-structured task there is no reason why the majority of candidates should not score well in skills C1 and C2.

Credit in C3 is dependent on having good data with which to work. This is sometimes not the case in an investigation planned by the candidate.

It is impossible to assess C1 and C4 on the same task since one involves following instructions and the other involves writing them.