CO-ORDINATED SCIENCES

Paper 0654/01

Multiple Choice

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

General comments on whole paper

Candidates, and their teachers, can be well-satisfied with the performance shown on this paper. The mean for the whole paper was over 67%, which is not only a very satisfactory performance but also a considerable improvement on last November. The mean for Physics items only was slightly higher, even that this. Clearly this group of candidates were well prepared for this exam.

Comments on individual questions (Biology)

General comments

Only one question in the Biology section failed to discriminate adequately between candidates of differing abilities. Otherwise, all questions were well suited to the target group.

Comments on individual questions

Question 4

The term *pleural membranes* was not entirely familiar to all candidates – even less so their position in the body. A significant number (almost a quarter) believed them to be between the bronchi and bronchioles and it was apparent that many had resorted to guess-work indicating a less than sound grasp of this section of the syllabus.

Question 8

This question revealed confusion between the effects of carbohydrate and of protein in the diet. This led a quarter of the candidates to suggest that a high-protein diet would cause an increase in blood insulin levels.

Question 9

In this question all options were popular and not all of the best candidates chose the correct one. It would appear that many candidates had experienced difficulty in remembering their seed structure as specified in the syllabus since the position of the micropyle was thought to be either in the cotyledon or in the radicle by well over half the candidates.

Question 12

This was the easiest of the Biology questions. Candidates are normally comfortable with the concept of food chains and were so here, despite the question being presented in a slightly unusual form.

Question 13

This was well answered by most candidates, but it was, perhaps, a little surprising that a quarter of them felt that photosynthesis would not be reduced by deforestation.

Comments on individual questions (Chemistry)

Overall the examination performed well with 3540 candidates gaining marks well distributed across the range.

The Chemistry questions performed well being of approximately the same difficulty as those for Biology and Physics.

Comments on individual questions

Questions 16, **21**, **22** and **27** proved to be very straightforward with a large majority of candidates scoring the correct response.

Question 23 proved to be difficult with less than half the candidates scoring the correct response. This was due to a lack of knowledge of the test for nitrate ions. Both response B and response C, were popular distractors.

Popular distarctors in other questions were:

In **Question 14** Response B because candidates took P_4 and O_{10} to be two separate molecules.

In **Question 19** Response A because chlorine and hydrogen were known as products but they guessed the wrong way for the third.

In **Question 24** Response B because they knew it was some kind of medicine but chose the wrong one.

In **Question 25** Response A because of confusion of what an emulsion is. Not a liquid colloid but a colloid made up of two liquids.

Comments on specific questions (Physics only)

The Questions which candidates found "easy" (facility ≥ 70%) were **29, 30, 33, 38, 39** and **40**. There were no Questions where the facility showed that candidates found the topic particularly difficult. The items where the facility was high were such that in many cases no worthwhile comment need be made, but the following comments on selected questions may be of help to teachers.

In **Question 28**, over half answered correctly, but almost as many thought that the average speed could be found by calculating the arithmetic mean of 90 km/h and 30 km/h.

Question 30 caused few candidates any problems, but it is interesting that of those who answered incorrectly, a very big proportion thought for some reason that all the forces were equal.

Question 31 showed up a common misconception, namely that heating water is not involved in the production of electricity using nuclear energy.

A lot of candidates thought, in **Question 32**, that the density of the gas would decrease when the piston was pulled out. No reason can be suggested for this, especially as even the density of the dots on the diagram suggests a decrease in density.

In **Question 34** it was interesting to note that a fifth of candidates thought that the whole tank of water would be heated more quickly using the upper heater. Perhaps these candidates knew that hot water is available in the house more quickly if the upper heater is used, and did not bother to consider that the question referred to **all** the water. Candidates are advised to read the questions carefully.

It would be difficult to have a more basic optics question than **Question 36**, but only half the candidates answered correctly. Over the years the Principal Examiner of this paper has commented on numerous occasions that candidates seem to find even simple optics difficult, and that teachers need to take this into account when planning their teaching programmes. In this particular instance, over a third of candidates wanted the ray of light to go through F'.

A lot of candidates thought that the current in **Question 37** would remain constant even when the voltage changed, but it was pleasing to note in **Question 38** that at last candidates are beginning to realise that the current is the same at all points in a series circuit. **Question 40** posed no real problems for most candidates, but there is still a significant minority who think that the half-life is half the maximum time shown on the graph (in this case, half of 5 days = 2.5 days).

CO-ORDINATED SCIENCES

Paper 0654/02

Core Theory

General comments

Most candidates were able to attempt most questions. Parts of a few questions seemed quite inaccessible to many candidates. There was a good range of marks on most questions. Candidates generally scored on all questions. Very few gained no marks on any question and very few gained full marks on any question. Although it appeared that candidates often knew the answer to the question, their answers were very vague. Language difficulties played some part here, although the general level of English was reasonable. Performance depended not only on scientific knowledge but on the ability to understand the question. There were many examples of good science being explained which did not answer the question.

Questions 8 and **11** seemed to be the most difficult for the candidates to answer successfully. **Question 5** was answered best by candidates.

It is becoming apparent that when a numerical answer is required, weaker candidates will merely take any numbers that are given in the question and either multiply them or divide them. Quite often they make up a formula / equation to confirm this. Another problem with calculations is that candidates will often draw a triangle with three letters in it and expect that this will be accepted as a formula / equation. Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided.

There was no evidence of candidates running short of time to complete the examination.

Comments on specific questions

Question 1

The responses to this question seemed to depend on the confidence of the candidates. It was evident that some candidates were not at all clear about ideas of radioactivity, half-life etc.

(a) (i) This was well answered by most candidates, showing good data handling skills.

(ii) Responses such as radiation causes cancer were insufficient. Candidates needed to use the graph to explain the link between the two variables.

(iii) Most candidates showed their understanding here by referring to mutations or some other health risk. Some candidates however referred to other forms of cancer e.g. lung cancer despite the instructions in the question.

(b) Few candidates were able to suggest suitable penetration tests to identify either radiation.

(c) (i) Few candidates were able to explain half life in terms of either the reduction in mass of a radioactive isotope or the reduction in activity.

(ii) Some candidates knew how to do this. 8 days was a common wrong answer.

Question 2

Most candidates gained good marks on some parts of this question, but few answered the whole question consistently well.

(a) This was well answered, showing a good knowledge of the topic.

(b) Most candidates managed to gain at least one mark here from the five alternative marking points.

(c) (i) Plasma was well known as the part of the blood that transports water around the body

(ii) Many candidates gained one mark here at least. However the idea of osmosis is not well known.

(d) Most candidates knew that chlorine killed bacteria, but the reason why bacteria need to be killed was less well known.

Question 3

Some parts of this question were not well answered.

(a) Whilst a sizeable number of candidates understood that molecules were atoms bonded together, there were many confused ideas about cells and that molecules joined together to make atoms.

(b) This part was very poorly answered, with few candidates scoring more than one mark for a reference to scum formation. Few candidates understood that soap reacts with hard water or that this would mean less soap was left to wash the cloth.

(c) (i) Many candidates correctly worked out that there were 11 atoms in the formula. There was no obvious wrong answer given.

(ii) This part was well answered with most candidates correctly identifying the number two and correctly suggesting an explanation in terms of either the periodic table or the overall electron configuration.

The only common wrong answer was 20.

Question 4

This question was not well answered.

(a) (i) Many candidates gained full marks here, but a number of candidates failed to put all the components into the circuit or were unable to determine whether they were paced in series or parallel.

(ii) Few candidates knew the purpose of the variable resistor.

(iii) This was well answered. A number of candidates had difficulties stating a formula in a recognisable format.

(iv) This part confused many candidates, who ignored the question and attempted to explain why the relationship did correspond to Ohm's law.

(b) Whilst many candidates found it difficult to explain what the problem was, almost all candidates were able to suggest the consequences in terms of electric shocks etc.

Question 5

Parts of this question were well answered.

(a) (i) This was well answered, with many candidates gaining both marks.

(ii) This was also well answered, although a few candidates reversed their answers.

(iii) Many candidates had some idea of what a binomial name was. Many however reversed the name or only gave half of it.

(iv) Most candidates gained at least one mark here for stating the adaptation. Fewer candidates gained the second mark for describing the adaptation.

(b) (i) Many candidates gained the mark here for correctly suggesting that the temperature of animal A was constant.

(ii) This was well answered.

(iii) Few candidates gained either mark here.

(iv) Few candidates gained either mark here.

Question 6

This question was well answered by the majority of candidates.

(a) Many candidates correctly identified either magnesium sulphate or hydrogen. Few identified both.

(b) (i) Some candidates knew this but there was lots of guessing .

(ii) Most candidates were able to identify one factor to change to decrease the rate of reaction. Few identified two. Many candidates gave answers relating to increasing the rate of reaction.

(iii) There were many correct answers here, showing a good understanding of exothermic reactions.

Question 7

(a) (i) Many candidates found this difficult, despite being given the formula to use.

(ii) This was a difficult calculation but a good number of candidates successfully produced the correct answer and were able to explain how they had done it.

(b) Many candidates gained both marks here, but also many candidates did not appear to know the correct formula to use.

(c) (i) Many candidates found this difficult. Many other versions of water waves and sound waves were common wrong answers.

(ii) Many candidates gained the mark here by sensibly drawing a diagram to explain their answer.

Question 8

Most candidates gained some marks on this question, but few answered the whole question consistently well.

(a) (b) and (c) In all three of these parts many candidates failed to identify the seedling or seedlings they were describing. Many tried to describe what was happening to all four seedlings in each part. This was unnecessary and confusing.

(d) Many candidates gained one mark here for a reference to photosynthesis. Few candidates managed to gain the second mark by referring to light as an energy source or that plants grow faster with more light.

Question 9

This question was not well answered. Candidates seemed unable to use the information they were given.

(a) (i) This was surprisingly badly answered by many candidates. Many labelled the wrong electrode and many more labelled some other part of the circuit close to the cathode.

(ii) Chlorine was quite well known.

(iii) Hydrogen was less well known.

(iv) Few candidates were able to suggest that the solution became alkaline. Even fewer were able to explain why.

(b) (i) Many candidates were able to suggest the type of reaction but not that chlorine was more reactive than iodine.

(ii) A good number of candidates correctly write out the word equation. Many candidates failed to gain the mark because one of their reactants or products was wrong.

Question 10

(a) (i) This was not well answered. To gain both marks candidates needed to refer to alternating current and the number of times it alternated per second.

(ii) Most candidates correctly substituted in the correct data and produced the correct answer.

(b) There were some serious misconceptions about the ideas of efficiency. Few were able to give any idea of a basic formula or definition. Many were also unable to suggest where the energy was wasted.

(c) This was generally well answered. Some candidates however failed to explain their answers in terms of heat transfer.

Question 11

This question was not well answered. Answers given suggested that many candidates were not familiar with these parts of the syllabus.

(a) (i) Proteins was not well known.

(ii) Few candidates knew that nitrogen was the element found in amino acids but not carbohydrates.

(b) (i) Some candidates were able to suggest that separation was done because there is a difference in boiling points.

(ii) Few candidates gained the first marking point for correctly describing a hydrocarbon. More candidates were able to suggest that all the bonds were single.

(iii) This part was well answered. Many candidates were able to state that electrons were shared and that this allowed the atoms to gain full outer shells of electrons.

(c) (i) This was not well answered. There were four marking points but few candidates were able to contribute anything more than a reference to photosynthesis.

(d) Similarly, in this part there were three possible marking points but few candidates gained any credit. Those who did described acid rain.

Location Entry Codes

UNIVERSITY of CAMBRIDGE
International Examinations

As part of CIE's continual commitment to maintaining best practice in assessment, CIE has begun to use different variants of some question papers for our most popular assessments with extremely large and widespread candidature, The question papers are closely related and the relationships between them have been thoroughly established using our assessment expertise. All versions of the paper give assessment of equal standard.

The content assessed by the examination papers and the type of questions are unchanged.

This change means that for this component there are now two variant Question Papers, Mark Schemes and Principal Examiner's Reports where previously there was only one. For any individual country, it is intended that only one variant is used. This document contains both variants which will give all Centres access to even more past examination material than is usually the case.

The diagram shows the relationship between the Question Papers, Mark Schemes and Principal Examiner's Reports.

Question Paper	Mark Scheme	Principal Examiner's Report
Introduction	Introduction	Introduction
First variant Question Paper	First variant Mark Scheme	First variant Principal Examiner's Report
Second variant Question Paper	Second variant Mark Scheme	Second variant Principal Examiner's Report

Who can I contact for further information on these changes?
Please direct any questions about this to CIE's Customer Services team at: international@cie.org.uk

CO-ORDINATED SCIENCES

Paper 0654/31
Extended Theory

General comments

The majority of candidates were able to make creditable attempts at most questions. It was rare for a question or part question not to be attempted. Most candidates appeared to have no difficulty in interpreting the questions and there was no evidence that they ran short of time.

Candidates are advised that it is very important that if they wish to change their answer, they cross out the wrong one and make their final answer very clear. It is not a good idea to overwrite the first answer, as it can be impossible for the Examiner to be certain what the candidate intends their final answer to be.

Candidates should also be reminded that they are expected to give units with answers where appropriate.

Comments on specific questions

Question 1

(a) (i) Most candidates were able to draw a suitable circuit using acceptable symbols. The most common error was to show the voltmeter in series with the lamp, or in parallel with the cells, or to show the ammeter in parallel with the lamp.

(ii) This was also generally well answered, although some candidates simply said that it was to vary the resistance.

(iii) Almost all candidates answered this correctly. However, a few used units in their formula, which is not acceptable. The expected formula was some version of voltage = current x resistance (which could be stated in any arrangement and using accepted symbols), but not volts = amps x ohms. Formula triangles are also not acceptable.

(iv) This was much more difficult, and discriminated well between weaker and stronger candidates. The latter were able to state that the lamp filament would get hot and increase resistance. Some candidates did mention an increase in resistance, but appeared to be relating this to the variable resistor, which was not credited.

(b) (i) This was generally answered correctly.

(ii) This, too, was usually correct.

(iii) Many answers to this were correct, but weaker candidates either gave an entirely inappropriate answer or stated that the *changes* in the current would be small. The expected answer was that the current generated would be very small.

(iv) This question proved surprisingly difficult, with more candidates incorrectly suggesting a motor or electromagnet than giving a correct answer such as a dynamo or generator.

Question 2

(a) (i) Most candidates gained at least 1 mark here, as they knew that sweat glands secrete sweat. The second mark required an understanding that it is the evaporation of the water in sweat which has the cooling effect on the skin.

(ii) This was less well known than **(i)**, and there are still numerous candidates who believe that the blood vessels move up and down through the skin. Nevertheless, there were many answers that were entirely correct.

(b) (i) Where candidates recognised that respiration is involved, answers were generally quite competent, with many explaining that respiration is an exothermic reaction or that it releases heat.

(ii) Many candidates recognised that the body would continue to cool after the exercise had stopped because the cooling mechanisms would still be working, or because sweat secreted earlier would still be evaporating from the skin. Relatively few, however, stated that less heat would now be being generated within the body.

(iii) This was very poorly known, with only a few candidates stating that shiny or silver objects are poor radiators of heat.

(c) This simple recall question proved to be surprisingly difficult, many candidates apparently confusing vitamin D with melanin and describing how it would protect the skin from sunlight. However, there were also many entirely correct answers relating to the use of calcium, strength of bones or avoidance of rickets.

Question 3

(a) This was generally well answered. However, some candidates wrote at length about health benefits of natural rather than synthetic dyes, which was not credited.

(b) A wide range of answers was seen here. Many candidates obtained full marks for excellent simple descriptions of how the soap molecules would remove the dye, usually with the aid of labelled diagrams showing the soap molecules and their action in relation to the dye and to water. It was much more difficult for marks to be awarded if the diagrams were not labelled. At the other end of the scale, there were numerous answers scoring 0, often because the candidate wrote about enzymes rather than soap.

(c) (i) This proved to be a very difficult question, with relatively few candidates recognising that $CaCO_3$ would be produced, and even fewer correctly including water and carbon dioxide in their equation.

(ii) There has been an improvement in the level of response to this type of question, with many more candidates now able to explain their answers in terms of charge balance. However, many made the question impossibly difficult for themselves by trying to work out how many electrons there would be in the shell of each atom in the hydrogencarbonate ion.

Question 4

(a) (i) Almost all candidates read the graph correctly and entered a correct value in the table.

(ii) As this Paper is designed for candidates aiming for Grades A* to C, a relatively high-level response was expected for this question. The mark was given for the idea that the relationship between the two parameters is directly proportional, and a simple statement that a rise in one caused a rise in the other was not credited.

(b) Many candidates gave correct answers, usually by stating that beta radiation would pass through paper while alpha would not. A few referred to skin or hands instead of paper, and this was not credited, as this would not be a suitable way to distinguish between the two types of radiation. Some did not refer to penetrating powers at all, instead writing about the response to magnetic or electric fields.

(c) (i) This was not an easy question, and it was pleasing to find many candidates coming to grips with the graph and able to give an entirely correct answer. This required recalling knowledge of the structure of an alpha particle, interpreting what was being shown on the graph, and then linking these two ideas together. However, these candidates were in the minority, and scores of 0 or 1 were far more common than scores of 2.

(ii) Many answers correctly began by stating that radon and polonium have different numbers of protons, but then spoilt their answer by adding 'and neutrons'.

(iii) This also proved a fairly difficult question, with relatively few candidates able to state clearly that gamma emission does not change the particles in an atom.

(iv) Many candidates struggled to put their ideas about half-life into words. It would clearly be wise for them to learn a formal definition of terms such as this.

(v) Even those who were not able to define half-life frequently demonstrated some understanding here, correctly dividing the mass by 2 three times over. However, some then failed to remember that the half-life is 4 days, so gave an answer of 3 days rather than 12.

Question 5

(a) (i) Most candidates were able to state one characteristic feature of insects (generally wings) but could not always give a second one. The most commonly-seen correct second point was that they have one pair of antennae, but many did not state how many antennnae there are, or could not remember the correct term. Anthers and antlers appeared frequently. Others correctly stated that they have three parts to the body. However, numerous answers gave characteristics of arthropods in general, rather than of insects.

(ii) This was generally well answered.

(b) (i) Candidates who had some understanding of genetics were able to answer this correctly, but they were not in the majority. They needed to appreciate that the upper case letter should represent the dominant allele, and to work out that the allele for brown must be recessive and the allele for green dominant.

(ii) Candidates were often able to gain some marks here even if they had answered **(i)** incorrectly, by showing a cross between two heterozygous locusts. Some answers were entirely correct, but many lost a mark by not giving the parental genotypes – a Punnett square alone is not a complete genetic diagram, which should always begin by stating the parental genotypes. It is also necessary to indicate the phenotypes of the offspring, or to give some indication of which ones would be brown (as asked in the question).

(c) Relatively few candidates knew the differences between continuous and discontinuous variation. Many incorrectly attempted to explain in terms of how the colour passes from one generation to another, or whether the colour changes during an animal's lifetime.

(d) There were numerous good answers here, generally referring to the harmful effect of the insecticide on other organisms or to its potential to harm humans. Some answers, however, included reference to global warming or simply to unexplained 'pollution'.

Question 6

(a) Most candidates correctly identified the anode, although some failed to earn a mark because they simply indicated that it was Q, rather than labelling the anode itself on the diagram as asked. Fewer gained the second mark, often because they incorrectly stated that 'chlorine' is negative. They needed to state clearly that *chloride ions* are negative, and are therefore attracted to the positively charged anode.

(b) (i) This was often answered correctly, although weaker candidates often tried to involve the relative molecular mass of chlorine in their answer.

(ii) A wide range of answers was seen here. Many answered entirely correctly, but most failed to complete all three steps of the calculation. Some failed to calculate the relative formula of NaOH correctly, often because they multiplied the atomic mass of Na by 2, while not doing so for O and H. Some then failed to multiply 40 by 2 or by 0.01. The final answer required a unit.

(c) (i) A disappointing number of candidates were not even able to write the correct formula for potassium bromide, even though this was provided in the question. Many did not know the formulae for chlorine and bromine, so that their equations included 2Cl or 2Br instead of Cl_2 and Br_2. In general, this question was very poorly answered.

(ii) This, however, was generally well done, although some candidates showed only the shared pair and not the rest of the electrons in the outer shells of the two atoms. A few incorrectly wrote 'Cl' or 'Na' in one of the atoms.

(iii) Many candidates did not know the bromine test for unsaturated hydrocarbons, and many of those who did were not able to state the colour change correctly (from orange or a similar colour to colourless, not to 'clear' or 'transparent').

(iv) This proved more difficult than expected. Although many candidates correctly worked out that the formula of the compound would be C_4H_8, it was much less common to see a correct displayed formula. Some candidates had several attempts, and it was not possible to tell exactly what their final diagram showed, particularly whether bonds were single or double. If the first attempt is wrong and cannot be erased completely, it is best to start again with a fresh diagram.

Question 7

(a) This question tested the ability to find relevant evidence to support a statement. The majority of candidates were able to find the relevant evidence in the diagram, stating that seedling B or E, or the 'ones with the tips cut off', did not grow. Some, however, could not be credited because they also described whether or not seedlings grew towards the light, which is not relevant evidence.

(b) This question added another level of difficulty compared with **(a)**, because candidates needed to know the meaning of the terms 'receptor' and 'effector' before once again looking for appropriate evidence from which to draw conclusions. Numerous candidates were able to do this and scored full marks, but this was relatively rare and most scored 0, 1 or 2.

(c) This was a straightforward recall question of material in the supplement of the syllabus, but it was not well known. Better candidates frequently scored 2 marks, but it was rare to see an entirely correct and complete answer.

Question 8

(a) (i) Most candidates made a reasonable attempt at this question and obtained an answer of 5000, but some did not give the correct units (which were provided in the question) and so did not gain the mark.

(ii) This question was often well answered, with many candidates correctly deducing that the pressure would be 10 N/cm^2 and also giving a suitable explanation of their reasoning.

(b) Candidates who knew that momentum = mass x velocity generally gave entirely correct answers to both **(i)** and **(ii)**. This question was well answered.

(c) (i) The formula velocity = frequency x wavelength is not well known. Many candidates got things the wrong way up, dividing frequency by velocity in an attempt to find wavelength. Those who did get the formula and calculation right did not always give a correct unit, often writing this as λ.

(ii) This was a recall question, and many candidates did not know it.

(iii) Candidates who knew that they needed to find the area under the graph generally answered this entirely correctly, although some incorrectly calculated the whole area up to 25 s, not the first 20 s as asked. Many, however, simply used the formula distance = speed x time, with no account taken of the acceleration during the first 10 s.

Question 9

(a) A surprisingly large number of candidates were unable to give the two products of the reaction between a metal and acid. The commonest error was to give water instead of hydrogen, and 'magnesium sulphide' also made numerous appearances.

(b) Where candidates recognised that the graph showed the reaction taking place rapidly at first and then slowing, they were generally able to earn at least 1 or 2 marks, and numerous candidates gained all three. Marks were often lost for stating that there would be 'more collisions' in the early stages, rather than 'a greater frequency of collisions' or 'more chance of collisions'.

(c) There were many excellent answers to this question, earning all 4 marks. However, this was by no means the norm, and there were many entirely inappropriate diagrams and explanations. Diagrams did need to be drawn with enough care that it was clearly intended for the particles in the diagram of the pure metal to be all the same size, whilst those in the alloy needed to be shown clearly as having two different sizes.

(d) This proved to be one of the most difficult questions on the paper. Many candidates assumed that all of the particles were atoms, and therefore wrote about how one might need to lose or gain an electron to become 'stable', and how this could lead to the formation of ionic or covalent bonds between them. Better candidates, however, were able to see that particles W and X had an imbalance of protons and electrons, giving them opposite charges and therefore producing attraction between them.

CO-ORDINATED SCIENCES

Paper 0654/32
Extended Theory

General comments

The majority of candidates were able to make creditable attempts at most questions. It was rare for a question or part question not to be attempted. Most candidates appeared to have no difficulty in interpreting the questions and there was no evidence that they ran short of time.

Candidates are advised that it is very important that if they wish to change their answer, they cross out the wrong one and make their final answer very clear. It is not a good idea to overwrite the first answer, as it can be impossible for the Examiner to be certain what the candidate intends their final answer to be.

Candidates should also be reminded that they are expected to give units with answers where appropriate.

Comments on specific questions

Question 1

(a) (i) Most candidates were able to draw a suitable circuit using acceptable symbols. The most common error was to show the voltmeter in series with the lamp, or in parallel with the cells, or to show the ammeter in parallel with the lamp.

(ii) This was also generally well answered, although some candidates simply said that it was to vary the resistance.

(iii) Almost all candidates answered this correctly. However, a few used units in their formula, which is not acceptable. The expected formula was some version of voltage = current x resistance (which could be stated in any arrangement and using accepted symbols), but not volts = amps x ohms. Formula triangles are also not acceptable.

(iv) This was much more difficult, and discriminated well between weaker and stronger candidates. The latter were able to state that the lamp filament would get hot and increase resistance. Some candidates did mention an increase in resistance, but appeared to be relating this to the variable resistor, which was not credited.

(b) (i) This was generally answered correctly.

(ii) This, too, was usually correct.

(iii) Many answers to this were correct, but weaker candidates either gave an entirely inappropriate answer or stated that the *changes* in the current would be small. The expected answer was that the current generated would be very small.

(iv) This question proved surprisingly difficult, with more candidates incorrectly suggesting a motor or electromagnet than giving a correct answer such as a dynamo or generator.

Question 2

(a) (i) Very few candidates appreciated that blood flows through arteries in pulses, with changing pressure, and that elastic tissue enables the artery wall to stretch and recoil as these pulses of blood pass through. A simple reference to 'high pressure' does not explain the need for the walls to be elastic. Some candidates appear to believe that arteries pump blood, which is incorrect.

(ii) Most candidates appreciated the function of valves, and were able to explain why arteries do not need them. However, many tried to do so with reference to oxygenated blood and deoxygenated blood, which is entirely irrelevant. Others explained why valves need them, with no reference to why arteries do not.

(b) (i) This question was not well answered, although many candidates did earn at least one mark, generally for some reference to respiration. Relatively few candidates mentioned the need for energy for muscle contraction (either in the heart or in the muscles involved in running). However, some did explain that a higher uptake of oxygen by the heart muscles is a result of the heart pumping blood more rapidly to supply oxygen to leg muscles.

(ii) Once a candidate appreciated that anaerobic respiration had been taking place, they generally wrote a good answer, including reference to the need for oxygen to break down the lactic acid that had been produced. However, many did not do this and the most common mark for this question was 0.

(c) This question was difficult, and it was pleasing to see some candidates able to give thoughtful and sensible answers to it, referring to anaerobic respiration in sprinters not being dependent on the availability of oxygen, whereas long-distance runners rely on aerobic respiration and are therefore more affected by the shortage of oxygen in the atmosphere.

(d) It was expected that this question would prove relatively easy, but in fact a majority of candidates scored 0. Many gave entirely inappropriate suggestions, for example stating that iron gives you strong bones. Others did mention oxygen transport or red blood cells, but did not mention haemoglobin.

Question 3

(a) This was generally well answered. However, some candidates wrote at length about health benefits of natural rather than synthetic dyes, which was not credited.

(b) A wide range of answers was seen here. Many candidates obtained full marks for excellent simple descriptions of how the soap molecules would remove the dye, usually with the aid of labelled diagrams showing the soap molecules and their action in relation to the dye and to water. It was much more difficult for marks to be awarded if the diagrams were not labelled. At the other end of the scale, there were numerous answers scoring 0, often because the candidate wrote about enzymes rather than soap.

(c) (i) This proved to be a very difficult question, with relatively few candidates recognising that $CaCO_3$ would be produced, and even fewer correctly including water and carbon dioxide in their equation.

(ii) There has been an improvement in the level of response to this type of question, with many more candidates now able to explain their answers in terms of charge balance. However, many made the question impossibly difficult for themselves by trying to work out how many electrons there would be in the shell of each atom in the hydrogencarbonate ion.

Question 4

(a) (i) Almost all candidates read the graph correctly and entered a correct value in the table.

(ii) As this Paper is designed for candidates aiming for Grades A* to C, a relatively high-level response was expected for this question. The mark was given for the idea that the relationship between the two parameters is directly proportional, and a simple statement that a rise in one caused a rise in the other was not credited.

(b) Many candidates gave correct answers, usually by stating that beta radiation would pass through paper while alpha would not. A few referred to skin or hands instead of paper, and this was not credited, as this would not be a suitable way to distinguish between the two types of radiation. Some did not refer to penetrating powers at all, instead writing about the response to magnetic or electric fields.

(c) (i) This was not an easy question, and it was pleasing to find many candidates coming to grips with the graph and able to give an entirely correct answer. This required recalling knowledge of the structure of an alpha particle, interpreting what was being shown on the graph, and then linking these two ideas together. However, these candidates were in the minority, and scores of 0 or 1 were far more common than scores of 2.

(ii) Many answers correctly began by stating that radon and polonium have different numbers of protons, but then spoilt their answer by adding 'and neutrons'.

(iii) This also proved a fairly difficult question, with relatively few candidates able to state clearly that gamma emission does not change the particles in an atom.

(iv) Many candidates struggled to put their ideas about half-life into words. It would clearly be wise for them to learn a formal definition of terms such as this.

(v) Even those who were not able to define half-life frequently demonstrated some understanding here, correctly dividing the mass by 2 three times over. However, some then failed to remember that the half-life is 4 days, so gave an answer of 3 days rather than 12.

Question 5

(a) (i) Most candidates were able to state one characteristic feature of insects (generally wings) but could not always give a second one. The most commonly-seen correct second point was that they have one pair of antennae, but many did not state how many antennnae there are, or could not remember the correct term. Anthers and antlers appeared frequently. Others correctly stated that they have three parts to the body. However, numerous answers gave characteristics of arthropods in general, rather than of insects.

(ii) This was generally well answered.

(b) (i) Candidates who had some understanding of genetics were able to answer this correctly, but they were not in the majority. They needed to appreciate that the upper case letter should represent the dominant allele, and to work out that the allele for brown must be recessive and the allele for green dominant.

(ii) Candidates were often able to gain some marks here even if they had answered **(i)** incorrectly, by showing a cross between two heterozygous locusts. Some answers were entirely correct, but many lost a mark by not giving the parental genotypes – a Punnett square alone is not a complete genetic diagram, which should always begin by stating the parental genotypes. It is also necessary to indicate the phenotypes of the offspring, or to give some indication of which ones would be brown (as asked in the question).

(c) Relatively few candidates knew the differences between continuous and discontinuous variation. Many incorrectly attempted to explain in terms of how the colour passes from one generation to another, or whether the colour changes during an animal's lifetime.

(d) There were numerous good answers here, generally referring to the harmful effect of the insecticide on other organisms or to its potential to harm humans. Some answers, however, included reference to global warming or simply to unexplained 'pollution'.

Question 6

(a) Most candidates correctly identified the anode, although some failed to earn a mark because they simply indicated that it was Q, rather than labelling the anode itself on the diagram as asked. Fewer gained the second mark, often because they incorrectly stated that 'chlorine' is negative. They needed to state clearly that *chloride ions* are negative, and are therefore attracted to the positively charged anode.

(b) (i) This was often answered correctly, although weaker candidates often tried to involve the relative molecular mass of chlorine in their answer.

(ii) A wide range of answers was seen here. Many answered entirely correctly, but most failed to complete all three steps of the calculation. Some failed to calculate the relative formula of NaOH correctly, often because they multiplied the atomic mass of Na by 2, while not doing so for O and H. Some then failed to multiply 40 by 2 or by 0.01. The final answer required a unit.

(c) (i) A disappointing number of candidates were not even able to write the correct formula for potassium bromide, even though this was provided in the question. Many did not know the formulae for chlorine and bromine, so that their equations included 2Cl or 2Br instead of Cl_2 and Br_2. In general, this question was very poorly answered.

(ii) This, however, was generally well done, although some candidates showed only the shared pair and not the rest of the electrons in the outer shells of the two atoms. A few incorrectly wrote 'Cl' or 'Na' in one of the atoms.

(iii) Many candidates did not know the bromine test for unsaturated hydrocarbons, and many of those who did were not able to state the colour change correctly (from orange or a similar colour to colourless, not to 'clear' or 'transparent').

(iv) This proved more difficult than expected. Although many candidates correctly worked out that the formula of the compound would be C_4H_8, it was much less common to see a correct displayed formula. Some candidates had several attempts, and it was not possible to tell exactly what their final diagram showed, particularly whether bonds were single or double. If the first attempt is wrong and cannot be erased completely, it is best to start again with a fresh diagram.

Question 7

(a) This question tested the ability to find relevant evidence to support a statement. The majority of candidates were able to find the relevant evidence in the diagram, stating that seedling B or E, or the 'ones with the tips cut off', did not grow. Some, however, could not be credited because they also described whether or not seedlings grew towards the light, which is not relevant evidence.

(b) This question added another level of difficulty compared with **(a)**, because candidates needed to know the meaning of the terms 'receptor' and 'effector' before once again looking for appropriate evidence from which to draw conclusions. Numerous candidates were able to do this and scored full marks, but this was relatively rare and most scored 0, 1 or 2.

(c) This was a straightforward recall question of material in the supplement of the syllabus, but it was not well known. Better candidates frequently scored 2 marks, but it was rare to see an entirely correct and complete answer.

Question 8

(a) (i) There was 1 mark available here for the use of the term 'acceleration', and another for stating that the acceleration was steady or uniform. Unfortunately, many candidates said that acceleration was taking place 'at a constant speed' which is clearly not correct.

(ii) This was almost always answered correctly.

(b) Most candidates knew the correct formula, and many were also able to use it correctly to calculate the energy. Some, however, forgot to square velocity, and others gave no unit or an incorrect unit with their answer.

(c) Most candidates answered **(i)** and **(ii)** entirely correctly.

(d) This was also well answered, most suggesting that the skier would have accelerated more rapidly at the start of the race, reaching the same top speed earlier, or reaching a higher top speed. Some, however, failed to show this on the graph and so gained only 1 mark.

Question 9

(a) Most candidates knew the test for oxygen, although several said that you would 'blow out the splint' before placing it in the gas, or that you would place a 'burning splint' in the gas. Neither of these would work – the splint needs to be glowing.

(b) (i) Almost all candidates answered this correctly.

(ii) Most candidates were able to use the data to conclude that a higher concentration of hydrogen peroxide gave a higher rate of reaction. However, they had more difficulty in using ideas relating to collisions between molecules to explain this. Some did explain that there would be more frequent collisions (not just 'more collisions') at higher concentrations. Relatively few explained that these collisions would be between hydrogen peroxide and the catalyst, with many suggesting collisions between hydrogen peroxide molecules, or between oxygen molecules, or between something and the wall of the container.

(iii) Weaker candidates often simply gave a description of what a catalyst does, which did not answer the question. Good answers generally suggested that the candidate could measure the mass of the catalyst before and after the reaction and show that it had not changed.

(c) (i) This was generally well answered, with most candidates scoring 2 marks.

(ii) About equal numbers of candidates chose Q (correct) and P (incorrect), with a few opting for R.

CO-ORDINATED SCIENCES

Paper 0654/04

Coursework

(a) Nature of tasks set by Centres.

Of the Centres which submitted coursework for the June examination, most have provided coursework in previous years and have acted on advice given. In most Centres all the tasks set were appropriate to the requirements of the syllabus and the competence of the candidates.

All Centres had a good understanding of the skills being assessed. The standard of candidates' work was the same as in previous years. Candidates' work covered the whole mark range.

(b) Teacher's application of assessment criteria.

In all Centres the assessment criteria were understood and applied well for all of their activities. There has been a steady improvement in the Centres' application of assessment criteria.

Two Centres did not produce assessment criteria specific to the tasks set, basing their award of marks on those in the specification.

Some Centres use too many tasks, leading to candidates from the same Centre having a different assessment experience from their colleagues. This raises questions about internal moderation. Advice has been given to help these Centres avoid confusion in future.

(c) Recording of marks and teacher's annotation.

Tick lists remain popular particularly with skill C1.

Many Centres prefer to write a brief summary at the top of the script justifying their marks. Recommendations have been made encouraging the use of annotation on candidates' scripts. Many more Centres are using this technique to indicate or justify marks awarded.

There is still scope for further improvement with some Centres writing comprehensive summaries but not indicating the point at which the mark was awarded.

(d) Good practice.

Some Centres make very useful comments about individual candidates' performance on a summary sheet. Most Centres have developed a booklet of tasks and dedicated assessment criteria.

CO-ORDINATED SCIENCES

Paper 0654/05

Practical Test

General comments

Several Centres had difficulty in obtaining the chemical copper(I) oxide and they must be congratulated in their efforts to ensure the chemistry question could be answered. Others found their sample appeared black rather than red and the mark scheme was adjusted to take care of this. Some Supervisors may not have read the instructions carefully enough and not prepared the materials exactly as requested. Precise instructions were given for the preparation of the hydrogen peroxide for use in question 1 and a specific test-tube size was required for question 2. If these instructions were not adhered to, candidates may well have been penalised. Any changes to the instructions must be notified if Examiners are to be fair to candidates. The overall performance of candidates was similar to previous years.

Comments on specific questions

Question 1

Most candidates scored both marks in part **(a)**. A considerable number gave their answer in centimetres and then plotted it in mm. As mentioned above, the hydrogen peroxide solution needs to be prepared so that the height of foam produced in the test-tube after 5 minutes was no greater than 8 cm. A small number of Centres did not do this as candidates recorded heights of foam well in excess of 8 cm. This resulted in numbers too large for the printed scale on the graph and a consequent loss of marks. Actual plotting of points was good but the standard of drawing a smooth curve was very poor indeed. This is an annual complaint but mainly applies to curves in response to a biology exercise. Why candidates can draw smooth curves in a physics question but not when answering a biology question is inexplicable. Two of the four marks for this part were for drawing a smooth curve. Joined up points indicate a failure to appreciate the purpose of representing results graphically. Although most identified the curve C, many stated that it was the height of foam which showed this rather than referring to the rate. Part **(c)(ii)** usually produced one mark rather than two. Many appreciated that hydrogen peroxide needed to be removed quickly but made no reference to the potential build up in the liver. There were inevitable misreads in part **(d)**. Good candidates appreciated that hydrogen peroxide was running out whilst weaker candidates thought the enzyme had run out. Many lost a mark in part **(f)** for failing to state that the detergent should be left out of the experiment. There was a variety of descriptions for measuring the volume of oxygen, many failing to score anything. The use of a measuring syringe or even an upturned measuring cylinder was expected.

Question 2

The table was mostly well completed with only the weaker candidates recording weird values. Assuming the specified tubes were used the first value of h would be of the order of 30 mm and the last value around 110 mm. A few managed to record values of V increasing! Graphs in this question were of a high standard with correct labelling of the axes and sensible scales chosen. Many incorrectly assumed that the line passed through the origin which sometimes meant several points were ignored. Part **(e)** was answered quite well. Calculation of the internal diameter was usually well done. The answers were expected to be within the range 20–23 mm. All three marks were used in part **(g)** although only a small number appreciated that winding the string around the tube many times would increase the accuracy. In this instance, repeating the experiment many times did not score a mark.

Question 3

Answers to parts **(a)** and **(b)(i)** were taken together to avoid penalising those who had to use poor quality copper(I) oxide. **(b)(ii)** was poorly answered because in most cases the solid did not completely dissolve. This should not have prevented seeing a green colour followed by a blue colour when plenty of water was added. The colour of the residue and filtrate in **(c)** were mostly correct although a small number confused residue with filtrate. The majority obtained both marks for **(c)(ii)** but only by generous application of the mark scheme. In most cases there was no attempt to separate the colour of the precipitate from the colour of the solution and probably no shaking of the tube. Again there was much confusion between colour of solution and colour of solid and it was somewhat surprising that so few candidates recorded brown fumes in part **(d)**. Maybe 50% obtained the mark for copper in part **(e)**. A named compound was not accepted. The commonest incorrect answers were iron and even ammonia!

CO-ORDINATED SCIENCES

Paper 0654/06
Alternative to Practical

General comments

There was a high overall standard in the answers to this paper and teachers are to be congratulated for their careful preparation of their candidates in particular areas such as graph drawing and interpretation. However, answers to questions in chemistry continue to reveal weaknesses in knowledge and understanding.

The Examiners have long experience in writing questions and know the importance of using language that is accessible to candidates whose mother tongue is not English. Equally, the answers sometimes reveal these candidates' inability to explain ideas correctly and intelligibly. This is particularly true for questions involving specialised terms such as acceleration, speed, rate and so on.

The detailed comments on the questions will deal with these and other issues that arose during the marking of this paper.

Comments on specific questions

Question 1

Candidates are asked to construct a table to compare features of wind- and insect-pollinated flowers. The mark scheme shows that the correct construction of the table earns 2 marks, then the comparison of three features merits three others. The final mark is for any allusion to the mechanism of pollination.

The table needed headings for the two flowers and then three rows for the three features. Only one mark was awarded if the headings for the features were omitted.

The Examiners wanted a real comparison of the shape, attitude or size of the features in the two flowers. Some candidates contented themselves with a table containing ticks to show that the flowers possessed the features, and others did not compare the features correctly but made random statements. Any mention of, for example, the wind carrying away pollen from the exposed anthers of the wind-pollinated flowers, or insects carrying pollen to an upright stigma, earned the last mark.

Some candidates thought that the stigma produced pollen, and others used the word "seeds" instead of "pollen".

There was a very wide spread of marks awarded for this question.

Question 2

In this question, candidates were shown a diagram of zinc reacting with acid in a test-tube. The resulting gas was collected in an inverted measuring cylinder and readings were taken of the volume every minute for five minutes, when the reaction was nearly complete.

(a) Diagrams of the measuring cylinder showed the inverted scale, and the volumes of gas for the 2nd, 3rd and 4th minutes were read and recorded by the candidates. This was usually done correctly and was the easiest task in **Question 2**. Those who failed did not notice that the intermediate marks on the scale denoted the volume in increments of 2 cm^3.

(b) (i) This question was surprisingly difficult for many candidates. The question asks "The candidate decides that the gas is produced at a slower rate as time goes on. What does the candidate observe in the test-tube that confirms this?"

The problem phrase was "in the test-tube". Anyone who has ever added zinc to dilute hydrochloric acid should remember the bubbling and fizzing that occurs. So many candidates forgot this, or had never seen it. So they answered the question with reference to the measuring cylinder and the data in the table. Even so, they could have said that fewer bubbles were seen as time passed. The mark was awarded only if this observation was mentioned.

(ii) Now candidates had to use the data to illustrate the decrease in the rate of production of gas. Having already used the data in **part (i)**, many candidates looked for different ways to answer the question. Large numbers of candidates actually drew a graph and earned the two marks, although this was not asked for and not much space was available. All that was needed was a statement that, say, during the second minute a smaller volume of gas was produced than in the first minute, and numbers from the table quoted to support this statement. This question was usually answered fairly well.

(c) Here, a conventional multiple-choice question was used. Candidates had to choose the correct answer from five reasons why the rate of gas production slowed down. A diagram of the piece of zinc after the reaction had finished showed that it had decreased in size but it was still large enough for a further reaction if more acid had been added, so the zinc was in excess. In these circumstances, it is only the concentration of the acid that is the limiting factor and nothing else. The distractors in this question were the surface area of the zinc, the mass of the zinc, the temperature of the mixture and the volume of the acid. The surface area of the zinc cannot be the reason why the reaction slowed and stopped, because the surface was still significantly large after the reaction had finished. Response **A** was a popular, but it was pleasing to note that many very good candidates chose **D**.

(d) (i) "Describe how the candidate can show that the gas is hydrogen. " Examiners expected that this would be found easy by almost every candidate. Many answered the question well, but glowing splints were very common. It was apparent that the "pop" heard when the hydrogen is ignited is seen to be the important sign, so candidates do not understand that this is caused by the hydrogen burning in air.

(ii) The complete failure of all candidates from many Centres to write a word equation for the reaction of the hydrogen in the "pop" test illustrates the last remark above. Many word equations involved carbon dioxide as a product, and "hydrogen oxide" was also a common occurrence (though it was merited!) This was the most disappointing feature of the answers to this question, showing that the combustion of hydrogen is very widely misunderstood.

Question 3

This question is based on the movement of a trolley along a track, pulled by a hanging weight having the same mass as the trolley. It is an attempt to explore candidates' understanding of ideas about speed, time and acceleration.

(a) Images of the trolley and track, at 0.1 second intervals, show the position of the trolley next to a scale. Candidates had to read the scale and complete the table of times in seconds and distances in centimetres. This was usually satisfactorily done. A few candidates failed to notice the marker arrow and read the position of the front edge or some other part of the trolley, so they earned a maximum of one mark out of three.

(b) A graph showing distance on the vertical axis and time on the horizontal axis had to be drawn. A few candidates reversed the axes and lost a mark, but most candidates earned all three marks.

(c) Candidates were asked to show, using the graph or by some other means, that the trolley accelerated. There was a wide variety of answers here. The Examiners looked for a statement such as "the gradient (or slope) of the graph increases." This was enough to earn both marks available. The better candidates quoted the figures from the table to show that the distance moved in each 0.1 s increased as time went on. There were far too many statements such as "the graph curves up so the trolley is accelerating." A few candidates incorrectly wrote that "if the graph is horizontal the speed will be constant". Others declared that "the distance travelled increases with time". This statement is, of course, true about a trolley moving at a constant speed, so there must be reference to increasing distances in equal time periods to explain the concept of acceleration.

Despite the problems, many candidates scored well in this section.

(d) (i) Now the candidate must first predict how the results will change if the mass of the trolley is 2 kg instead of 1 kg. Some candidates thought that, because the trolley is now heavier than the hanging mass, it would not move at all. Other answers not credited include statements such as "the trolley will move shorter distances". The Examiners needed a statement about the distances travelled in unit times, or that the speed of the trolley would be less. Strictly, the answer "the speed of the trolley will decrease" is not accurate since it suggests that the trolley will start at a fast speed and then slow down; however, answers of this kind were often credited.

(ii) Secondly, the 1 kg mass is replaced by a 2 kg mass. "The trolley will move faster" gained the mark, and so did "the trolley would accelerate more." It was implicit that the original 1 kg trolley remained, though a few candidates thought that the trolley was now also 2 kg. If the candidate's answer clearly showed that this was how he or she understood the question, a mark was given for an answer that the results would be the same as the original experiment.

Question 4

In the experiment on which this question is based, living tissue is placed in a solution containing hydrogen peroxide and detergent. The oxygen liberated by catalase enzymes is trapped in a foam whose height in the reaction tube is measured.

(a) Two heights of foam must be recorded from diagrams showing the centimetre scales on the reaction tube. Most candidates read the scales correctly.

(b) Graphs must be plotted using data from the two experiments with pieces of potato and pieces of animal liver. In experiment **A**, the potato caused heights of foam that were much smaller than those produced by the liver in experiment **B**. A few candidates plotted the results of experiment **A** using the total height of the graph paper and then found that they had to plot experiment **B** on the same graph; they failed to read the question through first. However, most candidates produced good answers.

(c) Which tissue contained the more active catalase? This was easily answered, but explanations of how this was decided were not always convincing.

(d) The increase in height of foam for the first 2 minutes, and between the 3rd and 5th minute, of the liver experiment, had to be calculated. Sometimes the question was not read accurately, leading to wrong answers here.

An explanation was sought for the smaller increases in the height of the foam as the reaction proceeded. Some candidates thought that the surface area of the liver had broken down as a result of the reaction. Others said that the catalase had been used up or denatured. The answer that the hydrogen peroxide had decreased in concentration, so less oxygen could be evolved, was given only by a minority of candidates.

(e) Lastly, candidates were asked how the experiment could be adapted so that the volume of oxygen given off could be measured. A diagram could be drawn. The Examiners looked for a diagram that included a suitable way of collecting the oxygen, e.g. over water or in a gas syringe. Some graduations on the apparatus must be shown for the second mark. Answers that merely said that the foam could be measured in cm^3 in a graduated tube were given no credit.

Most candidates scored well in this question. Marks were lost mainly in ***sections (d)*** and ***(e)***.

Question 5

Like **Questions 1** and **6**, **Question 5** is based on the corresponding question in the Practical Paper 5. The question includes references to chemical reactions found in the biology section of the syllabus. These include the use of Benedict's reagent and the colour reaction of iodine added to starch.

(a) Benedict's containing copper(II) sulfate is added to glucose solution and warmed. There is a red precipitate.

(i) Most candidates knew that Benedict's reagent is a blue solution.

(ii) A diagram must be drawn to show how the red precipitate could be removed from the colourless solution. A sketch showing a filter paper in a funnel could gain two marks here. The diagrams were often messy and inaccurate.

(iii) The teacher says that the red precipitate is copper oxide, formed by reduction of copper(II) sulfate. Given a choice between three possible formulae of the red copper oxide, candidates must choose Cu_2O. Only a minority did so.

(b) The red copper oxide is placed in acid. A blue solution is formed with a brown solid. How can the candidate show that the brown solid is a metal? There were many candidates who suggested the use of a magnet. Others said that the metal will give hydrogen when it is reacted with an acid. The correct answer, that a metal will conduct electricity, was not often provided.

(c) Copper(II) sulfate is added to potassium iodide, and the mixture becomes brown. How can the candidate confirm the presence of iodine? This was answered by a number of candidates who recalled that iodine gives a blue/black mixture with starch. Some acceptable answers involved the use of potato or bread! Some candidates, remembering the test for starch, merely wrote "add iodine to give a blue/black colour."

(d) Copper(II) sulfate is added to powdered zinc. There is an exothermic reaction and a change of colour. What three observations can the candidate make?

As in **Question 1(a)** there seems to be a general misunderstanding about the use and meanings of the words "observe" and "observation". In this and in other Science examinations, it means something that is seen and noted that is relevant to a particular change, reaction or event. The question gives some information about the reaction between copper(II) sulfate and zinc, and it is reasonable to expect that even if candidates had never seen this done, they could deduce what can be observed during the reaction.

Far too many candidates gave vague suggestions that were irrelevant to the described reaction or were just wrong, gaining no marks. For example, "1. the change of temperature 2. the change of colour 3. there is a precipitate."

The Examiners were very disappointed by the answers to this question.

Question 6

Amounts of water are transferred from a measuring cylinder holding 100 cm^3 to a large test-tube. The heights of the water in the test-tube are found and a graph is drawn, from which the internal diameter of the test-tube can be calculated.

(a) (i) Candidates must use a ruler to measure, to the nearest millimetre, the heights of water in diagrams of test-tubes. This was usually well done. A few candidates, despite the instructions in the question and the heading of the table, measured the heights in centimetres; this meant difficulties in plotting the graph. Some candidates did not possess a ruler, and in one case, a Centre had forbidden the use of rulers in the examination. The syllabus makes it clear that rulers, calculators, protractors and other aids may be used and are often needed in this examination.

(ii) The volumes of water left behind in the measuring cylinder were read and recorded. This sometimes led to errors when candidates did not notice that the scale was calibrated in 2 cm^3 increments.

(iii) The volume left in the cylinder must be subtracted from 100 to find the actual volume transferred to the test-tube. Three values were already noted in the table. There was a slight problem in that one of these values, where the volume transferred was stated to be 9 cm^3 where it should have been 11 cm^3. The Examiners ensured that no candidates would be disadvantaged by this problem .

(b) Candidates had to plot a graph of the volume of water /cm^3 against the height of water in the test-tube/ mm. Then they had to draw the best straight line. Centres should note that points to be plotted never fall on exact straight lines. This is for two reasons: 1. experimental results always contain a degree of experimental error, 2. it is then easy for the Examiners to spot when a candidate has obtained a reading direct from the graph instead of from a scale or calculation.

In this question, one mark is awarded for plotting at least four of the five points on the graph. The second mark is for drawing the best straight line, and even if this line did not pass through the origin, a mark was still awarded. So the problem in the data referred to above did not affect the marks awarded in this part of the question.

The majority of candidates obtained two marks, and those who lost a mark did so because they did not draw a straight line.

(c) (i) The graph must be used to find the volume of water, $\mathbf{V_w}$, between the heights in the test-tube of 30 mm and 100 mm. The graph must be suitably marked to show how this calculation was done. A majority of candidates managed to find an answer to this question, although some of them did not show the 30 mm and 100 mm lines that would indicate their method. The Examiners accepted any indication such as marks at h = 30 and h = 100 on the actual straight line.

(ii) Now the value of $\mathbf{V_w}$ was used to calculate **d**, the internal diameter of the test-tube using a given equation:

$$\mathbf{d} = \sqrt{\frac{\mathbf{V_w}}{0.24}}$$

Some candidates did not know the meaning of the square root sign or had no calculator to use. This was a pity, but the syllabus makes it clear that finding the square root is an essential mathematical skill.

Question 6 was well answered by most candidates.