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CO-ORDINATED SCIENCES

Paper 0654/01
Multiple Choice

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18	**C**	38	**C**
19	**D**	39	**A**
20	**C**	40	**C**

General comments

All questions, apart from **Question 8**, performed very satisfactorily. They provided acceptable levels of difficulty and discriminated well between candidates of varying ability.

The paper achieved a mean mark of 27.3 (equivalent to an average mark of 0.68 per question) with a standard deviation of 6.7. These statistics indicate that the paper was satisfactory in discriminating between candidates of differing competence in the subject. However, the average mark per Chemistry question was slightly lower at 0.53. Poor recall seems to be relevant in explaining this lower facility. See also below in the **Comments on specific questions**.

As has been the case for several years, the paper is offered by candidates aiming for Grades A to C as well as those of more modest expectations. This being so, the **Comments on specific questions** concentrate on aspects of the performance of the lower scoring candidates. However, with a small entry, the inferences to be drawn from the statistics for the individual questions are less certain.

The mean on this paper has fallen slightly since this time last year, but is still very satisfactory. In particular, the Physics items showed a high degree of competence amongst the candidates.

Comments on specific questions

Question 1

This was the easiest of the biology questions requiring candidates first to recognise the class to which the animal belonged, then to select a further feature of this class. This represented a novel approach to a familiar theme, but candidates coped admirably.

Question 2

There was rather a lot of information here for the candidates to digest before arriving at the correct answer. An understanding that muscle X can only pull on the bone, that the bone in question is the radius, and a familiarity with the word 'flexes' are all necessary. 42% were guilty of faulty navigation when finding their way to the answer.

Question 8

Many candidates were either guilty here of failing to think sufficiently carefully before answering or of confusion between anaerobic respiration when it occurs in muscles and when it occurs in yeast in a sugar solution. Just over half the candidates thought that CO_2 would be evolved, and this included a significant number of candidates who, otherwise, did very well in the paper.

Question 11

That the changes that occur in the male between the ages of 8 and 20 years are due to a sex hormone was almost universally known, but that as many as 5% should think that they are the result of progesterone production was, perhaps, slightly surprising.

Question14

This question had a low facility primarily because the key (**A**) was the least favourite choice amongst the lower scoring candidates. Across the ability range, response **C** was rather popular but the characteristic of glass is the disordered arrangement of its atoms.

Question 15

This was also found hard but it discriminated very well. About a third each of the lower scoring candidates chose **B** and **D**. Copper has the first of the three properties listed whereas sulphur has the other two. Did these candidates latch on to the bits they knew without tying all three properties together in carbon (as graphite)?

Question 16

This caught-out candidates across the ability range. Response **C**, rather than the key **D**, was the most popular choice. This points to a lack of understanding of the difference between simple distillation and fractional distillation.

Question 17

Section C1 of the syllabus requires candidates to "know quantitatively that 'amount of substance' has a precise meaning in chemistry". This question sought to test this concept. Only 30% answered correctly with 39% choosing **B**. The atoms of different elements have different masses so, in the context of this question, atoms have to be counted to compare different amounts of substance. Response **B** is precisely the wrong way round.

Question 19

It is surprising and not readily explicable that 40% of the lower scoring candidates chose **B**.

Question 20

A similar comment as for **Question 19** except that, this time, response **A** was too attractive for the lower scoring candidates (47%).

Question 21

It is almost certain that the lower scoring candidates merely guessed. The basis of the question is, of course, that neutralisation is an exothermic reaction so that the temperature rises and reaches a maximum as the point of neutralisation is reached.

Question 22

It is disappointing that as many as 40% of the lower scoring candidates chose **B** with only 20% answering correctly. Alkali does release ammonia from its salts but this is not the test.

Question 24

This had excellent discrimination. This arises from the fact that, amongst the lower scoring candidates, responses **A** and **C** were both much more popular than **B**. No obvious explanation suggests itself.

Question 25

Most of the lower scoring candidates did choose the key (**D**) but all of the other responses were not far behind. This is, again, surprising – see section C14 of the syllabus – "be aware of the use of oxygen in welding .....".

Question 26

Although 40% of the lower scoring candidates answered correctly, some 30% of them chose **B**. It might be worth stressing that in a simple cell the electrodes have to be different.

Question 27

It is disappointing for such a question based on simple recall that only 10% of the lower scoring candidates answered correctly.

Amongst the Physics questions, only **Question 33** caused any serious problems, and that was not because the question was particularly difficult; indeed it was set on a very basic part of the syllabus, and it was surprising that so many competent candidates answered it incorrectly. All the items in the range **28 – 40** (i.e. the Physics items), with the exception of **33** and **35**, were answered correctly by a large percentage of candidates.

Question 33

This showed a general lack of understanding about energy changes. Most realised that the car had kinetic energy to start with, but the vast majority thought that the energy of the slowing car was converted into gravitational energy.

Question 35

When answering this question, some candidates appeared uncertain about the order of the regions in the e-m spectrum and only just under two-thirds answered correctly.

Paper 0654/02

Paper 2 (Core)

General comments

Most candidates were able to attempt most questions and often managed to write a considerable amount. Many gained good marks on one question but then gained few marks elsewhere. **Questions 5**, **9** and **10** were very poorly answered by many candidates. Many marks were lost by a lack of precision in giving answers. Although it appeared that candidates often knew the substance of the question, they gave answers, which were very vague. Perhaps language difficulties played some part here. There was no evidence of candidates suffering from a shortage of time to complete the examination, although it was evident that some of the weakest candidates appeared to make little effort with some of the questions.

Comments on specific questions

Question 1

This question was generally well answered by only the better candidates.

(a) Only the more able candidates knew that tissue was the answer.

(b) Many candidates gave a correct answer. A few lost the mark because their labelling line was not accurate enough.

(c) Many candidates gained one mark here. Either they mentioned chloroplasts or chlorophyll or discussed the absorption of sunlight.

(d) This was poorly answered. There were five possible marking points and most candidates failed to score even one. The significance of the position of these cells and their function was not well known.

(e) Photosynthesis was well known, but respiration less so.

Question 2

This question was well answered.

(a)(i) Almost all candidates scored at least one mark here for correctly identifying at least two stages on the journey. A good number of candidates scored full marks, showing good data handling skills.

(ii) This part was well answered.

(b) Most candidates gained some credit in this part. A common error was to either omit the half at the beginning of the formula or omitting the squaring of the velocity.

(c)(i) Answers to this part were generally good. A few candidates drew series circuits.

(ii) This was well answered.

(iii) This was very well answered.

Answers: **(a)(ii)** 100 km/h; **(b)** 200 000 J; **(c)(iii)** 13 A.

Question 3

This question was not well answered by many candidates.

(a) Although many candidates correctly gave C and A for the first two answers, most gave either B or D for the giant structure. Perhaps these candidates mistakenly assumed that each answer could only be used once.

(b) This was surprisingly poorly answered.

(c) Although many candidates realised that paint acted as a barrier, few candidates stated that the barrier was to stop both water and oxygen. The majority appreciated that bicycle chains are oiled.

(d) Few candidates gave answers in terms of chemical reaction. Many suggested that electrons were used up.

Question 4

(a) Many candidates correctly identified the lens as **A**, but the identity of **B** as the vitreous humour and **C** as the choroid were not well known.

(b) This part was also poorly answered. Many candidates labelled the blind spot as the point where the image is focused.

(c) There was a very disappointing level of correct answers for this part. The role of the optic nerve was known by many but not the fact that electrical impulses are transmitted.

(d)(i) There were very few correct answers here. Few answers were given in terms of different frequencies or wavelengths.

(ii) Here the vast majority of answers given were in terms of warm blooded animals, without any explanation of where the heat comes from.

Question 5

This question was reasonably well answered.

(a)(i) Very few candidates were able to give an answer in terms of electrons.

(ii) Very few candidates chose to give an answer relating to the charge on a beta particle. Most gave a reference to penetration but were unclear what it would penetrate and what it would not.

(b) This was well answered by the more able candidates. There was a lot of misreading of the graph intercept by the majority.

(c) Although many candidates only gained one mark here, the ideas were well known.

Answer: **(b)** 5500 years.

Question 6

Many candidates gained marks on a variety of parts of this question, although there were few, who gained high marks overall.

(a)(i) Most candidates correctly identified aluminium and many correctly identified iron and chlorine.

(ii) Fewer candidates were able to identify sodium as the most common alkali metal and even fewer gave the correct symbol. Calcium was a common wrong answer.

(iii) Many candidates gained one mark here for correctly identifying either silicon or oxygen.

(b) Only the more able candidates scored anything here. The answer required a good understanding of chemistry and the ability to explain this in words.

(c)(i) This part showed few good descriptions of weathering/erosion. These ideas were not well known by the candidates.

(ii) This was well answered.

(iii) This was well answered. Most candidates gained at least one mark but few gained both.

Question 7

Most candidates gained some marks on this question.

(a) Most candidates gained full marks here.

(b) Many candidates thought that sperm cells needed to be small so that they could enter the egg cell or that they needed to be small because of the large number produced.

(c) Only the more able candidates managed to answer this correctly.

(d) Most candidates gained at least one mark here.

Question 8

This question was quite well answered. Many candidates found some parts of this question, which they could answer correctly.

(a) Most candidates knew most of the correct answers, but few knew all five.

(b) Few candidates knew that the temperature remained constant when ice melted into water. Fewer realised that the constant temperature was $0^{o}C$.

(c) This part was well known

(d) Efficiency was not a concept which many of the candidates could begin to describe. There were many blank spaces on this question.

Question 9

This question was well answered until momentum was questioned.

(a) Most candidates correctly identified the skier and the idea of reduced pressure because of greater surface area.

(b) Most candidates gained at least one mark here. The common source of error was that many candidates forgot to calculate their answer on the basis of both feet rather than just one.

(c) Most candidates knew what the correct answer was but some failed to explain it sufficiently. Many candidates did not use the word friction, which would have helped their answer.

(d) Both parts of this question were poorly answered. Even the most able candidates were unable to answer in terms of conservation of momentum or even just momentum.

Answer: **(b)** 2 N/cm^2.

Question 10

This question was well answered in parts.

(a) Almost all candidates gained some marks on this part. Parts **(i)**, **(ii)** and **(iii)** were the best answered. In part **(iv)**, many candidates gave the units as cm^3 rather than dm^3. Few candidates appreciated the problems of adding too much alkali to the acidic waste.

(b)(i) Few candidates gave an answer other than dumping rubbish in rivers.

(ii) This was well answered. Most candidates gave chlorination as their answer.

Answer: **(a)(iv)** 4000 dm^3.

Question 11

(a)(i) Most candidates were able to write down the correct food chain. Common mistakes were either to draw the arrows going the wrong way or to refer to the grass as plants.

(ii) Few candidates referred to energy transfer here. What eats what was a very common answer.

(iii) Almost all the candidates correctly identified the grass as the producer.

(b)(i) Few candidates understood the function of protease.

(ii) Even fewer candidates were able to explain the function of amylase.

(c) Any characteristic of a mammal was often suggested here, although hair was the commonest answer.

Paper 0654/03
Paper 3 (Extended)

General comments

A very wide range of performance was seen on this paper. Some Centres appeared to have entered all of their candidates for this route, rather than for Paper 2 and consequently many struggled to answer questions that included material with which they appeared to be unfamiliar. In contrast, many candidates did very well indeed, showing mastery of almost all of the topics covered by the questions. Language was a problem for some, causing difficulties both in understanding the requirements of the question and in communicating answers.

It is important for candidates to understand that, where they are asked to state a formula, only the full formula will be credited. For example, simply stating 'mass x specific heating capacity x temperature change' is not enough in **Question 10 (b)(i)** – the full formula should begin with 'energy transferred = mass x ....'. The reason for this becomes obvious when using formulae such as the one for calculating total resistance in a parallel circuit. It is also important that, where abbreviations or symbols are used in formulae, they should be ones which are universally understood and not ones invented by the candidate.

Comments on specific questions

Question 1

(a) This was done well on the whole. Most were able to show on the graph that they were looking for the time that corresponded to a halving of the count rate, although many did not read the scale correctly.

(b) Some candidates correctly identified the type of radiation as beta, and explained that a neutron had been converted to a proton and electron, the latter being emitted. However, many others were unfamiliar with this material and could not offer any correct response.

Question 2

(a)(i) Most correctly named carbon, hydrogen and oxygen, although weaker candidates often gave lists of nutrients, such as starch, sugar and glucose.

(ii) Many weaker candidates could not provide a relevant answer to this question, often writing about plastics. Those who related their answer to starch and glucose often scored at least one mark, but did not always make clear that the monomers are *linked in a chain* in a polymer.

(iii) This was surprisingly poorly answered, a very frequent incorrect response being 'amino acids'.

(b) The expected answer here was that the kinetic energy of the molecules increases when the temperature increases, resulting in them hitting the 'walls' of the grain more often or with more force. The question discriminated well.

(c)(i) The commonest answer was 'emulsion', which was not accepted as the general term 'colloid' was required.

(ii) This was well answered overall, many answers including light rays bouncing off the 'particles' in the diagram.

(d) The diagrams offered by candidates here were all too frequently carelessly drawn, so that it was difficult to be sure of their intention. Marks were awarded in the first diagram for all of the atoms being the same size (many varied enormously) and being close packed in a regular pattern (the regular pattern could not always be discerned). Similarly, the second box needed to contain two clearly different sizes of atom, with the 'new' atom breaking the pattern of regularity. Some candidates may have known this, but their diagrams did not clearly show it. With four marks available, it should have been realised that a little time taken here could be worthwhile.

Question 3

(a) Most labelled a cell wall, and this was well done with a label line drawn carefully and with a suitable cell wall chosen so that it could not be confused with a cell surface membrane. However, by no means all candidates knew the function of a cell wall, and many answers clearly confused it with a cell membrane. Marks were awarded for the idea that it supports the cell or holds it in shape, and also that it prevents the cell from bursting when 'filled' with water.

A few chose to label a vacuole, and marks could be gained here for mentioning that it contains cell sap, acts as store of minerals or other soluble nutrients (not starch) and helps to maintain turgor.

(b) Many candidates wrote an answer here that would have been more suitable as an answer to **(c)**. Those who did think about the *structure* of the cells usually picked up at least one mark, usually for a mention of the chloroplasts. However, they often did not *explain* their answer – for example by stating that the chloroplasts contain chlorophyll which absorbs energy from sunlight.

(c) Many arrived here having already given an attempt at this answer in **(b)**. The majority struggled to find anything at all relevant to say, and gave the impression that they had no knowledge at all of the position of these cells in the leaf, or how light and carbon dioxide reached them. This is very disappointing, as this is required material in the syllabus and is not conceptually difficult.

(d) Better candidates were able to give the term 'tissue', but most were still thinking only of leaves and suggested other leaf-related tissues such as 'mesophyll' or 'epidermis'.

Question 4

(a) Arrows were usually drawn correctly, although B was often shown pointing backwards rather than forwards.

(b) Where candidates thought of *acceleration* (as stated in the question), especially if they remembered the relationship f = ma, they usually scored at least 2 marks. However, most did not and suggested that having a low mass would reduce weight and so make it easier to lift off the ground, or that it somehow reduced air resistance.

(c) Answers needed to refer to both light and sound to gain full marks. Many answered only in terms of sound, stating that the athletes would hear the sound before the spectator, which does not really answer the question. Some included a calculation in their answer, working out that the sound would take 0.25 s to reach the spectator, and this was credited.

Question 5

This question was often well answered even by candidates who did not do well in other parts of the paper.

(a) Most knew that the gas was hydrogen, although some offered oxygen or carbon dioxide.

(b)(i) Almost all answered this correctly. A few weaker candidates listed actual metals (for example potassium, sodium and so on) in the order of the reactivity series.

(ii) Better candidates normally scored 2 or 3 marks here.

(c) This was usually answered correctly. However, many gave answers that bore no relationship to the solutions, such as copper as a product from magnesium sulphate.

(d) This was the most difficult part of the question, and discriminated well. There were many completely correct answers in terms of whether the metal is above or below hydrogen in the reactivity series, while others had the right idea but did not relate reactivity to that of hydrogen.

Question 6

(a) A surprising number of candidates could not label either the area where the image is focused or the iris. Some attempted to do so without drawing label lines, or drew lines carelessly so that it was not possible to be sure what they were labelling. Better candidates normally indicated both areas correctly.

(b) Weaker candidates often got bogged down with lengthy answers about how the image is upside down and the brain turns it right way up. This was not relevant to the question. Marks were awarded for the idea that the information is transmitted in the form of electrical impulses, along a sensory neurone, and in the optic nerve.

(c) This was not well answered, and even the better candidates often scored only two marks. Many refused to believe what they were told in the question, and wrote about how *relaxation* of the ciliary muscle achieves a clear focus in this situation. There was a great deal of completely irrelevant and wrong material about the retina changing shape, and some appeared not to know that the lens is involved in the fine-tuning of focusing. However, some candidates knew this well, and were able to describe the slackening of the suspensory ligaments, the increase in convexity of the lens, and the resulting reduction in focal length.

(d) The responses to this question were surprising, and suggested that some candidates were thrown by the context. Many stated that the snake would *not* be able to see colours or that it *could* see well at night, clearly imposing what they thought should be true of snakes on their previous knowledge of the functions of rods and cones. There were even many answers that made no use at all of the information given, making suggestions such as snakes have eyes without pupils, their eyes are not round or that they do not have eyelids.

(e)(i) This, too, was surprisingly poorly answered. Candidates were expected to state that infra-red radiation has a longer wavelength (or a lower frequency) than visible light.

(ii) This question was intended as a challenge for the more able candidates, and these often answered it well, stating that mammals are warmer than their environment, and explaining that this is because they maintain a constant body temperature. Some went further by explaining that metabolic reactions such as respiration release heat. Candidates should be steered away from the non-scientific term 'warm-blooded'.

Question 7

(a) This was answered correctly by almost all candidates.

(b) A wide range of answers appeared here. Better candidates had no difficulty, correctly calculating the area under the graph and giving their answer in metres (or kilometres). Many did not, simply using the formula distance = speed x time. Some knew how to do the calculation, but made an arithmetical slip along the way, which could still give them two out of the available three marks if they had showed their working fully.

(c) Candidates who realised that this was about momentum usually scored a mark for their formula, even if they could not work through the calculation correctly. On the whole, it was well answered by these candidates.

(d) Most knew the formula for this and were able to calculate the resistance correctly and give units in the answers. However, some did not know a suitable formula and even many of those who did were unable to handle the addition of fractions or turn over their answer to give a reciprocal.

Answers: **(b)** 5500 m; **(c)** 0.8125 ms^{-1}; **(d)** 2 ohms.

Question 8

(a)(i) It was very surprising to find many candidates unable to give the purpose of a catalyst.

(ii) While the majority of candidates were able to suggest that some of the nitrogen and hydrogen might not have reacted, relatively few explained that the reaction is a reversible one and that some of the product reacts to give hydrogen and nitrogen.

(iii) This was usually well done.

(iv) Very few candidates were able to name the substance as sulphur dioxide.

(b) Better candidates did this perfectly, but many did not know where to begin.

(c)(i) It was often very difficult to follow the working in the answers offered here. It was crucial that this should be shown clearly, as of course the actual answer was already known so it was the method of arriving at it that was being marked. All the same, many did this well and it was not uncommon to award three marks.

(ii) Weaker candidates were not able even to calculate the relative molecular mass of ammonium nitrate. Those who did so did not always remember that there was 0.01 mole of ammonium nitrate produced, or did not give the unit in their final answer.

Answer: **(c)(ii)** 0.08 g.

Question 9

(a)(i) The most frequent error here was to draw arrows pointing in the wrong direction.

(ii) The expected answer was 'energy flow'. 'Eaten by' was not credited.

(iii) Candidates should realise that a pyramid of biomass is a type of graph, in which the area of each box represents the biomass at that particular trophic level. It should therefore be drawn as a stack of rectangular boxes and not as a triangle, even when it is not intended to represent actual data.

Answers did not always use the correct terms for the feeding levels.

(b)(i) Many answered this well. Credit was given for the idea that this would be caused by genes, either by a mutation or because offspring were born to two heterozygous parents each carrying a recessive allele for albinism.

(ii) While this was very well answered by many candidates, in some cases candidates appeared to know nothing at all about natural selection, and wrote answers along the lines of 'nature knows that brown is the best colour and so makes sure that white deer are not born'. Most, however, suggested that the white deer might be more easily seen by tigers, and therefore killed more often than brown ones. Only the best candidates continued their explanation by stating that the white deer would therefore be less likely to breed and pass on their genes to the next generation.

Question 10

(a) Where the formula was the right way round, candidates normally did well here, although a common error was to use the figure of 6 rather than 0.06 in the calculation.

(b)(i) A very pleasing proportion of candidates knew the correct formula to use, stated it correctly and arrived at the right answer.

(ii) A candidate either knew how to do this or not. Errors from **(i)** could be carried forward to this part of the question.

(iii) This was usually answered with an appropriate suggestion.

(c) This was not well done by most. However, many correctly suggested that the switch only closed and completed a circuit when the door was closed. Some also stated that it would contain a magnetic strip which would be attracted (or repelled) by the magnet in the door when it was closed.

Answers: **(a)** 5×10^9 Hz; **(b)(i)** 180 000 J, **(ii)** 75% (0.75).

Paper 0654/05

Practical Test

General comments

Both questions and answers were of a similar standard to previous years. There were very few good answers, but few poor ones. The most difficult parts of questions are still those parts where candidates are required to think for themselves rather than simply follow instructions. It is appreciated that Supervisors have great responsibility and sometimes need to improvise. For example, the use of hydrogen peroxide should suggest care in its storage over a period of time. A complaint from some candidates referred to poor fitting bungs.

Comments on specific questions

Question 1

Answers to part **(a)** were very varied. Some found that no bubbles were produced, some that the number of bubbles increased as the temperature increased whilst others thought that the number of bubbles decreased. It should be noted that many candidates did obtain a rise for the first two or three temperatures then a fall. One has to ask why some could perform the experiment satisfactorily whilst others could not. One answer, already alluded to above, concerns the handling of the hydrogen peroxide. Did some candidates allow the solution to heat up too much and thus destroy the activity or was the solution left too long in the laboratory for some groups. Some presumably misunderstood the meaning of the column headed 'number of bubbles per minute.' Did they think it was necessary to carry out the experiment a second time and count per minute? If not, then they were unable to correctly divide by two.

The quality of graph depended very much upon the values obtained in **(a)**. Many seemed to realise that enzymes work best at certain temperatures and tried to make their graph indicate this. Very difficult if there were few or no bubbles to count.

Part **(c)** was often answered from knowledge rather than experimental data. It is important to emphasise that using the collected data, even if it conflicts with their knowledge, is what scores the marks.

Almost all candidates thought that cutting the potatoes more accurately was the required answer for **(d)**. Only a small number thought about keeping a constant temperature or measuring the gas more carefully. Answers to part **(e)** revealed how few understand the difference between the words area, volume, amount and size. These words do not equate to surface area. Answers such as 'use smaller or bigger pieces of potato' did not score. Perhaps not surprisingly, the most common error was to restate the question e.g. 'do the experiment again with more surface area'. Clearly it is necessary to describe how this is done. Few mentioned the need to retain all other variables constant to produce a fair test.

Question 2

Presumably some Centres had difficulty in producing a darkened area for good quality images to be seen. However, once again, some candidates did succeed in doing a good experiment and must have overcome such difficulty. Values of 'f' varied greatly and only values within 15% of the Supervisor's value were acceptable. Very few could correctly complete all of Fig. 2.3. A numerical value was acceptable for the image position as well as an answer in words.

Answers to part **(c)** were very poor. One of the requirements of the practical examination is to 'follow instructions' and another is to 'measure accurately'. Few demonstrated these skills in this part of the question. A surprising number were unable to construct the ray diagram correctly. Lines were often drawn all over the place. Many who did succeed in producing a suitable ray diagram were very careless and often lost marks because it was drawn with a thick pencil or pen. Consequently it was not possible to accurately measure the vertical distance. A height of between 23 and 27 mm was acceptable. A significant number could not record their answer in millimetres, so losing a mark.

Question 3

Despite the difficulty in achieving consistent values for the time, the experiment was done quite well and many candidates scored highly. Again, the Supervisor's values were important but candidates were only required to be within 20% of such values. Clearly the value for the lowest concentration was the most unreliable. Some lost a mark because they did not record all times in seconds. Most candidates coped well with the graph. One very large value made scaling somewhat more difficult than usual but this did not appear to worry too many. Reasonably smooth curves were usually drawn and the reading was mostly correct. A number of candidates were reversing values on the horizontal axis i.e. starting with the large value and moving to the lowest value. This ought to be discouraged as a matter of principle.

The mark in part **(d)** was only awarded if the answer referred to the rate and not just time. Answers to part **(e)** varied greatly. Some thought it was an experiment to prove hydrogen was evolved and consequently scored nothing. Others had clearly met the idea of measuring the gas with a syringe or upturned measuring cylinder and produced satisfactory answers.

Paper 0654/06

Alternative to Practical

General comments

This paper was devised for candidates to show experience of laboratory techniques, read and record data to be used in drawing conclusions and to suggest modifications or further experiments. A good knowledge of the syllabus content is also required, and last but by no means least, candidates should have used and learned the Notes For Use In Qualitative Analysis printed on page 22 of the syllabus. The Alternative-to Practical paper is therefore not an easy option for candidates, and the year-on-year statistics support this statement. However, some Centres find it a useful alternative to the Practical Examination.

This session's paper was successful in all the above aims. The Examiners have been pleased to mark many excellent scripts.

Comments on specific questions

Question 1

This easy experiment can be used at IGCSE Level to investigate the characteristics of enzymes. The apparatus required is simple. The more able candidates were able to suggest improvements to the method based on their appreciation of the ways in which change of temperature affects the activity of enzymes. A commendable number of candidates gained 9 or 10 marks for their answers to this question.

(a) Almost all candidates correctly read and recorded the temperature.

(b) The completion of the table depended on the candidate reading the column headings. A few candidates did not do so but guessed at the answers.

(c) The size of the graph grid meant that candidates had to carefully decide on the scale to be used. Some candidates sensibly began the number scale at 10 per mnt and the temperature at 20°C; this meant that the origin must not be labelled "0", or a mark is lost. Ideally a curve should be drawn for this graph but the drawing of straight lines between the points was accepted.

(d) The Examiners looked for references to characteristics of enzymes in the answers, such as the increase in reactivity as the temperature is raised, an optimum temperature and the effect of denaturing at higher temperatures. Answers that merely explained the shape of the graph in terms of change of reaction rate gained no marks.

(e) The answers to this question varied with candidates' perceptions of the reasons for the investigation. Those who were content to suggest ways to improve accuracy of the results in Fig 1.3 merely suggested repeating the experiments and finding the average, measuring the volume of oxygen given off using a syringe, or using a water bath to ensure a constant temperature. Some better candidates, understanding that the whole experiment may be designed to find the optimum temperature, suggested finding the enzyme activity at intermediate points or over a wider range of temperatures. The explanations had to match the suggested improvements to deserve the second mark. Some answers referred rather illogically to changing the size of the potato pieces.

Question 2

This question is based on a simple investigation, requiring only different concentrations of acid, a few centimetres of magnesium and a stop-clock. Several skills are involved in giving correct answers; despite the problems, a significant number of candidates scored full marks on this question.

(a)(i) Some candidates did not see the easy way to calculate the concentrations of acid; find the fraction *volume of acid/100* and then multiply it by 4. It is likely that many candidates perceived the answer without doing any mathematics. Some wrongly gave the concentration in experiment 4 as 0.3 or 0.33 mol/dm^3.

(ii) As usual in questions of this type, a few candidates tried to fill in the table without reading the information given in part **(ii)**, so the times given were 24 and 96 seconds. A few candidates interpreted 1 minute 50 seconds as 150 seconds, and one or two others as 90 seconds (1.5 minutes)

(b) Weaker candidates made errors of several sorts. Here are some of them: axes were reversed so that time was plotted on the horizontal axis, labelling (especially the units) of axes was omitted, the concentration was shown decreasing from 4 to 0, points were joined by straight lines instead of a smooth curve. Others plotted the volume of acid in cm^3 instead of the concentration of the mixture. A few candidates, having correctly numbered and labelled the axes, drew the "mirror image" of the correct line, showing the minimum time at concentration 1.0 mol/dm^3. However, many candidates drew perfect graphs.

(c) Most candidates deduced the correct answer for the time taken for the magnesium to dissolve at concentration 2.5 mol/dm^3, about 32 s. The errors in graph drawing were "carried forward" so that the Examiners accepted the value shown on the candidates' own graphs.

(d) Many suggestions were unworkable. Candidates who did not realise that hydrogen is gaseous showed liquids being collected in closed tubes. Some diagrams showed the 100 cm^3 of gas being collected in containers that were too small such as a test tube. Often, the reaction vessel was a beaker with a lid, or a beaker beneath a filter funnel that led the gas away to be collected. There were even Liebig condensers to liquefy the hydrogen! The better-prepared candidates drew good diagrams of a reaction vessel fitted with a stopper and a delivery tube that led gas to be collected into a measuring cylinder inverted over water or into a graduated syringe.

Question 3

Like **Questions 1** and **2**, this is based on the corresponding question in the November 2005 Practical examination. Candidates' answers clearly showed if they had used convex lenses in the ways specified in the syllabus.

(a) The Examiners tried to find out if candidates knew how to use a lens to produce a real image at the focus using parallel rays of light, for instance from a light source several metres away. Alas, too many answers placed the light at one end of a metre rule and the screen at the other; candidates were desperately trying to find clues from the rest of the question! Some candidates talked about the lens (or the screen) reflecting the light; others suggested that light rays could actually be seen crossing at the focus. The focal length was occasionally stated as the distance from the source to the lens. Some candidates referred to measuring without specifying what is to be measured. There were many accurate descriptions of the image being formed on the screen and then the measurement of the correct focal length.

(b) This exercise tested awareness of distance and scale and was nothing to do with light rays. The weak candidates gave answers that showed their lack of use of a metre rule.

(c) All the correct answers are provided in the question, yet some candidates did not seem able to tell the difference between *upright* and *inverted*, terms that are essential in describing images produced by refraction through a lens. One mark was awarded for each correct description of the image; smaller and inverted, same size and inverted, larger and inverted. Many candidates scored all three marks.

(d) Careful reading of the instructions enabled candidates to draw the ray diagram correctly. Many could not do so, suggesting that experience of ray diagrams was almost essential for success in this part. Some did not draw a straight line from point **C** through the centre of the lens, so the image was formed in the wrong place and was upright rather than inverted; the information given in part **(c)** had not been understood.

(e) When candidates had drawn an image that was not like any of those shown in part **(c)**, this part presented a problem both to the candidate and to the Examiner marking it. The object at point **C** was between one and two focal lengths away from the lens, therefore the diagram should conform to Experiment No. 3. This was the only answer accepted.

Question 4

The syllabus contains references to the structure of plant cells in leaves and stems and the suggestion that candidates should see microscopic slides or pictures. Practical aspects of the study of functions of parts of a plant is tested in here.

(a) Many candidates did not seem to realise what is needed, a large diagram of the cell as similar as possible to the cell shown in Fig. 4.1. Many candidates drew stylised representations of a palisade cell, the shape very different from cell **A**. This suggests a lack of experience in drawing cells actually seen using a microscope or hand lens.

(b)(i)(ii) The height of the cells, in the drawing and in Fig. 4.1, was often correctly measured. A minority of candidates expressed the measurements as centimetres. This resulted in the loss of 1 mark.

(iii) Most candidates could calculate the magnification. A few expressed the value as a ratio; this was accepted if in the form 1 : x. Magnification shown as a percentage greater than 100% also earned a mark.

(c)(i)(ii) Marks were awarded if the labels were placed on Fig. 4.1 in appropriate places. The nucleus of a cell was more often correctly identified than a chloroplast.

(d) Answers to this part of the question were disappointing. A minority of candidates suggested standing a complete plant in water containing a dye. Very few went on to suggest making cross-sections of the root, stem and leaves. A mark was not awarded for naming any type of cell as responsible for transporting water.

Question 5

This question explored the understanding of oxidation and reduction, using simple reactions. The reduction of an oxide by carbon monoxide is a reaction of the highest commercial importance.

(a) All the answers needed to fill in the empty boxes were already shown in Fig. 5.2. Proper understanding of what was happening was really necessary, because there was no reaction in experiment No. 1; nearly all the “guessers” fell into the trap and wrote that a change occurred. A surprising number who knew that copper was left behind in experiment 5 said that a blue solid would be seen.

(b) Far too many did not know a test for water, so they suggested the use of an indicator. Determination of boiling or freezing point, the use of anhydrous copper sulphate or of cobalt chloride paper were the expected answers. The colour changes for these last two tests were sometimes confused.

(c) Many candidates gave definitions of oxidation and reduction but were unable to link them to the reactions in any of the experiments. This link was essential for the marks. The best way to demonstrate the concepts was to refer to the reaction between copper oxide and either carbon monoxide or hydrogen. Many candidates said that oxidation was loss of electrons and reduction was gain, but the link to the reactions was not explained, especially if the reaction between oxygen and carbon was chosen to illustrate their definitions. The mnemonic “OILRIG” is not always the best way to remember or explain redox reactions. At this level its application should be reserved for reactions involving metal ions.

Question 6

The whole area of energy conversions is relevant to modern life, for we live in an age where it is important to achieve the maximum efficiency of conversion from, say, thermal to electrical energy.

Many candidates do not seem to appreciate that energy is a universal currency whether it is potential, kinetic, solar, nuclear or of any other type.

(a) The 5 kg mass is shown falling from its highest point, so its energy is potential and kinetic; either gained the mark. The pulley is rotating and has kinetic energy. "Electrical" or "electric" or "electricity" was accepted for the energy in the circuit. Some candidates suggested chemical energy in the circuit.

(b) The voltmeter and ammeter were read correctly by the majority of candidates but a few thought that the graduations in the scales were for 0.1 V or 0.1 A, giving incorrect answers.

(c) The symbol for the acceleration of gravity, **g**, was wrongly used by a few candidates who multiplied it by 5 kg, not noticing that this mass was already mentioned in the equation. Most correctly found the work done as 50 J.

(d) The work done in lighting the lamp, 17.6 J, was easily found, except by those who did not record the correct time lapse. Examiners marking this item carried forward errors from **(b)**.

(e) Sensible answers to this part included the idea that the generator was not efficient so energy was lost as heat. Heat loss was also caused by friction in the bearings of the pulley system and by resistance in the connecting wires. It is important to note that heat loss by the bulb is not acceptable as an answer, since this is part of the 17.6 J converted by the bulb. A few candidates also scored by suggesting that energy loss as heat and sound would occur when the 5 kg mass hit the bench. It was in this part that many candidates displayed their ignorance of the idea that all energy is converted from one form to another. Their answers said that there could be no agreement between the two figures simply because they were calculated using different variables.

(f) A surprising number of candidates could not answer this question. The Examiners looked for an *observation* that would be made as a result of the faster descent of the mass. Acceptable answers included a shorter time of fall and increase in ammeter or voltmeter reading. Wrong answers said that the work done would be less (or, in some cases, more!); but the actual work done would be just the same as before using the same mass and the same distance of falling. Other candidates said that the bulb would light up "faster". Some candidates suggested that the mass would be greater, but this answer was not necessarily true, since the faster descent could be caused by reduced friction in the pulley system.