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COMBINED SCIENCE

Paper 0653/01
Multiple Choice

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20	**B**	40	**C**

General comments

Four of the biology questions were answered correctly by fewer than half the candidates, but only one question (**Question 1**) proved particularly difficult. All other questions both allowed candidates to show accurate knowledge and discriminated successfully between candidates of differing abilities.

The paper achieved a mean mark of 25.3 (equivalent to an average mark of 0.64 per question) with a standard deviation of 6.5. 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 0.54. Indeed, a lack of recall seems to be relevant in explaining this lower facility.

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 Individual Comments concentrate on aspects of the performance of the lower scoring candidates. One or two of the questions generated slightly surprising statistics and these are considered below.

The mean score on this paper was 63%, which is less than would be hoped for. However, candidates generally performed very well on the Physics items on the paper, for which they are to be commended.

Comments on specific questions

Question 1

There were several steps that candidates had to take in this question before they could arrive at the ans **Q** has first to be recognised then identified as the partially permeable membrane. The function of th membrane then has to be known. It is, thus, not too surprising that this proved the hardest question in the biology section, with more candidates appearing to believe that structure **Q** was completely rather than partially permeable.

Question 2

Although this was a relatively straightforward question, it was disappointing to note that over quarter of the candidates tested believed that hydrogen is released as a result of the action of catalase on hydrogen peroxide. They were, however, largely from the lower end of the ability range.

Question 3

This proved to be something of a testing question. Candidates may not have been sufficiently familiar with the appearance of the tissues in a cross section of a leaf since almost half of them believed that starch is found in the vascular bundle. Such an error might suggest a basic misunderstanding of the chemical properties of starch as well as faulty knowledge on the functions of leaf parts.

Question 10

Candidates who had set up experiments on transpiration in shoots might have been expected to know that care must be taken to prevent air-locks in the xylem. Answering without careful thought led over a third of them to suggest that a shoot is cut and assembled under water to 'prevent water entering the stem'.

Question 11

This was the easiest of the biology questions with only those who did not think carefully and thus linked alcohol with a fast rather than a slow reaction time failing to select the correct answer.

Question 14

This discriminated extremely well even though it was answered correctly by only 30% of the candidates. Amongst the lower scoring candidates, nearly half chose **A** and a third chose **C**: this latter response was favoured by nearly a third of the higher scoring candidates. Carbon dioxide and nitrogen are two of the three molecules specifically mentioned in the syllabus for which candidates are expected to be able to draw displayed formulae showing multiple bonds.

Question 15

This did not work as well as expected. Apart from disregarding **A**, there appears to have been widespread guessing amongst the other responses right across the ability range.

Question 17

This is probably an example of lack of care in reading the question. Half of the lower scoring candidates chose **D**. The question referred to most *elements* not most *atoms*.

Question 18

Why did as many as 40% of the lower scoring candidates choose **C**?

Question 19

With the lower scoring candidates, response **B** was more popular than the key, **D**. This seems to suggest difficulty with the reactivity series but the question was based on an explicit reference in the syllabus.

Question 21

This discriminated very well but only 64% of the higher scoring candidates answered correctly and only 18% at the other end of the scoring range. Across the ability range, response **D** was the most popular wrong choice. This question should have been a matter of simple recall.

Question 23

This also discriminated very well but the lower scoring candidates were rather seduced by resp evidently being confused about whether nitrogen or oxygen had multiple atoms in nitric acid. Simple re

Question 24

Another question with very good discrimination but over half of the lower scorers chose **B** and even 28% of the higher scorers did so. Not a question thought likely to be so relatively difficult.

Question 25

This needed more thought perhaps than the more direct simple recall questions but was not intrinsically very demanding in relation to the explicit reference in the syllabus. In this respect, it is a little disappointing that response **D** should have been the most popular, more "complex" is incorrect for both processes.

Question 26

This was found hard across the ability range and accordingly did not discriminate very effectively. Was the term "redox" the problem? However, candidates need to appreciate that reduction and oxidation occur together so that if, in this case, hydrogen is oxidised, the oxygen is reduced.

There were several questions in the final section which large numbers of candidates answered correctly (facility greater than 70%). These were **Questions 28**, **29**, **31**, **32**, **34**, **36**, **37** and **39**.

It is difficult to find useful comments from questions which were answered correctly by the majority of candidates, but the following few points are worth making.

Question 33

This caused significant problems for large numbers of candidates. 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, candidates appeared uncertain about the order of the regions in the e-m spectrum and only just over half answered correctly.

Question 40

This worked well, but nearly one quarter of candidates thought that either alpha or beta particles would penetrate the lead walls.

Paper 0653/02
Paper 2 (Core)

General comments

Performance across the three Science disciplines was even, and candidates were generally able to complete the paper in the allotted time. Some parts of the syllabus continue to cause problems and in this paper the significance of the double circulatory system and radioactivity had not been learned very well by many candidates. On the other hand, most candidates scored highly on questions dealing with pollination, atomic structure and energy calculations. Questions requiring candidates to interpret experimental data were generally not done well. The examination produced the full mark range and some excellent scripts were seen from several candidates who demonstrated good knowledge of the syllabus and used scientific terminology appropriately.

Comments on specific questions

Question 1

(a)(i) The majority of candidates had learned the characteristics of red blood cells very well and a variety of acceptable answers were seen. The most common correct answers referred to the lack of a nucleus or the bi-concave shape.

(ii) Platelet function was also fairly well known. Any reasonable attempt to describe clotting gained credit.

(b)(i) Candidates tended to have difficulty with this question. The letter **O** had to be placed clearly over the representation of the alveoli at the top of the diagram and the letter **A** on the vein returning from the capillaries.

(ii) The importance of the heart in boosting blood pressure following oxygenation was very poorly understood. Marks could have been gained simply for referring to the role of the heart as a pump as well as to the importance of increasing blood pressure so that blood travelled faster to all parts of the body. Many candidates wrote about the need for oxygenated blood to avoid heart attacks.

(iii) Large numbers of candidates failed to score any marks for their answers to this question. They wrote about lung disease and general health problems associated with smoking. It had been hoped that the stem of the question would lead candidates to discuss the reduced oxygen transport leading to impaired respiration.

Question 2

(a)(i) Most candidates scored this mark.

(ii) The required answer was covalent. Common answers which did not gain credit were simple bonding and single bonding.

(iii) All reasonable attempts to communicate the concepts of atom and molecule were accepted and candidates gained the benefit of the doubt whenever possible. A very wide range of answers was seen which revealed many misconceptions about these particles. References to methane atoms being smaller that methane molecules were not uncommon.

(b)(i) This proved to be more difficult than had been anticipated. Many candidates did not refer to Table 2.1 and in some cases the concept of fractions from distillation had not been learned.

(ii) To gain the mark candidates needed to specify that gasoline would be used as fuel for vehicles. Answers such as '*to make cars go*' or '*for gasoline*' were not accepted.

(c)(i) The only answer which was accepted was *monomer(s)*. This had been learned fairly well by most candidates.

(ii) Most reasonable responses were accepted and most candidates scored the mark. The most common answers referred to health and safety issues. The most common incorrect answers tried to compare the ease of re-cycling of plastic and glass.

(iii) This question required candidates to apply their knowledge of complete combustion of hydrocarbons, and many were able to do this. The main confusion came when candidates tried to include the oxygen required for combustion as being part of the polymer molecules. The question clearly asks candidates to suggest the *two* elements combined in the polymer, which have to be carbon and hydrogen. The third mark was for any reasonable use of the information to support their choice of element.

Question 3

(a) The circles drawn had to be touching, arranged in an ordered manner and approximately t[illegible] diameter. The question was marked strictly and deviation from the criteria was pena[illegible] Candidates should be clear that diagrams of this type need to be carefully drawn.

(b) The majority of candidates had learned how to do this type of calculation, and large numbers arrived at the correct answer of 8.83 g/cm^3. The units were required in order to gain all three marks. Some candidates went astray when they attempted to use alternative units, converting grams to kilograms and centimetres to metres. One mark was available for calculating the volume of the block, one for the working/answer and the third for the correct units.

(c) Although the majority of candidates arrived at the correct answer of 6.36 (J) they did not always quote the formula correctly and consequently lost one mark. Candidates in general were very familiar with this type of calculation.

(d) The required answer was potential energy. *Gravitational energy* was not accepted but *gravitational potential* was. The most common incorrect response was *kinetic energy* but the question clearly refers to the condition of the block after it has been raised.

Question 4

(a) This was answered well and most candidates gave the correct responses **A** and **D**.

(b) Most candidates scored at least one mark on this question but the award of all three marks was relatively uncommon. Candidates had to be precise about the sequence of events. One mark was for describing why insects would be attracted to the flower, the second was for the attachment of pollen to the insect and the third was for describing the deposition of pollen onto the stigma.

(c) This question required candidates to interpret data, which proved to be very challenging for the majority. A score of zero for this question was not uncommon. Marks were available for discussing the need for pollination before fruit can develop, for making the link between numbers of insects and the frequency of pollination and a comment about the low yield reflecting a small (background) population of insects in the absence of hives.

(d) Either candidates were familiar with the Benedict's Test or not. It was essential to mention the need for warming the mixture and failure to do this lost a mark. Many candidates discussed the test for starch.

Question 5

(a)(i) Most candidates were able to draw the magnesium atom and most scored both marks.

(ii) Most candidates were able to use their Periodic Tables to find neon.

(iii) Most candidates correctly explained the inert nature of neon. Simple answers such as neon being a noble gas to more complex ones involving complete electron shells were accepted.

(b) The correct response of copper oxide and lead oxide was seen from about half the candidates.

(c)(i) Candidates found a variety of ways of describing the difference between an atom and an ion of sodium. It was important that their answer involved electrons and so it was insufficient to make simple statements such as *an ion is charged but an atom is not.* Vague statements that *ions form when atoms gain or lose electrons* were not credited since the answer had to refer to sodium.

(ii) This question was a challenging one and proved to be too difficult for the majority of candidates. In order to gain the marks candidates needed to make it clear that sodium ions were positively charged and that oxide ions were negatively charged leading to the idea that oppositely charged particles attract (strongly). Simple answers such as *because they form an ionic bond* were not credited.

(iii) Most candidates scored this mark. The most common error was to include spurious additional elements and compounds on one or both sides, but this was only in a minority of cases. In general candidates were clear about this word equation.

Question 6

The whole of this question proved to be very challenging for the general level of ability shown by ca entering for this component.

(a)(i) Few candidates referred to background radiation directly although some gained the mark fo describing something which clearly was meant to imply background.

(ii) The required answer was 184, and this was gained by the better candidates.

(iii) Candidates generally did not think in terms of radiation emanating in all directions from the source, and this answer was hardly ever seen. Sensible suggestions such as air absorption of some of the radiation did receive credit.

(iv) This was one of the more successful questions and candidates were generally aware that alpha particles are stopped by paper.

(v) This required interpretation of the data and many candidates did suggest that gamma was the other type of radiation. About an equal number suggested beta. The second mark for realising that the failure of the aluminium to stop the other radiation shows it to be gamma was rarely scored.

(vi) Surprisingly this relatively easy mark was often missed. Candidates' answers were often vague or lacking in common sense. The use of radiation badges had not been learned in the majority of Centres and vague references to protective clothing were common. Suggestions that the source should be kept inside its lead shield at all times negate any experimental work with the source.

(b)(i) There was little scope for candidates to deviate from the required answer of helium nucleus. The description of an alpha particle had been learned well by some candidates.

(ii) The characteristics of alpha particles were fairly well known and two marks here were not uncommon.

(c)(i)(ii) Although every effort had been made to key candidates in to discussing nuclei, very few marks were gained here. The concepts of fission and fusion were beyond the experience of most candidates, with many not attempting these questions.

Question 7

(a)(i) Most candidates could draw the food web although about half made the common mistake of using the arrows to show predation rather than energy flow.

(ii) Most candidates gave the required answer *consumers*.

(b) Many candidates simply re-drafted the question without scoring. The key ideas which gained marks were the role of chlorophyll (although on this occasion chloroplasts was accepted) to trap light which is used to combine carbon dioxide and water, with the chemical energy stored in glucose. This was generally a low scoring question.

(c) The majority of candidates scored some marks on this question. It was important to make it clear that it is dead organisms which decomposers break down and that consequently nutrients are recycled. Answers which made vague references to making soil more fertile were not accepted.

(d) Most candidates scored at least one mark on this question. Candidates in general showed good awareness of environmental issues surrounding deforestation. Acceptable answers referred to preservation of high species diversity (not simply large numbers of animals), preservation of oxygen supply and maintenance of carbon dioxide levels to avoid climatic changes. Other answers gaining credit included the need to prevent soil erosion and flooding and the need to maintain habitats.

Question 8

(a)(i) Candidates were expected to deduce that carbon dioxide would be produced and limewater would turn cloudy. Many candidates did deduce this but an equally large number m the point of the question and simply referred to the fact that bubbles showed a gas had be produced. The most common incorrect name for the gas produced was hydrogen.

(ii) Whether or not candidates identified copper chloride was rather Centre dependent.

(b) About half the candidates correctly identified thermal decomposition, and any reasonable explanation for this choice gained credit. The absence of oxygen on the reactant side of the equation was one way of gaining a mark and a description of breakdown into simpler or smaller particles was another.

(c) This question was not well answered and in many cases the characteristics of transition metal compounds had not been learned very well. Several candidates claimed that all carbonates were white. Many suggested that since copper was a coloured metal then copper carbonate would not be white, which, although a reasonable idea, could not be accepted.

Question 9

(a)(i) The simple answers of convection and conduction were rarely given and candidates tended to think that this was a much more complicated question than it was.

(ii) Very few candidates scored this mark. The idea that a silvery material would be a poor emitter of infra red radiation was beyond most, although it had been hoped that clues given in the stem of the question would guide candidates. It may be advisable to emphasise to candidates that such clues often exist in question stems. Sensible suggestions such as the reflection of heat back into the pot by a silvery surface were accepted.

(iii) An easy mark could have been gained by simply stating that the wool acts as an insulator, but many candidates did not realise this. A second mark was available for stating that the wool slows down or reduces convection and conduction but in view of the poor response to part **(i)** this mark was generally not awarded. It was also possible for candidates to gain a mark by describing the science behind the insulating properties, for example trapped air being a poor conductor, but this too was rarely suggested.

(b) A majority scored at least one mark on this question with many scoring both. The most common answer was *x*-rays although the candidates had to say more than *for medical uses* to score the second mark.

Paper 0653/03

Paper 3 (Extended)

General comments

The entry for this paper ranged widely in ability. It is good to see many candidates demonstrating mastery of almost all of the concepts and facts within this syllabus. However, others struggled severely and would perhaps have fared better if entered for Paper 2.

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 'change in speed divided by time' is not enough in **Question 6 (a)**, where the full formula is 'acceleration = change...' and so on. 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 that are universally understood and not ones invented by the candidate.

Comments on specific questions

Question 1

(a) This was usually answered well, with most candidates able to give correct answers to both parts.

(b)(i) Many correctly gave lymphocyte, phagocyte and antibodies, but some candidates appeared not to have covered this material as they did not give any appropriate answers here.

(ii) This was not well answered, many candidates falling back on vague statements that the body would 'remember' about the infection – several appeared to think that the brain is responsible for this.

(iii) This proved to be surprisingly difficult, and even candidates who were strong in other parts of the paper often only scored one mark here. Two marks were available simply for stating that proteases break down proteins to amino acids. It was very rare to find an answer suggesting that bacteria contain proteins.

Question 2

This question was accessible to even the weakest candidates, and almost all gained at least some marks.

(a) This was usually answered well. However, some candidates struggled to find words to describe a glowing splint.

(b)(i) While most had no difficulty in naming filtration, some appeared not to be familiar with this method of separation at all and had no vocabulary to describe it.

(ii) This was almost always correctly answered, although some of the very weakest candidates suggested that it was hydrogen peroxide.

(iii) Whilst most understood that the manganese dioxide had acted as a catalyst and therefore would still have a mass of 5.0 g, a significant number did not and thought that the oxygen given off had come from this substance, which would therefore have a lower mass. Some lost a mark by not giving a unit in their answer.

(c) This was usually answered well. In **(i)**, the answer needed to include a reference to time as well as volume, so that an answer 'because it produced the least oxygen' was not quite enough to earn the mark. Almost all correctly identified B as being the experiment using manganese dioxide with the largest surface area, and were able to explain their answer in terms of surface area and reaction rate.

Question 3

The first part of this question proved very difficult, but most candidates were able to get somewhere with the later parts.

(a) The context here appeared to be unfamiliar and confusing to a large proportion of candidates, who did not recognise the diagram as a transformer. Even those who did, often did not appreciate that they only work with an a.c. supply. A few even thought it was a motor, and wrote about the coils turning. Better candidates, on the other hand, gave clear and often very full answers.

(b) This question was answered correctly by more candidates than **(a)**. Credit was given for referring to the high energy loss if electricity is transmitted using a high current, or for saying that thicker (and therefore more expensive) wires would need to be used.

(c)(i) Almost all knew that this is a parallel circuit.

(ii) Many had difficulties in putting their ideas into words. The Examiners were looking for the idea that the front lamp is still in a *complete circuit*, so will not go out.

(iii) Many candidates did not know the formula for calculating the sum of two resistors in parallel. Even those who did, often struggled with the addition of fractions, or the inversion of their answer.

(d) Once again, many struggled to find words to describe a ‘complete circuit’. Most we[illegible] the combined resistance correctly.

(e) Surprisingly few candidates were able to answer this. Many showed the ray leaving through the back of the plastic, or bouncing off the inner surfaces many times and exiting through the bottom of the diagram. Very few appeared to make a real attempt to judge the angle of incidence and angle of reflection by drawing a normal – if they had done this they would have been fine.

Answers: **(c)(iii)** 2 ohms; **(d)(ii)** 8 ohms.

Question 4

(a) Most answered this correctly.

(b) Unfortunately, many of the weaker candidates did not see, or did not remember, the information at the beginning of the question just above the diagram. However, this was not a problem for most of them, who did understand that the flower was pollinated by insects. Nevertheless, candidates from many Centres were not secure with this topic, and gave answers that confused stigmas with stamens, pollen with gametes and pollination with fertilisation.

(c)(i) Most answered this appropriately, but some confused the stamens with stigmas, or suggested that the stamens themselves would blow away.

(ii) The majority of answers here were appropriate, although language skills sometimes let a candidate down. Some idea of the lower chances of pollen landing on an appropriate flower was credited, and that the large amount of pollen increased this possibility.

(d) The majority of candidates knew that sexual reproduction produces offspring which vary from each other, and some were able to continue their explanation by stating that this would improve the chances of at least some of them surviving in changing environmental conditions, or if attacked by a disease.

Question 5

Weaker candidates in general, often scored 0 or 1 on this question.

(a) A surprising number of candidates could not answer this, and it was not always easy to see how they could have arrived at their answers.

(b)(i) A few candidates appeared not to have seen this question. Better candidates had no difficulty in identifying Cu.

(ii) Where candidates are aware that the compound resulting from ionic bonding has a neutral charge, they were able to give a brief and correct explanation here. However, some still answer in terms of the *technique* they have learned for working out a formula, such as ‘swap and drop’. This is not an explanation, and is not credited.

(c) Better candidates clearly stated that magnesium and zinc are more reactive *than copper*, but many others simply said that they were ‘more reactive’, or ‘more reactive than silver’, which was not a sufficient explanation for the results.

(d)(i) It was good to see many candidates handling this question well, correctly identifying the two electrodes and explaining their answers in terms of negatively charged chloride ions, positively charged copper ions and the gas chlorine being formed at the positive electrode. However, a great many answers incorrectly stated that ‘chlorine is negative’ or that ‘copper is positive’.

(ii) The required answer here was simply that a copper ion has two fewer electrons than a copper atom. Some, however, answered the question they expected to see – asking how a copper ion becomes a copper atom at the cathode – and Examiners had to try to extract the relevant information from this. Some said that a copper atom has an equal number of electrons and protons while a copper ion has two more protons than electrons, but unfortunately this information did not tell the Examiner about the difference in *electrons* between the two. Many of the weaker candidates had no idea at all.

Question 6

(a) Some candidates were able to give a full and correct formula and to do the calculation, b… included 'speed' in their formula rather than 'change in speed' and some wrote formulae inc… distance in some form or another. The answer needed to have correct units in order to be mar… correct. (See also the general comment about writing formulae at the beginning of this report.)

(b)(i) There were many wrong answers here, for example showing the seal reaching a final velocity of 3 m/s rather than 2, or reaching its final velocity at 1 second instead of 0.6 second.

(ii) Candidates were given credit for indicating that they were attempting to calculate the area under the graph. Some could do this, but others did not know how to deal with the 'triangles'. They were given credit for giving an answer with correct unit which resulted from subtracting their 'seal' answer from the 'penguin' answer, even if these were not right.

Answers: **(a)** 3.33 m/s^2; **(c)** 13.6 m.

Question 7

(a) This was usually done well, although a significant number showed the arrows pointing in the wrong direction.

(b) A mark was given for 'photosynthesis', and many picked this up even if they were not able to say any more. Many gave good answers, explaining that energy from sunlight is trapped by chlorophyll, and used to help carbon dioxide and water to react together, producing glucose which contains chemical energy.

(c) This was usually well answered, most of the better candidates correctly explaining that energy losses occur between each trophic level, for example as heat energy or by respiration.

(d) There was a wide range of accepted answers here, and most were able to give at least one correct response. However, the Examiners were looking for the idea of high biodiversity – for example a 'large number of different species' – living in the forest and losing their habitats, rather than just 'many animals'.

Question 8

(a) This was usually answered well. Almost all were able to place chlorine in the first box, and the majority also completed the second two boxes correctly.

(b)(i) This caused a surprising number of problems for some. The most common incorrect answer was 17.

(ii) The simple answer here was that it has the same number of protons and electrons. It was surprising to see a significant number of candidates stating that it is neutral because 'it contains more neutrons than protons.'

(c)(i) Writing a balanced equation for this reaction proved to be much more difficult than expected, and even good candidates went astray here. The root of the problem appeared to be not knowing that these two gases exist as diatomic molecules.

(ii) Many candidates could answer this correctly, showing one hydrogen atom bonded to one chlorine atom, even if they had given a formula such as H_2Cl in their answer to **(i)**. Several made a lot of unnecessary work for themselves by showing every electron in every shell.

Question 9

This was the lowest scoring question on the paper, and really tested even the best candidates.

(a) This was perhaps the most accessible part of the question, but even so many could not begin to answer it.

(b) This caused difficulties for almost all candidates. Relatively few answered in terms of *pressure*, which increases as temperature increases. Many suggested that the cans contained flammable substances.

(c) Quite a few candidates did manage to answer this well, so long as they thought about convection. Several slipped into writing about 'hot air rising' rather than hot water. Some suggested that the 'hot particles expanded' to become less dense, which was not credited.

(d) This question provided a challenge that only the very best candidates could respond to. A worrying number of candidates think that there is no gravity once you get above the atmosphere, in particular above the ozone layer.

Paper 0653/04
Coursework

General comments

Nature of tasks set by Centres

Only a few Centres submitted coursework for the November examination. All the assessments set were appropriate to the requirements of the syllabus and the competence of the candidates. The nature of the tasks was well understood.

The standard of candidates' work was comparable with previous years, with candidates covering the whole mark range.

Teacher's application of assessment criteria

The assessment criteria were understood and applied well for all of their activities. No Centre tried to assess both Skill C1 and C4 in the same investigation.

Recording of marks and teacher's annotation

Some Centres still need to increase the use of annotation on candidates' scripts.

Paper 0653/05
Practical Test

General comments

The general standard of candidates' work was very similar to previous years. Slightly disappointing that there are so few very good candidates. Although it is appreciated that Supervisors do bear a great responsibility in preparing the examination, often for large numbers, some of the difficulties encountered could have been avoided. The instructions do need careful reading. For example, there was a specific instruction for **Question 1** regarding the preparation of the hydrogen peroxide and to report that there were no bubbles when used, is questionable. The full one and a half hours was required but few failed to complete the paper. All allocated marks were used in applying the mark scheme.

Comments on specific questions

Question 1

Almost all candidates recorded a suitable starting temperature and completed five sets of readings. However, the readings were often all over the place. Many thought they should show a steady increase, others thought a steady decrease whilst too many found no bubbles at all. Assuming the hydrogen peroxide provided conformed to the requirement as written in the instructions, candidates must have allowed the solution to reach a high temperature thus reducing its effectiveness. Alternatively, the solution was left standing for too long before use. Presumably some misunderstood the 'number of bubbles per minute' or could not divide by two.

Many clearly knew what the shape of the graph should be and consequently there were few straight lines although not many really smooth curves. A large number made no attempt to use the whole of the graph grid and the graph was very small. Some plotted the number of bubbles counted in two minutes. Part **(c)** was often answered from theory and no reference was made to the graph drawn. It must be emphasised that it is comments on the figures obtained that are required and not what might be expected. Many were able to score both marks in this part. Part **(d)** however, rarely produced any marks. Most based their answers on the size of potato and the need to cut more accurately. Very few thought of repeating the measurements, measuring the volume of gas or trying to keep a constant temperature.

Question 2

This was very disappointing. It is appreciated that some had difficulty in making the laboratory dark enough to allow good images but the instructions could have suggested what was going to be required of the candidates and more effort made to help them. It is often necessary in practical work to make some modifications to meet the local need. Part **(a)** produced a wide variety of numbers, nowhere near the Supervisor's value. Some were recorded in centimetres and therefore lost a mark. Despite the difficulties already referred to, some did score well on the answers to part **(b)**. The difficult part was the position of the image. Some were clearly uncertain as to what was required. Numerical values were acceptable. It was quite surprising that so few could correctly complete part **(c)**. Following instructions is one of the required skills in practical work and few demonstrated that skill in this question. Lines were drawn all over the place but few in the correct place. Of those who did manage to draw a respectable diagram, many were careless, seldom using a sharp pencil and consequently the distance measured produced values from about 20 mm to in excess of 30 mm. A value of about 24 or 25 mm was expected. Some could not even record their value in millimetres.

Question 3

This question was reasonably well answered and some candidates did very well. Obviously the times for the smallest concentration of acid varied greatly but the mark scheme allowed for this. A good number lost a mark for recording one or more time values in minutes. The standard of graph construction varied greatly, but despite the large difference between the smallest and largest time, many coped well with the scale. Too many candidates have a bad habit of starting the *x*-axis with their largest value and working towards the smallest. Reading from the graph caused no problem and most scored the mark.

Paper 0653/06
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. 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 hydroge[n] ... s showed liquids being collected in closed tubes. Some diagrams showed the 100 cm^3 o[f] ... collected in containers that were too small such as a test tube. Often, the reaction vess[el] ... beaker with a lid, or a beaker beneath a filter funnel that led the gas away to be collected. ... were even Liebig condensers to liquefy the hydrogen! The better-prepared candidates drew g[ood] 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 candidat[illegible] standing a complete plant in water containing a dye. Very few went on to sugg[illegible] cross-sections of the root, stem and leaves. A mark was not awarded for naming any typ[illegible] 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 ... *observation* that would be made as a result of the faster descent of the mass. Acceptab... included a shorter time of fall and increase in ammeter or voltmeter reading. Wrong answ... that the work done would be less (or, in some cases, more!); but the actual work done wou... just the same as before using the same mass and the same distance of falling. Other candida... 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.