COMBINED SCIENCE

Paper 0653/01
Multiple Choice

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

General comments on whole paper

The mean for the whole of this paper was very nearly 60%, which is a considerable improvement on the mean for last November. This is a great credit to teachers and candidates alike, and should be an encouragement to them. The mean for the Physics items only was even higher, which is very gratifying, as there is no suggestion that the level of difficulty of the items on this paper was any less than on previous occasions.

Comments on individual questions (Biology)

General comments

Three of the questions in the Biology section, for differing reasons, presented some difficulties for candidates, but most questions made a meaningful contribution and fell within the capabilities of the target group.

Comments on individual questions

Question 2

Significantly, a small percentage of the better candidates believed that the cell wall is not fully permeable, and over a third of them suggested that full permeability is a property only of the cell membrane. Perhaps inclusion of the word 'surface' caused confusion over the location of the two structures in a plant cell, but this term is specified in the syllabus. Despite its problems, the question proved a suitable challenge for over half the candidates.

Question 3

This question relied, perhaps a little too much, on the perceived definition of the term *metabolic*. However, statement 2, that enzymes are produced only inside living cells, is of such signal importance that option **A**, chosen by most of the better candidates, offers the most realistic combination of statements.

Question 4

This was always likely to be a demanding question, and it would appear that there was a good deal of guess-work employed. The clearest error involved confusion over the function of the left side of the heart, since many thought that deoxygenated blood was being pumped to the lungs.

Question 5

Unfortunately, this question failed to make a valid contribution to the test, not because there is any problem with what the question was asking, but because over 60% of the candidates believed that water evaporates out of the stomata. Candidates commonly fail to understand that evaporation takes place from the water film around the mesophyll cells and then the vapour diffuses (not 'evaporates') out of the stomata.

Question 13

In contrast to **Question 5**, this question proved insufficiently demanding, largely because it was testing little more than an understanding of the term *diversity.* Nevertheless, candidates did require an ability to read carefully and to digest the information presented in a form that may not have been totally familiar to them and this they did remarkably well.

Comments on individual questions (Chemistry)

Overall the examination performed well with 1160 candidates gaining marks well distributed across the range.

The Chemistry questions performed well seeming slightly more difficult than the Biology questions and slightly easier than the Physics questions for candidates.

Comments on individual questions

Question 18 proved to be very straightforward with a large majority of candidates scoring the correct response.

Questions 15, **16**, **20**, **23** and **25** were more difficult with less than half of the candidates scoring the correct response.

Question 15 was a particular problem as response A was a more popular choice than the correct response D. This arose due to candidates confusing the meanings of nucleon and neutron as well as failing to realise that element X was a noble gas and so formed no bonds. Had candidates referred to the periodic table when answering they would have been more successful.

Popular distractors in other questions were:

In **Question 14** Response B; due to confusing the nature of compounds and mixtures.

In **Question 20** Responses B and C; largely due to guesswork.

In **Question 23** Response C; candidates considered how the rate would change but did not take account of the fact that, in this experiment, the mass would be decreasing.

In **Question 26** Response D; candidates confused the fact that a plastic is made from small hydrocarbon molecules and did not realise that the question required that they know what it consisted of after being made.

Comments on specific questions (Physics only)

Items where the facility was over 70%, showing that in general candidates coped well with the topic, were **Questions 29, 30, 31, 33** and **40**. The only item where the facility suggested that candidates found the topic particularly difficult was **Question 38**. The following comments on selected questions may be of help to teachers.

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

Question 31 caused few candidates any problems, but it is interesting that of those who answered incorrectly, a very big proportion thought for some reason that all the forces were equal.

Question 32 showed up a common misconception, namely that heating water is not involved in the production of electricity using nuclear energy.

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

It would be difficult to have a more basic optics question than **Question 35**, but less than half the candidates answered correctly. Over the years the Principal Examiner of this paper has commented on numerous occasions that candidates seem to find even simple optics difficult, and that teachers need to take this into account when planning their teaching programmes. In this particular instance, a third of candidates wanted the ray of light to go through F'.

A lot of candidates thought that the current in **Question 36** would remain constant even when the voltage changed, but it was pleasing to note in **Question 37** that at last candidates are beginning to realise that the current is the same at all points in a series circuit. When it comes to combining resistors, the core syllabus does not expect candidates to be able to calculate the combined resistance of resistors in parallel. However, it does expect them to know that this combined resistance is "lower than the lowest". Therefore, in **Question 38**, the resistance of circuit C must be lower than that of circuit A. Unfortunately, nearly half the candidates disagreed.

COMBINED SCIENCE

Paper 0653/02
Core Theory

General comments

The entry for this component was about 400 candidates, a little higher than at the same time last year. There was a noticeably greater number of candidates scoring higher marks than in previous years. Some excellent scripts were seen from candidates who would have been more suitably entered for the extension paper. The range of marks out of the maximum 80 was from four to 69 with the majority of candidates obtaining a raw score lying between 24 and 50. The three Science disciplines generally provided challenge in equal measure, although it was apparent from the scripts of otherwise able candidates, that in some Centres, all three disciplines had not been learned with equal success. As usual, calculations were done well but questions which required candidates to interpret information, apply their knowledge and express their ideas in structured written form proved less accessible. It is policy in this and other CIE Combined Science papers to ask candidates to write down any mathematical formulae they use in Physics calculations. Marks are lost if this is not done even if the final numerical answer is correct. Candidates should be advised to use either words or recognised symbols when writing formulae. There was no evidence that candidates generally had difficulty in completing the paper in the available time.

Comments on specific questions

Question 1

(a) The three parts of the tooth were not recognised very well. Full marks were rarely awarded even for the better candidates. Many candidates suggested the answer *root* for part **C**, but more detailed responses such as *nerve, blood vessel* or *pulp* were required

(b) Most candidates scored one mark for describing how teeth are used to break food down physically. It was important to convey the idea of physical breakdown and so the simple statement *to break down food* on its own was insufficient. The second mark was rarely awarded, but better candidates did go on to discuss the increased surface area of broken down food or the way that this helped the action of enzymes.

(c) Many candidates scored both of these marks. A common mistake was to name specific food types which, although may have been sources of calcium and vitamin D, could not be credited.

Question 2

(a) (i) Most candidates were able to draw a sensible circuit which scored some or all of the available marks. The most common mistake was to draw a simple series circuit involving all of the components. There were also many circuits in which the ammeter had been connected in parallel with the lamp.

(ii) Candidates tended to find it difficult to explain the reason for the variable resistor, although it was clear from their answers that they probably understood its function in the experimental procedure. Large numbers of candidates wrote or implied that the variable resistor was used *to measure* or *calculate the current* or *voltage.*

(iii) This Ohm's Law calculation was completed successfully by the majority of candidates across the ability range. As stated in the introductory paragraph, candidates are required to write the formula, in this case Ohm's Law, using recognised symbols or words. Marks are lost if candidates use symbols for units in the statement of the formula. Thus in this question candidates should write either (resistance =) voltage / current or V / I but **not** V / A. The required numerical answer was **5.3(3)** Ω.

(b) This question about electrical safety was accessible to candidates of all abilities. Some candidates lost marks through poor examination technique by leaving too much for the Examiner to assume. However, full marks for this answer was the most common outcome.

Question 3

(a) Most candidates scored one mark for recognising chlorine, but the award of full marks was relatively rare. It was surprising that neon was not better known as an inert element. There was no particular pattern to incorrect answers but it was noticeable that many candidates reversed the positions of neon and cobalt.

(b) (i) Most candidates recognised the nucleon number **12**. The most common incorrect answer was **6**.

(ii) Most candidates were able to identify carbon. In order to score the second mark the candidates needed to be clear that the key identifier is the proton number **6**. However, all clear statements which unambiguously identified carbon were accepted.

(c) Candidates generally homed in on hydrogen and the acid-metal reaction producing it. Candidates should be advised that the syllabus states that alkali metals cannot safely be added to dilute acids. Consequently, if they suggest a Group 1 metal in this question it does not score the mark. Another mistake was to suggest the addition of an alkali metal to water. The question requires that the liquid should be a solution so no mark could be awarded.

Question 4

(a) (i) Many candidates were distracted by the diagram and suggested *flowers on stalk* as the source of pollen. However, many were able to state anther or stamen as required.

(ii) Only better candidates gave satisfactory answers to this question. Male gametes was the ideal response but reasonable implications of this answer were accepted.

(iii) Candidates needed to make it clear that pollination is the transfer of pollen to the stigma. This was another question in which poor technique lost marks even though candidates probably understood the process. Several candidates simply suggested that pollination occurred when pollen was *spread about by insects or wind.* Some better candidates gave elegant descriptions of fertilisation but could not be awarded any marks. The other recurring mistake in questions about pollination is discussion of seed dispersal.

(b) (i) The majority of candidates were able to describe the relationship shown on the graph.

(ii) This was a challenging question for the great majority. A very common error was that candidates re-visited the description of the graph they had already covered in part **(i)**. The two key marking points were that the heat energy used to attract insects is provided by respiration and that this requires oxygen. Marks could also have been gained by referring to *aerobic* respiration or by stating that respiration involves breakdown of glucose.

(c) Candidates needed to describe photosynthesis briefly. Many were able to do this and better candidates wrote a fully correct balanced chemical equation which is well beyond the requirement of this component. Marks could be gained for stating the term *photosynthesis* in a sensible context, for discussing the need for light or for stating that the process involves the combination of carbon dioxide with water. A sizeable minority suggested that glucose is raised from the plant roots along with water from the soil.

(d) Many excellent fully correct diagrams of plant cells were seen. It was fairly common to award all four marks for candidates' responses. The most common errors involved the cell wall and cell membrane which were often reversed. An equally common mistake was to label the vacuole membrane as the cell membrane.

Question 5

(a) (i) This was one of the most accessible questions on the paper and it was clear that most candidates had learned how to do speed/distance/time calculations very well. The required answer was **6** km/h. The reader's attention is drawn to comments already made about the need to state formulae using recognised symbols. In this topic, symbols from traditional Newton's Laws are of course acceptable and so for example both *s* and *d* were acceptable symbols for distance.

(ii) Some candidates made much more of this question than there really was and consequently became confused in copious calculations. The required numerical answer was **2** m/s.

(b) The concept of balanced forces was well understood and the majority of candidates scored the mark. A minority failed to use terms from the diagram, and lost the mark unless their answers were very closely linked to the context.

(c) The great majority of answers to this question showed confusion about the mechanism of how a fur garment would help to keep the body from cooling. Marks were awarded for the use of the terms *insulator* or *insulation* in a sensible context, for stating that an air layer would be trapped in the fur and for discussing how the latter would reduce both conduction and/or convection of heat away from the body. Many candidates talked about fur *not allowing cold to be conducted to the body*. Others suggested that the fur would *assist conduction and convection* thus *keeping heat in*. Weaker candidates simply stated that since the fur kept the original animal warm then it would do the same for the human body.

(d) The reader's attention is drawn to comments already made about the need to state formulae using recognised symbols. The required numerical answer was **7200** kg and this was obtained by about half of the candidates. The most common incorrect answer was 88.9 kg which is the result of the incorrect arrangement of the density formula mass = density/volume.

(e) (i) Acceptable answers were seen from about half the candidates. The mark was often lost for vague answers such as *water* or *air* without any further qualification.

(ii) This was well answered and a majority of candidates scored the mark.

Question 6

(a) Fractional distillation had been learned very well and most candidates could successfully join the boiling ranges to the take-off points shown on the diagram.

(b) (i) There were many possible correct answers to this question and most candidates scored the mark.

(ii) The conditions required for rusting had not been learned as well as expected and many candidates ignored the request for **names** of substances, giving chemical formulae instead. This was accepted in this case but candidates should normally be advised to give names if names are requested.

(iii) Only a minority of candidates were able to give a suitable suggestion for rust-proofing a steel bucket. This was intended to be a relatively straightforward question and the Examiners insisted on suitable methods as specified in the question. Hence *gold-plating* did not score a mark; neither did the suggestion to *cover the bucket with oil or wax* or the rather vague *use sacrificial protection* even though technically these methods would do the job. The expected answers were painting or galvanising.

(iv) This was not answered very well and only a minority of candidates were able to identify iron. A very wide range of incorrect suggestions were offered.

(v) Candidates needed to state *stainless steel*. This was not well known despite it being one of the few end uses specified for a material in the syllabus. Many candidates opted for silver or aluminium which do not meet the requirement that the answer should be an alloy.

Question 7

(a) Candidates generally did very well with their food webs, and the majority gained two or three marks. Common causes of lost marks were to omit the link between fungus and ants and missing or incorrectly pointing arrowheads.

(b) (i) Most candidates identified the producer. Both *leaves* and *trees* were accepted.

(ii) Recognition of the decomposer was not as successful as the producer. Every organism in this web was suggested as well as many which were not mentioned in the question. There was no particularly common incorrect suggestion for the decomposer.

(c) Marks could be gained by discussing loss of habitat, for stating that ants eat leaves and pangolins eat ants and that if ant number decrease then so would pangolin numbers. Many candidates obviously understood what this question was about but had great difficulty in expressing their ideas clearly enough. Candidates were given the benefit of any doubt where appropriate. A minority saw the word deforestation and reproduced well-practised answers about climate change.

Question 8

(a) (i) This calculation was successfully completed by just over half the candidates. The required numerical answer was **12800** N.

(ii) The reader's attention is drawn to comments already made about the need to state formulae using recognised symbols. There was a possibility in part **(ii)** of an error carried forward from **(i)**. This question proved to be more challenging than the other calculations on the paper. Even if the correct formula had been given, many candidates forgot to convert the distance moved by the lift into metres. Others did realise that this conversion was needed but interpreted the rise from Floor 1 to Floor 4 as 12 metres and not 9. Only a small number of candidates worked through to the correct numerical answer of **115200** J.

(b) (i) The mechanism of sound propagation had not been learned very well and large numbers of candidates did not score any marks for their suggestions. Possible marking points were that sound moves via vibration of particles/molecules which set up longitudinal waves involving compression and rarefaction of the medium. Many candidates assumed that the question was about sound reflection and echo, and many others gave the over-simplified answer that *sound waves are involved*.

(ii) This was reasonably well understood and a majority of candidates correctly stated that the sound would be louder.

Question 9

(a) A significant number of candidates did not recognise either of these common practical methods. The required answers were filtering/filtration for **A** and evaporation/crystallisation for **B**. **A** was often recognised, but correct responses for **B** were less common. Simply stating that **B** was *heating* or *boiling* was not accepted.

(b) Only a minority of candidates realised that this question was referring to the increased surface area of the solid leading to an increased reaction rate. It was not uncommon for candidates to state that the powdered solid would have a lower surface area. Responses which were not accepted included the suggestion that *powders would be easier to filter* and the vague idea that *reaction would be better.*

(c) (i) Candidates needed to be careful with spelling to score this mark. Zinc sulfide could not be accepted. About a third of the candidates identified zinc sulfate.

(ii) Unsurprisingly, the same candidates who scored part **(i)** tended to pick up one or two marks in part **(ii)**, although the most common mark for this question was zero. Since a word equation had been requested, formulae were not accepted in this case, and candidates should be advised that this rule applies to common substances such as carbon dioxide and water just as much as to less familiar compounds.

(d) (i) The concept of the balanced equation had been learned well by many candidates who gained at least one mark, although a majority failed to score. Candidates needed to make a general statement explaining what constitutes balance in an equation and then follow this up with some relevant detail about the particular example in this question.

(ii) All candidates needed to state was that this was an exothermic reaction or that the reaction produced heat (energy) or simply that heat was produced / transferred. This was fairly well recognised, but the number of correct responses was not quite as high as had been expected. The simple answer that *the mixture is getting warmer* did not go far enough and was not accepted.

COMBINED SCIENCE

Paper 0653/03
Extended Theory

General comments

There were some excellent performances on this Paper, with several candidates gaining very close to full marks. At the other end of the scale, numerous candidates were very poorly prepared, with marks in single figures more common than would be expected.

Candidates appeared to have no time difficulties, nor were there obvious problems in understanding what was required by the questions.

Candidates should be reminded that where a formula is asked for, there is generally a mark available for it, and that if no formula is included in the answer then this mark is automatically lost. Similarly, units should always be given with numerical answers.

It was apparent that not all candidates had access to an electronic calculator, and spent much time in carrying out long division or other complex calculations.

Comments on specific questions

Question 1

(a) Most candidates were able to label the liver. However, fewer correctly labelled the stomach or small intestine for C, and very few labelled the small intestine for B. Problems also occurred where candidates did not use label lines as asked, as it is then sometimes impossible to tell exactly which position their letter is trying to indicate.

(b) Some candidates did know that lipase breaks down fats, but not all of these were able to state the products of this reaction, or to state why it takes place.

(c) (i) Most candidates scored 0 for this question, but some correctly stated that high blood glucose levels cause insulin to be secreted.

(ii) This proved even less well known than **(i)**, but better candidates did explain that insulin causes the liver to absorb glucose from the blood, or to change glucose to glycogen.

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

(ii) It was surprising to see that relatively few candidates could state any correct difference between the structures of a vein and an artery. The most commonly seen correct answer was that arteries have thicker walls than veins, and candidates who gave this response were often able to relate this to the higher pressure of the blood in arteries. Many, however, gave differences in functions rather than structures, and many appeared to confuse arteries with veins, or veins with capillaries.

Question 2

(a)(i) This was very well answered. Almost all candidates gave a correct formula, and arrived at a correct answer with a correct unit.

(ii) Fewer candidates were able to complete this calculation successfully. The commonest error was to divide by 60, and not by 60 x 60.

(b) Success in this question depended on recognising that the appropriate formula to use was F = ma. Most candidates knew this, and were able to calculate the correct answer and give correct units.

(c) This, too, was well answered, with the majority of candidates gaining both marks.

Question 3

(a) Most candidates correctly identified the last of these three elements as neon, but the first two were less frequently correct. Many incorrectly chose sodium as the 'very reactive non-metal', and chlorine as the element that 'forms a green chloride'.

(b) (i) This was generally well answered, with the majority of candidates able to draw the electron shells in both atoms correctly.

(ii) The expected answer here, on this Extended paper, was that the sodium ion has one more proton than electron. Very few candidates gave this answer.

(c) (i) This was surprisingly poorly answered, with less than one third of the candidates able to write a word equation showing that hydrogen and oxygen react to form water. Alternatives such as 'hydrogen oxide' or 'hydroxide' were not accepted. Many introduced other elements into their equations, such as carbon. Some attempted to write symbol equations, despite the instruction to write a word equation being printed in bold type.

(ii) Answers to this part were much better than **(i)**. Most described some indication of a gas being produced, and some also mentioned that the sodium would dissolve, or that something would get hot.

Question 4

(a) (i) Most candidates correctly gave an answer of anther or stamen. The commonest incorrect response was stigma.

(ii) This was more difficult, with only about one third of candidates giving a suitable answer, such as male gametes or male nuclei.

(b) (i) This was almost always answered correctly.

(ii) This was a difficult question, but numerous candidates did work out that heat was being produced by respiration in the arum lily.

(c) (i) Most candidates struggled with this question. It is likely that they would have had much less trouble with it if it had occurred within a 'physics' question rather than here within a 'biology' context.

(ii) Here too, relatively few candidates gave appropriate answers. Once again, they would appear to have been confused by the context, often writing answers relating to flowers or insects rather than to electromagnetic radiation.

(d) This was well known, and many candidates scored all four marks. The commonest error was to reverse the position of cell wall and cell membrane. Some candidates drew the nucleus and chloroplasts in the cell wall.

Question 5

(a) (i) This was well answered, and most candidates gave entirely correct answers.

(ii) Most candidates made a reasonable attempt at this question, but a mark of 0 was not uncommon. Of those who did work out what to do, some made the error of dividing 48 by 6 instead of 12, thus arriving at an answer of 8 carbons instead of 4.

(b) (i) Many candidates decided to answer a different question, and explained what happens during cracking rather than how it is carried out. Others confused it with fractional distillation. Most scored 0, and it was relatively rare to see answers worth 2 marks.

(ii) The bromine test for unsaturated hydrocarbons does not appear to be well known. Some candidates did correctly identify the two unsaturated hydrocarbons and describe how they would cause bromine to change from orange to colourless. Many, however, were unable to give an even partly correct response, and the commonest mark awarded was 0.

Question 6

(a) (i) This was answered correctly by a majority of candidates, although many of these went through a very complicated series of steps in order to arrive at their final answer. Weaker candidates often failed to appreciate that they had been asked to calculate *weight*, and gave an answer in kg.

(ii) Success in this question depended on knowing the appropriate formula to use, and then appreciating that moving up three floors is a distance of 9 m. Only about one quarter of candidates got all the way with this, although more were able at least to state a correct formula. It was interesting to see that some candidates who had given an incorrect answer to **(i)** somehow managed to use a correct value for weight in this calculation. Some multiplied the weight by 3 instead of 9.

(iii) Once again, little could be achieved here without knowledge of the formula relating power to work and time, which not all candidates knew. Problems also arose when attempting to give appropriate units.

(b) Many candidates had no difficulty with this calculation. Some, however, incorrectly gave the formula as $R = 1/R_1 + 1/R_2$ etc., although some of these did actually arrive at the correct answer in the end. Some gave the correct formula and substituted into it, but were unable to do the calculation. Many, however, simply added the three values together.

Question 7

(a) The food web was generally completed correctly, with all organisms included and connected by arrows pointing in the right direction.

(b) Both parts of this question were almost always answered correctly.

(c) This was by far the most difficult part of this question, and the majority of candidates scored 0. Many of these made no reference to energy in their answers.

Question 8

(a) Both **(i)** and **(ii)** were generally answered correctly. However, some candidates did not attempt to answer **(iii)**. Of those who did, some showed arrows going downwards from the heater, and not all showed complete circulation of air in the room.

(b) Most candidates correctly showed the particles in the solid touching and regularly arranged, and the particles for a gas widely spaced. However, it was rare to see appropriate diagrams for a liquid. The particles should be touching, with an irregular arrangement.

(c) (i) This was not well answered. Many drew rays that did not touch the man or the picture, or sometimes neither of them. Where rays were drawn, they generally did not reflect at even roughly appropriate angles. Candidates are advised that when they are asked to 'make an accurate drawing' involving light rays, they should draw lines using a ruler. A mark was available for drawing correct arrows on the lines, but these often did not appear at all and, when they did, were more likely to be drawn *from* the eye to the picture rather than from the picture to the eye.

(ii) This was not at all well known. Few candidates even drew a normal, and the majority scored 0.

(iii) Candidates often struggled to express their ideas about the meaning of the term 'virtual image'. It would be wise for them to learn a formal definition of terms such as this.

Question 9

(a) (i) It had been expected that this would be a high-scoring question, but it proved not to be so. Some candidates did correctly suggest that this would make the reaction take place faster, or that it would enable the metal oxide to dissolve faster.

(ii) This also proved difficult. Many simply said that the student should use an indicator, but this alone is not sufficient. There were various possible answers, of which the most commonly seen was that he should continue to add solid and keep testing with universal indicator, until a green colour was obtained.

(b) If the candidate knew the formula for hydrochloric acid, then this was generally answered entirely correctly, including balancing. However, this was not always the case, and marks of 0 were frequently given.

(c) (i) Many candidates demonstrated almost no knowledge of electrolysis and failed to score at all on this question. However, others did correctly state that the copper ions would be attracted to the negatively charged electrode and some were also able to explain that they would gain electrons there.

(ii) A small majority of candidates correctly stated that carbon dioxide must have been formed, and many of these went on to suggest that this might have been produced by reaction between oxygen and carbon from the electrode.

(iii) Fewer than half of the candidates answered this correctly. The most common error was to show only a single pair of shared electrons.

COMBINED SCIENCE

Paper 0653/04

Coursework

(a) Nature of tasks set by Centres.

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

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

(b) Teacher's application of assessment criteria.

In all Centres the assessment criteria were understood and applied well for all of their activities. All produced Marking Schemes specific to the task given.

No Centre tried to assess both skill C1 and C4 in the same investigation.

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

Following suggestions made encouraging the use of annotation on candidates' scripts many more Centres are using this technique to indicate or justify marks awarded.

Tick lists remain popular particularly with skill C1.

(d) Good practice.

Some Centres make very useful comments about individual candidate's performance on a summary sheet.

COMBINED SCIENCE

Paper 0653/05
Practical Test

General comments

Several Centres had difficulty in obtaining the chemical for question 2 and Supervisors are to be congratulated on their efforts to ensure the question could be answered. Although the purity of the chemical was sometimes questioned, candidates were not unduly handicapped.

The mark scheme worked well and produced a good range of marks. Time was not an issue for the paper as a whole. The overall standard was very similar to previous years although there were no outstanding answers.

Specific comments

Question 1

Some Supervisors appeared not to have carefully read the instruction regarding the pre-testing of the tissue sample and hydrogen peroxide. The hydrogen peroxide concentration needed to be adjusted to ensure the height of foam after 5 minutes was no more than 8 cm. In a number of Centres the height of foam greatly exceeded this, making it unnecessarily difficult for the candidates, particularly in respect of the plotting of the graph. Inevitably some candidates lost marks as a result. The drawing of a smooth curve left much to be desired and many candidates lost two marks by joining up the points. It is quite inexplicable as to why a candidate can draw a perfectly good curve in answering a physics or chemistry question but cannot do so when answering a biology question. Joining the points obtained from an experimental set of results is rarely justified and shows a lack of understanding as to why a graph should be drawn in the first place. Most were able to correctly deduce that the catalase was most active in tissue C, whilst fewer scored the second mark. The height of foam alone is irrelevant and a correct answer needed to refer to the rate at which the foam was produced. Most candidates scored one in part **(c)(ii)**. Examiners were looking for an answer to include the fact that the liver has many chemical reactions and hydrogen peroxide must not be allowed to accumulate. A common answer was to enable the animal to breathe better!

Question 2

Most were able to describe solid P as a red/brown solid. In some cases it was described as a black solid with red specks, that was acceptable. If the description was simply black then ‘no change’ was acceptable in **(b)(i)**. Part **(ii)** was poorly answered. Although not all the solid dissolved in the acid, a green solution should have been seen, certainly if the excess solid was given time to settle. The coloured solution indicated that the solid had reacted with the acid. Very few noticed the change to blue when water was added. A few candidates were unable to distinguish between residue and filtrate in part **(c)(i)**. A good majority scored both marks in **(c)(ii)** by noting effervescence, a brown or black residue or a blue solution becoming colourless. Part **(d)** simply required the name of the cation and it was not necessary to write an oxidation state. Any named compound was marked as incorrect.

Question 3

It is assumed that Supervisors adhere to the instructions exactly. Any deviance from the instructions must be reported to ensure candidates are not penalised. It was therefore assumed that a test-tube of size 150 x 25 mm was provided. If the tube was one-fifth full as specified then the value h should have been about 30 mm although 20–40 mm was allowed. A good number gave figures well wide of this figure and a similar error was common when the final reading should have been 100–140 mm. Some candidates gave a figure in cm and were penalised. Many realised their mistake when the graph was plotted and changed into mm. A small number managed to obtain values of V increasing and a few candidates only had four values of h. The values for (100–V) were almost always correct. The majority scored both marks for the graph although not all went on to calculate V_w correctly. The value for d in part **(f)** was usually calculated correctly and within the tolerance of 20–23 mm.

COMBINED SCIENCE

Paper 0653/06
Alternative to Practical

General comments

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

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

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

Comments on specific questions

Question 1

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

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

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

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

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

Question 2

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

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

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

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

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

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

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

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

Question 3

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

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

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

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

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

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

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

Question 4

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

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

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

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

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

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

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

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

Question 5

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

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

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

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

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

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

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

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

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

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

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

Question 6

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

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

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

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

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

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

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

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

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

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

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

Question 6 was well answered by most candidates.

