# CONTENTS

# COMBINED SCIENCE

**Paper 0653/01**
**Multiple Choice**

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

**General comments**

The mean score on this paper was less than 60%, which indicates that a good proportion of candidates had a lower competence than would be hoped for in this paper. As always, the items were those which had been previously used in papers of equivalent standard, so the low mean cannot be blamed on items which were too difficult for the standard.

All but two of the questions were pitched at an appropriate level for candidates offering this paper.

The mean mark for this paper was 23.7 and the standard deviation was 6.0. The reliability coefficient was satisfactory. With a relatively small entry, the inferences to be drawn from the statistics for the individual questions may not be altogether certain. Attention is concentrated on the performance of the lower-scoring candidates.

**Comments on specific questions**

**Question 5**

There is often a link in candidates' minds between 'strength' and 'iron'. Unfortunately this has its roots more in Physics than in Biology. Thus 38% of candidates thought that iron is necessary for healthy bone and tooth development, thereby overlooking the biological importance of vitamin D.

**Question 7**

Only 25% of candidates selected the correct answer. It was only the candidates who did well on the paper as a whole who knew the answer. Very surprisingly, 42% thought oxygenated blood would reach the heart muscle through the pulmonary artery – exposing further confusion between the type of blood carried in the pulmonary artery and in the pulmonary vein. It may well be that much of the trouble stemmed from a failure to read the question carefully, then thinking before selecting an answer.

**Question 9**

This was the easiest of the Biology questions, though it remained sufficient of a challenge for a significant proportion of the candidates. That nuclei fuse during fertilisation was clearly understood by 86% of the candidates.

**Question 11**

This was a question that proved difficult perhaps because those candidates who are familiar with the different types of contraception are less familiar with the ways in which different contraceptives work (as required by the syllabus). There was a higher percentage of candidates who believed that the IUD prevents fertilisation than believed that if prevents implantation.

**Question 14**

It is disappointing that this question proved to be so difficult in that the degree of chemical insight required is not very high. The question turns on understanding of the notation for the nucleon number and proton number of an atom. In this notation, $^{7}Y$ stands for lithium, which, as a Group I metal, both burns and conducts electricity. On the other hand, $_{7}Y$ stands for nitrogen which has neither of these properties.

**Question 15**

This induced a quarter of the lower-scoring candidates to choose response **D**.

**Question 16**

This relates directly to the reference in the syllabus to the existence of double bonds in carbon dioxide and ethene. Despite this, response **C** was the most popular choice for the lower-scoring candidates although both hydrogen and chlorine are monovalent.

**Question 18**

This had a rather low facility. This arose from the fact that as many as 60% of the lower-scoring candidates and 40% of the higher-scoring candidates chose response **C**. The question clearly describes **X** as being solid. Only metals conduct electricity when solid. The definition of an electrolyte refers to 'when molten or in solution'.

**Question 21**

This proved to be harder than expected because response **B** was the most popular choice with the lower-scoring candidates. This is rather surprising.

**Question 22**

This also seemed quite difficult but with very good discrimination. Amongst the lower-scoring candidates the key, **C**, was the least popular choice! Such candidates most strongly favoured response **B**. No obvious explanation suggests itself.

**Question 23**

As for **Question 22**, the key was the least popular choice for the lower-scoring candidates. Such candidates may well have been guessing between responses **B**, **C** and **D**. Perhaps it needs emphasising that Group VII elements form negative ions which are attracted to the positive electrodes.

**Question 24**

This was found very difficult by the lower-scoring candidates, it being evident that many of them merely guessed. Two concepts are involved. Aqueous ammonia and sodium hydroxide are alkaline, giving a white precipitate of zinc hydroxide whereas aqueous silver nitrate precipitates the chloride ions. The question does indicate that the reagents are 'aqueous' but candidates may have been deterred by the idea of ammonia being added "drop by drop".

**Question 26**

This was another question that – rather surprisingly – candidates found harder than expected. Response **D** was the most popular choice for the lower-scoring candidates and as many as 38% of the higher-scoring candidates chose this response.

**Question 27**

This was a standard question on the combustion of a hydrocarbon but the lower-scoring candidates favoured response **C** over the key. Complete burning of a hydrocarbon does, of course, produce carbon dioxide and water. Even with incomplete combustion, it is the carbon, not the hydrogen, of the fuel that is incompletely oxidised.

**Question 28**

This performed satisfactorily, but it was interesting to note that approximately a third of candidates thought that a measuring cylinder would be needed to find the area of the tiles. This suggests that many candidates do not know what a measuring cylinder is.

**Question 30**

This also performed satisfactorily, but the statistics showed that there are still a lot of candidates who do not know the units of mass.

**Question 31**

Candidates struggled with this question, with more of them calculating the mass of M by using the relative lengths of the spring, rather than the relative extensions.

**Question 32**

This clearly indicated that most candidates have little understanding of what happens in a nuclear power station.

**Question 36**

As is frequently the case, the ray optics of this question showed up the weakness of candidates in this area. Candidates really need to be prepared to spend more time on this topic, if they are to improve their chances of answering correctly questions like this one. The vast majority thought that the focal length is the distance of the focused image from the lens (i.e. they answered **C**).

**Question 37**

This was surprisingly poorly answered, the evidence suggesting that most candidates simply guessed.

**Question 38**

It was interesting that 18% of candidates answered **D**. In normal terminology, to “close a switch” means to complete the circuit so that there is a current in the circuit (i.e. the lamps light). It is possible, however, that to some “closing a switch” is taken as meaning the equivalent action to closing a water tap (faucet), namely that this stops the flow, rather than starts it. This could be the explanation to the 18% figure.

**Question 39**

This showed that many candidates do not understand the significance of the current rating of a fuse.

## Paper 0653/02
## Paper 2 (Core)

### General comments

The examination produced a mark range which was somewhat skewed towards the lower fifty percentile. This is not unexpected for the ability range of candidates which are likely to be entered for the Core Paper. Performance across the three Science disciplines was reasonably even and candidates were generally able to complete the paper in the allotted time.

### Comments on specific questions

**Question 1**

**(a)** The correct responses of **D**, **A** and **C** were often seen. Candidates needed to inspect the diagram very carefully in order to differentiate the cell membrane from the cell wall, and even for good candidates this often caused the loss of 1 mark.

**(b)(i)** The majority of candidates correctly identified xylem.

**(ii)** There were a number of ways that candidates could gain marks. If they discussed movement of water from within cells by osmosis they scored 1 of the available marks. Other marking points included movement of water by diffusion of water vapour through the stomata. A common error was a detailed description of transpiration, tracing the passage of water from root hairs to leaf, which failed to include any of the stated marking points.

**Question 2**

**(a)** The most commonly gained marks were for identifying placenta or umbilical cord and amniotic fluid. Many candidates gave amniotic membrane, and on this occasion it was decided to ignore membrane and award the mark. Many candidates gave placenta for both first and second points. The expected answer for the second point was blood.

**(b)(i)** Candidates had to indicate that the virus leading to AIDS may in some way enter the fetal blood, but they must not imply that the fetus and mother share the same blood. Many candidates lost this mark for this reason. Some explained that blood may become mixed during childbirth and this was accepted.

**(ii)** Candidates answered this question well and most scored the mark for references to abstinence or use of a condom. Vague references to protection were not accepted, nor were general answers involving non-specific methods of contraception.

**(c)** This was generally well known by candidates and most scored both marks for discussing the role of calcium in the formation of bones and teeth, and the need for calcium by the growing fetus.

**Question 3**

**(a)(i)** Most candidates correctly identified argon and were able to give a valid reason for their choice. Allowed reasons included the general answer that argon is a noble gas or reference to electronic configuration.

**(ii)** The majority of candidates scored this mark, correctly indicating magnesium and either oxygen or hydrogen. The most common mistake was a rubric infringement in which candidates used elements not specified in the main question stem.

**(iii)** This was well answered by candidates of all abilities. The most common mistake was again a rubric infringement in which candidates used elements not specified in the main question stem.

**(iv)** Most candidates identified hydrogen, and large numbers were able to explain how the chemical symbol shows that the atom contains no neutrons. Many did this very well showing that they were able to apply knowledge to a question which had not been asked in this component before.

**(b)** This is a question which is often asked and candidates still struggle to convey the essential point that the number of atoms (the term amount is allowed in this context) of each *type* of element is the same on both sides of the equation. Even allowing the benefit of any doubt for candidates not working in their first language only about half of the candidates scored the mark. A common insufficient answer is *the same number of atoms (or elements) on both sides.* Some candidates gained the mark by discussing the actual numbers of elements showing how they were the same. Some candidates in their attempt to do this focused on hydrogen and chlorine, losing the mark by forgetting to include magnesium.

**(c)(i)** This mark was gained by only a minority of candidates, with large numbers suggesting temperature and surface area despite the context of the question.

**(ii)** This proved to be very difficult for the majority of candidates and few scored both marks. In order to gain 1 mark, candidates had to indicate Experiment 3 and support this by some reference to 3 having the greatest rate of reaction. The second mark was for indicating that a large surface area and a temperature both increase rate.

**Question 4**

**(a)(i)** A wide range of frequencies were suggested and about half of the candidates gave an answer which was in the range accepted (less than or equal to 20 Hz).

**(ii)** This was not answered well by most candidates. It was important to indicate that molecules themselves are set into vibration and that vibrations are passed through the molecules to propagate the sound. Diagrams showing compression and rarefaction were accepted but rarely given.

**(b)(i)** Candidates of all abilities had learned how to do this type of calculation very well, and most scored at least 1 mark for the correct answer of 3 cm/s. The format exemplified in this question is frequently used and it is very important that candidates are taught to write formulae properly, using either variable names or suitable symbols.

In this case the following would be acceptable: speed = distance/time but not just distance/time or the commonly used triangular diagram used to help candidates construct the correct formula.

**(ii)** Similarly, in this question several candidates did not state the formula correctly and so did not score the first mark. Of the candidates who knew how to proceed with this question most lost 1 mark for failing to convert the distance travelled from centimetres into metres. Hence they ended up with the answer 0.42 J rather than the correct answer of 0.0042 J. An error carried forward was allowed and many candidates scored 2 out of the available 3 marks.

**(c)** Relatively few candidates scored 2 marks. Large numbers of candidates gave answers which more or less re-worded the question but added no scientific explanation. Hence many stated that the bear's fur keeps it warm without venturing into any explanation involving trapped air which acts as an insulating layer because air is a poor heat conductor. Credit was available for any correct adaptation with some supporting scientific principle.

**Question 5**

**(a)(i)** The action and function of cilia in airways is frequently tested, but candidates still struggle to score marks. By far the most common misconception is that the cilia act a filter which traps out unwanted matter. Candidates must refer to the role of mucus in trapping unwanted matter and then explain that cilia move mucus away from the lungs.

**(ii)** Candidates failing to score marks in part **(i)** rarely scored any here. The key ideas which candidates need to explain are that harmful gases may stop the cilia from working effectively which leads to the build-up of mucus containing bacteria in the airways and lungs, leading to disease.

**(b)(i)** The majority of candidates could process the information on the graph to obtain the correct answer of 650.

**(ii)** The majority of candidates were able to describe the correspondence of the two maxima on the graph. A simple statement such as, *When the amount of sulphur dioxide is the most there are the most deaths* was acceptable for 1 mark. Some candidates did not interpret the question and discussed reasons why sulphur dioxide would harm health.

**(iii)** The mark scheme for this question allowed candidates to score marks for any sensible suggestion which showed that some people adversely affected by sulphur dioxide may not die immediately.

**Question 6**

**(a)(i)** The form of word equations had been learned very well and most candidates had no difficulty in writing the correct equation.

**(ii)** The majority of candidates scored both marks by referring to flames or burning and that this shows the evolution of heat.

**(b)(i)** The majority of candidates correctly gave neutralisation.

**(ii)** However, very few identified hydrochloric acid or potassium hydroxide as the answers to this question. Most gave the acid as potassium and the alkali as chlorine.

**(iii)** Most candidates gained credit for discussing the use of an indicator and many went on to describe how their indicator would show neutrality. Marks were lost if vague statements such as *use pH paper* were suggested or if candidates failed to describe the neutral indication clearly.

**(iv)** In general, candidates could describe the process of warming the solution to evaporate water. Marks were also awarded for relevant practical details.

**Question 7**

**(a)(i)** Most candidates correctly indicated force **B**. Candidates needed to have made a good attempt to show the arrow pointing vertically downwards. The exact location of the arrow was not important.

**(ii)** Most candidates correctly discussed the requirement that **A** and **B** should be balanced, and any clear description was accepted.

**(iii)** Most candidates identified either of the accepted answers, gravity or weight. A minority suggested gravitational potential force which was not accepted because of the confusion between the concepts of energy and force.

**(b)** Please see comments above for **Question 4 (b)(i)**. The formula for density had not been learned quite as well as the formulae in **Question 4**. Most candidates had learned that density, mass and volume were interconnected but only about half could produce the correct version of the formula. The required answer was 0.83(3) $g/cm^3$.

**(c)** Many candidates across the ability range misinterpreted this question. The majority of candidates gained the mark for correctly identifying diagram **Y**. The second and third marks were for stating why diagram **Y** showed the particle arrangement in a solid. A significant number of candidates simply matched the diagrams to solid, liquid and gas without any reference to the spring. A significant number of candidates seemed to be thinking that because the spring had to be able to extend or generally move, then the particles needed room to move and so suggested either diagram **X** or **Z**.

**Question 8**

**(a)(i)** The majority of candidates gave the acceptable answers of either, enzymes, carbohydrase or amylase.

**(ii)** The role of the small intestine had been learned very well by most candidates.

**(iii)** Candidates generally gave the expected response that the contractions helped to move material through the alimentary canal.

**(b)(i)** Only a minority of candidates knew about the use of Benedict's solution, and of those who did, many lost a mark if they did not stipulate that the mixture of glucose and Benedict's must be warmed. A common error was to confuse the test for reducing sugar with the iodine test for starch.

**(ii)** In the respiration equation 2 marks were awarded for a fully correct response and 1 mark if two of the three blank spaces were correctly completed. It was less common for 2 marks to be awarded and in many cases candidates showed no knowledge of this part of the syllabus.

**Question 9**

**(a)** The only answer which was accepted was coal. The most common responses which were not accepted were fossil fuel and charcoal. About half of the candidates scored this mark.

**(b)(i)** This was not answered well. Candidates needed to identify **A** and then explain either that burning was a reaction which required oxygen or that the wood was combining with oxygen.

**(ii)** Most candidates suggested carbon dioxide and gained the mark. Other acceptable answers were water (vapour) and carbon monoxide.

**(iii)** Few candidates were familiar with thermal decomposition. Several suggested *endothermic* but this was not accepted. The second mark could have been gained by explaining that simple molecules are produce (by heating) from more complex ones or any similar description of decomposition.

**(c)(i)** This was intended to be a very simple question requiring no more than an obvious response such as the appearance of an orange or brown solid or the appearance of a shiny solid, or the appearance of a solid which made a metallic ring when struck or which was malleable. Instead of going for a simple description of metallic properties, candidates either offered no answer or became diverted into the concept of reactivity. The significance of the word *observation* in the question seems to have been overlooked or misinterpreted. Surprisingly few candidates scored the mark.

**(ii)** Better candidates successfully gave the word equation. There did not seem to be any particular pattern in the incorrect responses.

**Question 10**

**(a)(i)** Please see comments above for **Question 4 (b)(i)**. This part of the syllabus had been learned well by the majority of candidates who worked through to the answer 10 ohms. The most common mistake was the inversion of voltage and current in the formula.

**(b)** Candidates should learn to describe convection in terms of the movement of matter. The phrase *heat rises* should be avoided since it does not score any marks. Rather, candidates needed to specify that hot water rises which leads to more efficient heating of all the water. Large numbers of candidates discussed the process of convection in terms of air which meant that both marks could not be awarded. Some very good answers included a small labelled diagram showing the principle of convection. This alone scored both marks.

**(c)** This question was answered quite well and many candidates scored full marks. The most commonly missed responses were the first one, which required candidates to recognise *transverse* waves, and the last one which many candidates suggested was *sound* rather than *radio*.

**Paper 0653/03**

**Paper 3 (Extended)**

## General comments

The candidates entered for this paper covered a wide range of ability. Some had clearly not covered the supplement material in the syllabus, but others were able to answer most questions with confidence. A significant number, however, struggled to understand the questions, or to communicate their answers effectively.

## Comments on specific questions

### Question 1

**(a)** Most candidates were able to make at least one correct statement here, usually recognising that the anthers or the stigma were hanging outside the flower. Better candidates went on to explain how this could help wind pollination to take place. Weaker candidates frequently confused pollen with seeds.

**(b)(i)** This was found to be a difficult question which discriminated well. Many candidates explained that a cell in **P** would not have chloroplasts as it does not photosynthesise. Others wrote, incorrectly, about cell walls or vacuoles. A few thought that the cell in the diagram was an animal cell.

**(ii)** Most knew that **Q** was a nucleus, though a significant number wrongly identified it as a chloroplast. At this level, candidates should be discouraged from describing a nucleus as 'the brain of the cell'. They should be able to state that it contains DNA, and make at least a simple statement about the nucleus controlling cell activities.

**(c)(i)** Most correctly stated that this tissue is xylem.

**(ii)** There were many possible statements here that could gain marks, beginning with the loss of water from the leaf cells by osmosis, through to the diffusion of water vapour through the stomata. Quite a few answers began with lengthy descriptions of how water is taken up from the soil and how it travels up the stem to the leaves. On the whole, however, this was answered well.

### Question 2

This question was well answered, even by candidates who did poorly in the rest of the paper.

**(a)(i)** Most candidates were able to write a correct word equation.

**(ii)** Most correctly identified the flames as the relevant observation, although weaker candidates often referred to the clouds of potassium chloride particles.

**(b)** This was well answered overall. Weaker candidates, however, struggled to give the correct formulae for the reactants and products.

**(c)(i)** The expected answer was that positively charged potassium ions would be attracted to the negatively charged cathode. A few candidates thought that potassium ions are negatively charged, but they could still gain credit for explaining that they would be attracted to the electrode of the opposite charge.

**(ii)** This was the most demanding part of the question, but on the whole it was answered well. Some candidates, however, became confused about whether potassium ions gained or lost electrons at the cathode. Others wrote about gaining or losing ions.

**Question 3**

Many candidates sailed through the calculations, although they often failed to convert from cm to m, or to give correct units with their final answer.

**(a)(i)** Most correctly gave a number below 20 Hz. Some did not give units, so their answer could not be credited.

**(ii)** Weaker candidates were confused by the context, and there were many (entertaining) drawings of elephants. The Examiners were looking for the idea that vibrations are passed from molecule to molecule, that the wave is longitudinal, or a description or diagram of compressions and rarefactions.

**(b)(i)** Almost all candidates knew that work = force x distance; this could be expressed in a number of ways (for example, weight x height). However, they usually failed to convert 21 cm to metres, so that their answer was out by a factor of 100. Some could not give units.

**(ii)** Again, most knew the formula for power, and were able to do the calculation. Once again, many did not know the units. Those who had made an error in **(a)** could use their incorrect answer here with no further penalty.

**(iii)** The formula force = mass x acceleration was usually given correctly. Once again, there were problems in converting to kg and m, so that the answer given was usually 4 N instead of 0.00004 N. Most candidates clearly have no concept of what a force of 1 N is, or they would have recognised that a small spider is not likely to be able to exert a force of this magnitude.

**(c)** Most answers used some of the information provided in the question, and gave answers relating to the thick fur or its colour. However, many scored no marks at all, as they wrote about the fur trapping ‘heat’ (rather than warm air) or said that it ‘kept the bear warm’. Some described the thick layer of fat beneath the skin, and explained that it acts as insulator.

**Question 4**

The early parts of this question were very accessible to the whole range of candidates, but parts **(b)** and **(c)** were more testing.

**(a)(i)** The only accepted answer here was 650. A number of candidates read values from the wrong line, or stated how many people died on one of these dates, rather than calculating the difference between them.

**(ii)** Almost all candidates answered this correctly.

**(iii)** Most answers gave some idea of the delay between exposure and death. A few wrongly suggested that the sulphur dioxide remained in the air, despite the graph clearly showing otherwise. One inventive candidate suggested that the acid rain had weakened the stones in buildings, so that they eventually fell off and killed the people that they fell onto.

**(b)** This was surprisingly poorly answered. A large number of candidates wrote about the sulphur dioxide evaporating and condensing. Some did correctly explain how the gas dissolves in water in the atmosphere, falling to the earth as sulphurous (or sulphuric) acid.

**(c)** Many candidates were still thinking about transpiration from **Question 1**, and this took them off on the wrong track in this question. Better answers referred to the coating blocking light, or the inability of the stomata to take in carbon dioxide, and linked to this to reduced photosynthesis.

**Question 5**

The early parts of this question were accessible to all candidates, but the difficulty increased towards the end, so that the latter parts discriminated well at the top end of the ability range. Some candidates did not *name* the elements in **(a)**, giving their symbols instead. As one of the objectives being tested here was the ability to translate from a symbol to a name, this was penalised, but only once. A few candidates did not confine their answers to the elements stated at the beginning of the question.

**(a)(i)** Most correctly named argon and were able to explain that it has a full outer electron shell.

**(ii)** This was usually answered correctly, although some wrongly gave hydrogen and oxygen.

**(iii)** Once again, this was usually answered correctly.

**(b)(i)** Most answers were correct, although a few omitted the unit.

**(ii)** This proved more difficult. Many did not realise that they needed to use their answer from **(i)**. A common error was to subtract 2.4 from 5.0.

**(c)(i)** Hydrogen was the usual answer given here, although some suggested carbon dioxide and the weakest candidates often named a substance that is not a gas, such as magnesium chloride.

**(ii)** Some chose variables that were already controlled, such as the volume of acid or the mass of magnesium. The accepted answer was the concentration of the acid.

**(iii)** This was usually correct.

**(iv)** A pleasing number of candidates correctly identified experiments 1 and 2, and were able to explain why they had chosen these two. A few did not understand what they were being asked, and described how they would carry out this experiment.

**Question 6**

This question was probably the least mark-yielding on the paper, although better candidates frequently gained at least 5 marks out of the 6 available.

**(a)(i)** This part of the question was marked generously, and any rays that bent at the interface and reached the eye were credited.

**(ii)** This was difficult, and again was marked generously. One mark was awarded for either or both of the rays being extended back into the tank from the air/glass interface, and the second for some explanation of the brain's interpretation of the source of the rays (because it 'assumes' that light has travelled in a straight line).

**(b)** This was relatively easy, and most candidates could calculate the resistance and give the answer together with the correct unit.

**(c)** This was answered less well than expected. While some candidates did give entirely correct descriptions of convection currents, others wrote about air moving (rather than water) or heat rising (rather than hot water rising).

**Question 7**

The early parts of this question were answered well, but parts **(c)** and **(d)** were disappointing.

**(a)** Most could name at least one of these two parts, but it was quite rare to see both names correct. Many gave 'large intestine' as the name for B, which was not accepted because the diagram already carried the name 'colon' for the early part of the large intestine. The expected answers were oesophagus and rectum.

**(b)** This was usually answered correctly.

**(c)** One mark in this part was awarded for a correct statement about the function of the small intestine, and the second for an explanation of how its length helps it to carry this function out.

**(d)(i)** Examiners were looking for a description of respiration. The use of the term 'burns' is not appropriate when describing respiration. Many candidates did not think about respiration at all, so gained no marks.

**(ii)** This was very poorly answered. There was much confusion between biuret and Benedict's, and even those who knew that Benedict's reagent would be used did not say that it should be heated. The most common error was to describe the starch test. Others were more inventive, suggesting that the athlete should swallow some of the drink and then have his blood sugar levels tested, or that you could put an animal cell into it and see if shrank.

**Question 8**

This whole question seemed difficult for weaker candidates, and **(b)** seemed difficult for all.

**(a)** Many knew that the solid fuel mentioned was coal. A large number, however, gave the generic answer 'fossil fuel', or named one that is not solid, such as natural gas or crude oil. None of these were credited.

**(b)** Candidates found this the most difficult question on the paper. A few candidates recognised that this is (thermal) decomposition, and a very few backed up their statement by explaining that simpler molecules (methane gas) are being formed from the large ones in the wood.

**(c)(i)** Better candidates knew the bromine test, but others had no idea and either left this space blank or wrote entirely incorrect answers.

**(ii)** For some candidates, this was the only part of this question that they got right, even though this is not an easy equation to balance. Many, however, struggled and could not find the correct numbers.

**(iii)** Many answered this entirely correctly, but many others made no attempt.

**Question 9**

**(a)(i)** Almost all arrows were correctly drawn pointing downwards.

**(ii)** A very disappointing number of candidates gave a complete answer here. It was not enough to say that the forces were 'balanced'; the question asked about their sizes and directions, so the correct answer was that they are equal (in size) and opposite (in direction).

**(b)(i)** Most of the better candidates could give at least some description involving submerging the toy in water and measuring the displacement. However, a great many answers stated that you should find its density and its mass and calculate the volume from that. There seems to be a confusion between *measuring* and *calculating*.

**(ii)** This was well answered by many, but a large number thought that density is mass x volume.

**Paper 0653/04**

**Coursework**

## General comments

**Nature of tasks set by Centres**

A small number of Centres submitted coursework for the June examination. Some have provided coursework in previous years.

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.

**Teacher's application of assessment criteria**

In all Centres 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**

Centres are being encouraged to annotate candidates' scripts with levels at the point where they are awarded.

**Good practice**

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

## Paper 0653/05
## Practical Test

### General comments

Candidates seemed to find this paper slightly easier than recent years and the performance of candidates was certainly somewhat higher than last year. **Question 1** proved to be very straightforward and many scored highly. Supervisors were very good and ensured the rulers in **Question 2** were suitable. The information they give is invaluable to the Examiners in ensuring the candidates are not penalised because of local difficulties. There was no evidence of shortage of time and all candidates were able to access each of the questions.

### Comments on specific questions

**Question 1**

Most candidates produced very good diagrams, well-proportioned and appropriate detail shown. Some did not know which part of the flower was the sepal and rather more did not know the function of the sepal. The expected answer was to protect the flower in bud. Despite good large diagrams in part **(a)**, many produced very small diagrams of petal and stamen. Few filled the appropriate box and some were positively minute. The question asked for the drawing of a stamen, not several. A mark was lost if the single stamen was not drawn. Many failed to mark on the petal the label X as instructed and were penalised for this omission. The value was checked in each case although clearly the value for the actual petal could not be verified. A small number failed to record the value in millimetres and lost a mark. Part **(b)(iv)** was usually well done and some easy marks were gained. Although calculation of magnification had been asked in many previous papers, some were not familiar with the idea and subtracted their values.

**Question 2**

As suggested above, a few Centres had to improvise, as their metre rules did not bend sufficiently or bent too much. Candidates were not penalised and indeed most were able to produce a good set of results. A small number did not read the instructions carefully enough and simply recorded the value in **(b)** the same as $h_o$ written in the table rather than a value 40 – 50 mm less. Some are still confused by units and assume everything is to be measured in centimetres. A one-mark penalty was applied to such transgressors.

No candidates failed to record a complete set of readings although a very small number appeared to try and make their values fall exactly on a straight line. Some decided to weigh the plasticine very accurately i.e. not to the nearest gram, thereby losing a mark. Others gave the same value of mass for each piece of plasticine. If the instructions were followed exactly, it would have been almost impossible for this to happen.

Graphs were good and axes were labelled correctly and sensible scales chosen. Plotting was good and very few decided to ignore the instruction to draw a straight line. One mark was awarded for use of the origin. Most scored the two marks for reading from the graph. The commonest answer to **(h)** was "the deflection increases as the mass increases". This did not score. The Examiners were looking for the words 'directly proportional' although proportional on its own was acceptable. Most scored the final mark for this question.

**Question 3**

Clearly the quality of the metals varied and some were more finely divided than others. The instructions to Supervisors took care of this and the values of temperature change obtained by the Supervisor were taken as the standard. Candidates were expected to be within 1°C for a temperature rise below 5°, within 2°C between 5 and 10, 3°C below 20 and within 5°C above 20. This scale worked well although weaker candidates produced some very strange temperature rises. Many failed to appreciate the instruction to read the thermometer to the nearest 0.5°C and consequently lost a mark. Similarly, many did not heed the instruction to test the gas with a lighted splint and record the result.

The majority correctly named the gas given off although some thought it was carbon dioxide. The Supervisors order of reactivity was used and candidates marked against the stated order.

**Paper 0653/06**

**Alternative to Practical**

## General comments

As in previous reports, the Examiners are at pains to point out that this examination is an alternative to the practical examination, not a substitute for practical science. There was evidence that some candidates had very little experience of practical work. They were, for instance, unable to copy the outline of a biological specimen or measure its length using correct units, accurately read a thermometer or ruler or describe very simple and familiar chemistry experiments.

Despite these failings of a minority of candidates, there were very many excellent candidates who gained high marks on every question, showing that they have studied the syllabus material effectively and have confidence in practical work of all kinds.

Every question in the paper contained some easily gained marks to enable the less able candidates an opportunity to score. The gradient of difficulty in each question included harder and more subtle ideas so that A and *A candidates had an opportunity to shine. The Examiners were pleased to see a high proportion of good grades in the overall results, especially in the 0654 group.

Almost all candidates completed the paper except perhaps for a few whose limited grasp of English slowed their rate of working.

## Comments on specific questions

**Question 1**

This question involves some practical botany, a part of the syllabus content that is easy for candidates to undertake as part of their course even without the resources of a fully-equipped laboratory. The parts of a flower are easy to observe and draw, sometimes without the use of a hand lens.

**(a)** Many candidates did not see the instruction to label a sepal. The suggested functions of the sepals were many and varied; the Examiners gave a mark for almost all answers that mentioned protection, though this rôle is over once the flower has opened.

**(b)(i)** An artistic drawing was not needed. The approximate shape of the petal, drawn with clear lines, gained the mark. The stamen should show the correct ratio of lengths of stamen and filament.

**(ii)** Some candidates tried to find evidence of the anther or the filament somewhere on the petal; often the labels of filament and anther were reversed.

**(iii)** There are always candidates who attend the examination without the simple mathematical instruments needed for questions such as this one. Many candidates measured the petal and then expressed the length in centimetres, so gaining 1 mark instead of 2; others did so and multiplied by 100 to turn centimetres into millimetres.

"Magnification" posed a problem for candidates who drew diagrams that were smaller than the object, but of course the fraction $\frac{\text{size of drawing}}{\text{size of object}}$ gave the factor that is needed here.

Those who then multiplied by 100 to find the percentage were not penalised. If the magnification was expressed as a ratio in the form 1:x, credit was also given. Too many candidates thought that the magnification was obtained by subtracting one measurement from the other.

Many good candidates gained full marks on this question, but far too many could not use a ruler correctly.

**Question 2**

The 0653 Syllabus contains two references to magnetism. In the section on electric circuits and current, candidates are to be able to draw and interpret circuit diagrams containing magnetising coils. In the section on electromagnetic effects, they are to be able to describe the turning effect of a current-carrying coil in a magnetic field.

The Examiners constructed the question in the examination paper with the details of both the 0653 and 0654 Syllabuses in mind. A minimum of knowledge about magnets and their effects is needed, such as would be gathered by candidates whose preparation includes the material, admittedly limited, contained in the 0653 Syllabus. These details are referred to in the following paragraphs.

**(a)** The candidate must know that a magnet (or a coil acting as a magnet) will repel and attract another magnet. It is this force that causes the turning effect in a motor. This will enable the completion of line 1 of the table. Line 2 must involve soft iron since it cannot be in line 3. No candidate can be in ignorance of the magnetic attraction of ferrous metals to either end of a magnet, since soft iron is used in the armature of a motor and in the core of a transformer. Line 3 can then be completed even if there is uncertainty about the magnetic properties of aluminium. Most candidates answered this part of the question well, though many were unsure whether soft iron would repel when reversed.

**(b)** The repulsion or attraction between two magnets can be used in answering part **(b)**. Forces and their effects are referred to elsewhere in the syllabus. Examiners looked for an appreciation of the idea that like poles repel or unlike poles attract, then for some common-sense approach to the use of the third magnet to test the relative strength of two magnets. This may be done by finding the minimum distance from each of the other magnets when a noticeable attraction or repulsion is seen. Almost all candidates gained at least 2 marks here, but too many did not read the question carefully and described the use of paper clips or iron filings.

**(c)** Although the magnetic field is mentioned, no experience in mapping the field around a magnet is necessary. A compass points north; but so do all magnets when used as a compass, so a compass needle will be repelled from a north pole of another magnet and will be attracted to its south pole. 1 mark out of 2 could be gained if the needles pointed in the opposite direction.

**Question 3**

On first glance, this is an easy question for candidates who have done a minimum of simple heating experiments in chemistry, but it was the least well answered question in the paper. The diagram was rudimentary and gave only a hint of the function of the test-tube containing cold water. Very many candidates thought that the test-tube was being heated. Much ignorance was revealed by this question. The fascination of chemistry is epitomised for the young scientist by the excitement of heating things just to see what will happen.

**(a)** There was a problem for those who had never seen solid iodine or solid sulphur, so they labelled iodine as yellow (the colour of its solution) and sulphur as black or blue. Only a few candidates had heated copper sulphate crystals, so the "colourless liquid" was thought to come from any of the solids. The white residue could be identified as "anhydrous copper sulphate" by the better candidates, who then gained all 6 marks for this part of the question. It was almost impossible NOT to score at least 2 marks for part **(a)** merely by filling in the table at random, as long as the items were placed in the correct column!

**(b)** Only a very few candidates gave the answer “water vapour” or “steam”, and there were many fantastic suggestions.

**(c)(i)** A choice of 2 out of 3 was another gifted mark, but so many wrote “sulphur” because they had not realised that in the experiment described by the candidate, the sulphur had burned in air, so the reaction was not reversible. Either of the other two solids earned a mark, but many named substances that are not even mentioned in the question.

**(ii)** To earn the mark here, the candidate had to correctly describe the cooling of iodine vapour to make it sublime (even “condense the vapour” was accepted) or the addition of water to the white solid, to become hydrated copper sulphate. A very few candidates were able to answer this part.

**(d)** The original intention of the question was the eliciting of the hazard in burning sulphur or heating iodine in the open laboratory. An answer like this was very rare. However, a mark was given for the use of goggles for eye protection when heating chemicals, a practice that now seems to be universal, and also for tying back long hair lest it should catch fire. A lot of answers mentioned the hazards of heating the test-tube, showing that its function in providing the cold surface had not been correctly understood. One answer suggested that “the test-tube should be held by the tongue”!

**Question 4**

This was a beautifully simple experiment describing the conditions of photosynthesis in *elodea*, providing easy marks for the less able candidates; but the later parts of the question were more difficult.

**(a)(i)** Most candidates correctly gave all three averages, but some candidates conjured numbers out of thin air, or drew a straight-line graph and then read them off!

**(ii)** The graph exercise was deliberately kept as simple as possible, and the vast majority of candidates gained all 3 marks for correct choice of scale so that the maximum length of the axes was used, for correct plotting of all the points and for drawing a smooth curve.

**(iii)** The instruction “use your graph” was ignored by many candidates who merely said that “increased light intensity increased the rate of photosynthesis”. The marks were awarded to those who referred to the distance of the lamp and/or the number of bubbles of oxygen counted, in order to show that more light increased the rate of photosynthesis.

**(b)** Now the candidates had to refer to the conditions of the experiment in order to find reasons why, at the same distance, the bubble count had varied. Change of temperature, since the lamp also warmed the water, or change of carbon dioxide concentration, were most often suggested. Credit was also given to candidates who said that the current to the lamp might have changed, or that the response of the plant to changed light intensity might have been delayed.

**Question 5**

This question was the most complicated of all the questions in the paper; it was based on the corresponding question in the Practical Paper 5, just as were **Questions 1** and **6**. Despite the length of the question, it was in this question that most good candidates excelled, gaining 9 or 10 marks.

**(a)** 1 mark was awarded for reading and recording the two masses, and then 1 mark each for the heights. They were to be recorded in millimetres, though like real metre rules the scale was marked in centimetres. This was a problem for a few candidates. There were others who did not know how to find the deflection by subtraction; these candidates often read the deflection from the graph and then filled in the boxes later. Alas, this did not gain them the marks.

**(b)** There were very many creditable answers for this part, and the Examiners are pleased by the apparent improvement in graph plotting that has taken place over the years. Candidates who chose unsuitable scales lost a mark, as did those who plotted mass on the vertical axis. Others decided to use the whole of the vertical axis, say, for 90 mm deflection, only to find to their horror that they could not then answer part **(c)** by extrapolation. It was important that a straight line was drawn, passing through the origin.

**(c)(i)** This could easily be answered by extrapolation of the straight line, if the scales had been carefully chosen (the Examiners had been at pains to set the size of the graph grid so that this could be achieved).

**(ii)** The required answer is that the deflection is proportional to the mass added. Some candidates calculated an equation to relate deflection and mass; this was an acceptable answer. It was not enough to say, for instance, that "as the mass increases, so does the deflection". Proportionality is an important mathematical concept that applies elsewhere in the syllabus.

**(d)** This "thought experiment" was worked out by almost all the candidates who had answered the previous parts of the question, so they wrote that the deflection would be decreased.

**Question 6**

As noted above, this question corresponds to one in the Practical examination, Paper 5.

**(a)(i)** The thermometers were read with varying accuracy. All the temperatures had to be given to the first decimal place, so "20" was not accepted for the initial temperature for the experiment with metal **B**. The commonest errors were in reading the temperatures for metal **C**, where candidates did not realise that the scale of the thermometers was graduated in 2-degree intervals.

**(ii)** The temperature rises were usually correctly calculated.

**(b)(i)** Oxygen and carbon dioxide were the wrong answers sometimes supplied, though most candidates knew it was hydrogen.

**(ii)** It was unfortunate that a few candidates did not connect this part of the question with the experiment, so they answered the question "Which metal is most reactive with hydrochloric acid?" in a general sense. The vast majority referred back to the data in Fig. 6.1. and gave good reasons why metal **C** was the most reactive.

**(c)** The Examiners looked for *observations* that would be made when metal **E** is added to aqueous copper(II) sulphate. These were rarely given, even by candidates who wrote that "metal **E** will displace copper". This answer was given no credit. A mark could be gained by mentioning a brown or copper-coloured precipitate, or by saying that the blue solution would lose its colour; these, together with an expected rise in temperature, are ways in which it can be *shown* that **E** is more reactive than copper. Only a handful of candidates answered this part of the question by giving two observations. There were many other suggestions involving all kinds of chemical tests on copper and metal **E**, none of which conformed to the conditions mentioned in the question.