COMBINED SCIENCE

Paper 0653/11
Multiple Choice

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

General comments (Biology)

All questions fell well within the scope of the candidates taking the test, though there was sometimes a suspicion that more careful reading of the question before answering would have benefitted some of the candidates.

Comments on Specific Questions

Question 2

Candidates had first to decide whether a palisade cell was of plant or animal origin, then cope with a question that included both a positive and negative requirement. This made a usually straight-forward topic more demanding than usual. The better candidates managed well, but, in effect, almost as many suggested that a plant cell has neither cell wall, vacuole nor chloroplast. This was thus a question that would have benefitted from very careful reading before answering. It may just be that some candidates believed that a cross (*x*) indicated the existence rather than the absence of the structure.

Question 3

A handicap for candidates answering this question was the apparent belief, by well over half the candidates, that starch diffuses out of plant cells or chlorophyll diffuses into them – thus seeming to believe that these are soluble and diffusible chemicals. This inaccurate knowledge resulted is this question proving to be the most difficult of those in the biology section of the paper.

Question 4

This was the easiest of the biology questions, and reassuring to see that the very clear majority of candidates are aware of the chemical nature of enzymes.

Question 9

A phrase almost directly from the syllabus was misunderstood by a high percentage of candidates (including some who performed well in other questions in the test). However, there is the distinct possibility that, in this unusual situation of shoots growing away from light, candidates were led to believe that some phenomenon other than phototropism was responsible.

General comments (Chemistry)

Question 16, **Question 19** and **Question 23** were the easiest for the candidates, with 75% or more answering each of these items correctly. **Question 21** proved to be the most difficult question on the paper.

Comments on specific questions

Question 16

Candidates performed well on this question which required the identification of the formula of an organic compound.

Question 17

A good proportion of candidates were able to match the substances formed at the electrodes. There was still a significant number of candidates who confused the cathode with the anode, opting for answer **C** instead of the correct answer, **A**.

Question 18

Most candidates were able to relate a temperature change to the terms exothermic and endothermic. A pleasing proportion of candidates correctly identified the change as being endothermic, but a significant proportion of candidates confused exothermic with endothermic.

Question 19

Candidates performed very well on this question, showing a good understanding of factors influencing reaction speeds.

Question 21

In this item candidates had to identify the compound X from two test results. A large proportion of candidates chose distractor **C**, NaC*l*, more than chose the correct answer **A**, HC*l*. It appears that those who chose **C**, did so using the second piece of data only.

Many identified X as an acid, but then failed to use the second test result to identify X correctly.

Question 23

Candidates performed well on this question and had little difficulty relating the physical properties of copper and plastic to their uses.

Question 25

Candidates found this question surprisingly difficult. It is unclear why a significant number of candidates selected sulfur, **D**, from the list instead of calcium, **A**, from the options.

General comments (Physics)

In the physics section, no questions were found particularly difficult or easy.

Comments on Specific Questions

Question 29

Candidates should be advised to read questions carefully, especially words written in bold font. Here many forgot to take into account that there were **two** blocks of cheese on the balance.

Question 30

Distractor **B** was popular in this question on energy, and distractor **C** even more so. As in previous years, perhaps these candidates believed that the two columns must contain different choices, whereas this is often not the case. Also those choosing **B** could have failed to notice that the car was gaining speed.

Question 37

Many weaker candidates chose option **C**, despite this being a very straightforward recall question on the range of human hearing.

Question 38

Almost half the candidates could not answer this question on fuses correctly, including nearly a quarter of the stronger ones. A popular choice was **C**, despite the fact that the wires could only carry up to 5A safely.

Questions 39 and 40

These questions concerned meters and circuits. Although the majority of responses were correct, there seems to have been a considerable amount of guessing by weaker candidates in **Question 39**, and by all abilities of candidate in **Question 40**.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice

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

General comments (Biology)

Apart from one question, all biology questions fell comfortably within the scope of the candidates. There was a suspicion that several candidates did not always take quite enough time to read the question and carefully marshal their thoughts before answering. **Question 6** exposed a commonly-held basic misunderstanding about the nature of transpiration.

Comments on Specific Questions

Question 1

Candidates had first to decide whether a palisade cell is of plant or animal origin, then cope with a question that included both a positive and negative requirement. This made a usually straight-forward topic more demanding than usual. The better candidates managed well, but, in effect, almost as many suggested that a plant cell has neither cell wall, vacuole nor chloroplast. This was thus a question that would have benefitted from very careful reading before answering. It may just be that some candidates believed that a cross (*x*) indicated the presence rather than the absence of a structure.

Question 2

This was the easiest of the biological questions, perhaps as a consequence of the relative implausibility of the incorrect options, but it still discriminated between those who thought carefully and those who did not carefully check their answers.

Question 6

A serious misunderstanding was exposed by this question. Less than a fifth of the candidates appeared to be aware that water evaporates first from the walls of mesophyll cells into the intercellular spaces, before diffusing as water vapour through the stomata. The most popular suggestion was that it occurs from the epidermis and were thus apparently happy to overlook the waterproof nature of the cuticle.

Question 12

Allowing for those who were unsure of the difference between the words 'sexual' and 'asexual', there was a significant number of candidates (just over a quarter) who felt that asexual reproduction involves only one parent, but also involves gametes and a zygote.

General comments (Chemistry)

Question 17, **Question 20** and **Question 21** were the easiest for the candidates, with 75% or more answering each of these items correctly.

Candidates found **Question 23** and **Question 27** most difficult.

Comments on Specific Questions

Question 14

More candidates chose distractor **A**, than chose the correct answer **C**. It appears that candidates failed to recognise that they were asked to identify the number of hydrogen atoms in *three*, not *one*, molecules of ammonia, NH_3.

Question 17

This question required the identification of the formula of an organic compound and was very well answered.

Question 18

The vast majority of candidates identified the anode as the positive electrode. Although over half the candidates got the correct answer, **B**, a significant number of candidates answered **A** and were clearly confused over which product formed at the negative electrode.

Question 20

Candidates were required to predict the relative rates of reactions in three reactions between a metal and acid and candidates showed a good understanding of factors affecting reaction rates.

Question 21

Candidates were asked to explain the oxidation of magnesium in its reaction with carbon dioxide. The question was very well answered.

Question 23

Even more able candidates found this question on the properties of Lithium difficult. Just over half of candidates realised the alkali metal, lithium, is soft but a significant proportion of those candidates did not realise that it had the highest melting point in Group I.

Question 27

This question proved the most difficult of the chemistry questions. Nearly half the candidates chose distractor **B**, more than chose the correct answer **A**. Candidates may have failed to recognise that zinc, used in galvanising, prevents iron from rusting.

General comments (Physics)

In the physics section, **Questions 28** and **33** were the best answered, and **Question 38** was found particularly difficult by a large proportion of candidates.

Comments on Specific Questions

Question 28

Few candidates had difficulty in converting a time from minutes to seconds and then calculating a speed.

Question 29

Candidates should be advised to read questions carefully, especially words written in bold font. Here many forgot to take into account that there were **two** blocks of cheese on the balance.

Questions 30 and 31

Weaker candidates found these questions on energy and evaporation too taxing, and resorted to guessing.

Question 32

A significant proportion of candidates of all abilities chose distractor **C** here, failing to appreciate that for liquid and solid wax to be present, the temperature must be constant.

Question 34

Many weaker candidates could not recall that the amplitude of the wave would be twice the distance between the highest and lowest positions of the boat.

Question 38

In this question option **C** was very popular. However, of the fuses available, the one rated at 1.0 A would provide the greatest protection by blowing earlier than the one rated at 5.0 A.

Questions 39 and 40

These questions concerned meters and circuits. There seems to have been a considerable amount of guessing by weaker candidates in both questions, and to some extent by more able candidates in **Question 40**.

COMBINED SCIENCE

Paper 0653/13
Multiple Choice

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

General comments (Biology)

Generally, the questions in the biology section of the paper proved to fall within the capability range of the candidates, though one or two would have benefitted from careful reading before selecting an answer.

Comments on Specific Questions

Question 1

This question was, perhaps, somewhat demanding for the first question in the paper. It tested knowledge in two separate disciplines – that of four biological processes, then a knowledge of which product is a (chemical) element. It may be that many resorted to guess work, but it remains surprising that only a small proportion of candidates identified photosynthesis as a process that produces the element oxygen as a waste product.

Question 2

Candidates had first to decide whether a palisade cell illustrated is of plant or animal origin, then cope with a question that included both a positive and negative requirement. This made a usually straight-forward topic more demanding than usual. The better candidates managed well, but, in effect, a large number of candidates appeared to believe that a plant cell has neither cell wall, vacuole nor chloroplast. This was thus a question that would have benefitted from very careful reading before answering. There is just a chance that some candidates believed that a cross (*x*) indicated the presence rather than the absence of a structure.

Question 3

A handicap for candidates answering this question was the apparent belief, by well over half the candidates, that starch diffuses out of plant cells and chlorophyll diffuses into them – thus seeming to believe that these are soluble and diffusible chemicals. This inaccurate knowledge resulted is this question proving to be the more difficult of those in the biology section of the paper.

Question 6

The large number of candidates appearing to believe that the upper epidermis of a leaf contains light-absorbing structures – despite no chloroplasts being shown in these cells, might suggest that they were unclear of the appearance and function of the chloroplasts shown in large numbers in the palisade layer.

Question 13

This was the easiest question in the biology section of the paper in an aspect of the carbon cycle that can sometimes be insecure. A knowledge of chemistry may have proved helpful.

General comments (Chemistry)

Question 15, **Question 17** and **Question 20** were answered very well by the candidates, with 75% or more answering each of these questions correctly. **Question 22** proved most difficult.

Comments on specific questions

Question 14

A large proportion of candidates gave the correct answer **D**, correctly identifying the numbers of atoms in the three molecules. However, a significant number of candidates chose answer **A**, confusing the number of atoms with the number of different elements.

Question 16

Over half the candidates got the correct answer. A number of the more able candidates appear to have confused *nucleons* with *protons* (whose number would be the same as that of electrons).

Question 17

Candidates showed a good understanding of converting chemical compounds in words to the correct formula. A higher proportion of candidates gave the correct answer for this question than for any other question in the paper.

Question 18

Most candidates were able to identify the electrolyte correctly. However, nearly as many candidates thought copper would be deposited on the anode as those that realised the copper would be deposited on the negative electrode. There is evidence stronger candidates also confused the cathode and anode.

Question 19

The vast majority of candidates realised an endothermic reaction involved a temperature change. However, a similar proportion of candidates opted for the wrong answer, a temperature increase, as correctly realised a decrease in temperature results.

Question 20

Candidates performed very well on this question, showing a good understanding of factors influencing reaction speeds.

Question 22

In this item candidates had to identify the compound X from two test results. A large proportion of candidates chose distractor **C**, NaC*l*, more than chose the correct answer **A**, HC*l*. It appears that those who chose **C**, did so using the second piece of data only.

Many identified X as an acid, but then failed to use the second test result to identify X correctly.

Question 25

The same proportion of candidates chose distractor **D** as chose the correct answer, **A**. It is unclear why so many should have selected sulfur, **D**, from the list instead of calcium, **A**, from the options.

Question 27

A simple recall item, but many candidates appear to have confused *natural gas* with *air*.

General comments (Physics)

In the physics section, **Question 34** was the best answered, and **Questions 29**, **30** and **37** were found difficult by a large proportion of candidates.

Comments on Specific Questions

Question 28

A very large proportion of weaker candidates here simply divided the distance given by the time, ignoring the fact that both units had to be changed to answer the question.

Question 29

Candidates should be advised to read questions carefully, especially words written in bold font. Here, able and less able candidates often forgot to take into account that there were **two** blocks of cheese on the balance.

Questions 30

Very many candidates chose option **B** that gave the energy stored in a box of matches as ‘thermal’. It is possible that some of these believed that the choice must be different in the two columns, which is frequently not the case.

Question 31

This concerned evaporation and weaker candidates tended to resort to guessing.

Question 34

The topic here was wave frequency, and caused very few problems.

Question 37

The most common error here was to opt for **A**, being a frequency of 25Hz, which is within the normal range of human hearing. Candidates may have failed to convert this successfully from the value of 0.025kHz given in the question.

Question 38

This question concerned fuses, and more than one in three candidates subtracted one current from the other to give option **C**, 7 A, as the answer, whereas the air conditioner on its own took 9.0 A.

Questions 40

Many candidates, including several of the more able, did not know that connecting resistors in parallel reduces the total resistance, and therefore chose option **A**.

COMBINED SCIENCE

Paper 0653/21
Core Theory

Key Messages

Candidates should attempt as many questions as possible. In the script there were some questions which required candidates to select their answers from information provided in the stem of the question. Some candidates omitted these questions. Credit cannot be awarded for questions that are not attempted.

Candidates should not attempt to write formulae if a word equation is requested in the question.

General Comments

There were some good scripts provided by many candidates who showed a very good understanding of the syllabus. There was no indication that candidates had insufficient time for completion of the examination.

The space provided for answers gives an indication of how long the responses should be. It is therefore wasteful to repeat the question as part of the candidate's response.

Teachers should read this report and the published mark scheme together.

Comments on Specific Questions

Question 1

(a) (i) Many higher-scoring candidates understood the meaning of subatomic particles. They should understand that neutrons are not present in a hydrogen atom. Other candidates should know that names of elements were not being requested by this question.

(ii) The correct answer was given by candidates across the range. Incorrect responses included ionic and chemical bonding.

(iii) Only a few candidates successfully answered this question. One of the main misconceptions of candidates was the association of combustion with carbon-containing compounds. Therefore many incorrect scripts had carbon dioxide as the product. Some candidates wrote incorrect formulae instead of words, so they could not be awarded credit for this. Candidates should understand that water is not described as 'hydrogen oxide'.

(iv) Many candidates successfully answered this in terms of a reaction giving out heat. The releasing of energy by a reaction was not considered specific enough to gain credit.

(v) Some higher-scoring candidates answered this question well and it was clear that they had laboratory experience of the topic. There was a wide range of incorrect responses including oxygen and helium. Candidates are reminded that they should be familiar with the reactivity series of metals and their displacement reactions.

(b) This question was correctly answered by candidates across the range.

(c) The correct formula was given by most candidates. Others would have gained credit if they had remembered to use capital letters for the symbols, and subscripts for the numbers.

Question 2

(a) (i) The answers to both this question and **(a)(ii)** were provided as a list in the stem of the question. Therefore, all candidates should have attempted these questions. A minority of candidates did not complete these questions, therefore losing the chance to score credit. In this question higher-scoring candidates correctly identified the elements in carbohydrates. Carbon and hydrogen were correctly given as two of the elements. The third element, oxygen, was less frequently given, with nitrogen often given instead.

(ii) This question was less successfully answered than **(i)** by candidates across the range. Careful reading of the stem indicated that elements from the list could be used more than once. Many candidates who answered well in **(i)** wrote three different incorrect elements from the remainder of the list as their response to this question.

(b) (i) This was well answered by the higher-scoring candidates. Candidates should remember that a cell wall and chloroplasts are only found in plant cells.

(ii) Candidates responded well to this more challenging question with most responses showing an understanding about the role of the blood in transport. More credit would have been obtained if diffusion of oxygen, either at the lungs or at the muscle cell, had been described by more candidates. Many responses correctly mentioned the function of red blood cells. Candidates who just wrote 'blood cells' did not gain credit for this part.

(c) This question was challenging for many candidates. The main misconception was to confuse tissue respiration with breathing. There were many incorrect answers referring to breathing and heart rates instead of focussing on the need for increased energy requirement of the cells in the exercising muscles.

(d) (i) The calculation was successfully done by most candidates across the full ability range.

(ii) Most candidates correctly related the information in **(i)** to this question, identifying Sarbjit as using more energy. Candidates would have gained full credit if they had related their findings to the breaking down of food stores in the body.

(iii) There was a range of correct possibilities given for this. Candidates should be aware that just repeating the question was not acceptable. An example of this was 'Everyone uses different amounts of energy'. More detail such as variation in body mass was needed.

Question 3

(a) This was correctly answered by the majority of candidates.

(b) Most candidates across the range answered this well. Candidates are reminded that the straight line between points **B** and **C** indicates that the man is moving at a constant speed and is not stationary as would be the case in a distance / time graph.

(c) This was well answered by candidates across the range, who successfully gave the equation, working and correct answer. Although formula triangles were written by some candidates, they were usually followed by the correct formula. Credit was not awarded for the triangle on its own instead of the equation.

(d) (i) Many candidates successfully identified the reduction of friction as the reason for adding wax to the underside of the snowboard. Responses such as 'to make it slippy' were not acceptable since it did not include a reference to a force. Lower-scoring candidates gave responses which were a rewording of the question and these did not gain credit. An example of this was 'to make it move faster'.

(ii) It was clear from candidates' responses that they understood the idea of why the man bent low on the board. Responses such as 'it makes him more aerodynamic' indicated their understanding, but the explanation did not explain the forces acting on the man. A common misconception by the lower-scoring candidates was that the man became heavier by bending low.

(e) This diagram was generally well answered. Candidates are reminded that there should be no spaces between the particles, which should also be in a regular pattern. Incorrect diagrams included ones with random arrangements of particles.

Question 4

(a) (i) Several candidates identified the colour change correctly. Candidates are recommended to learn the range of colours produced by full-range (Universal) indicator since this indicator is used in a variety of contexts.

(ii) Candidates across the range found this challenging. Most responses correctly said that the low pH of the soil indicates that it is acidic. Very few candidates mentioned that the sulfur dioxide has to dissolve in water to create an acidic solution. Most candidates just said that the acidic gas fell on the soil to make it acidic without the need for dissolving in water.

(iii) Some candidates correctly identified the products of the reaction as calcium chloride and water. Other candidates wrote hydrogen as one of the products, even though carbon dioxide as the gas product appears in the stem of the question.

(b) (i) There were many correct answers to this question indicating that candidates were familiar with the experiment. Statements such as 'Increasing the surface area increases the rate of reaction' were not accepted because candidates had not related this to the size of marble pieces.

(ii) Many candidates successfully described how increasing the temperature or concentration of acid would affect the rate. Candidates who said 'The temperature affects the rate of reaction' did not gain credit since they needed to describe how the rate of reaction is increased as the temperature increases. Answers describing the use of powdered calcium carbonate were not credited since this was not considered to be a different variable.

Question 5

(a) (i) There were many correct answers given by candidates who successfully identified the anther on flower **A** and the stigma on flower **B**.

(ii) This question proved to be challenging. Candidates were requested to use features visible in the diagram in their responses. This meant that answers such as scent and presence of nectar were not accepted. The presence of large petals, and the anther and stigma being inside the flower were the points being looked for in this response.

(b) (i) Most candidates could follow the information provided about the germination experiment and the results table. Acceptable responses had to include reference to the dishes that did not germinate in cold or dry conditions. The higher-scoring candidates usually managed to do this. Statements such as 'Warmth is needed because the seeds germinated at 20 °C' were not credited because not all of the dishes at 20 °C showed germination. A similar situation occurred with the requirement for water. Credit was also lost by those candidates who did not make any reference to the data provided.

(ii) This question was generally answered well by the full range of candidates. They correctly compared dish 4 with dish 1. Candidates who made statements such as 'Light is needed because it is necessary for photosynthesis' did not gain credit since the question clearly asked them to draw a conclusion from the data provided in the table.

(iii) A few candidates succeeded in providing oxygen as a necessary condition for germination. Unacceptable answers included spacing of the seeds, or the presence or absence of soil.

Question 6

(a) (i) This was generally well answered by most candidates who wrote the cello as their response.

(ii) Most candidates correctly named the harp as the instrument with the shortest wavelength.

(iii) The relationship between pitch and frequency was well known by many candidates who gained credit in this question.

(b) (i) The drawing of an acceptable diagram was found to be challenging by many candidates. The vibrating string had to be secured at both ends to gain credit.

(ii) Although only a minority of candidates achieved credit in **(i)** many more understood that a louder sound would have a bigger amplitude. 'Bigger waves' was not accepted since it was not clear which part of the wave was bigger.

(c) This was well done by many candidates. Many of those who did not achieve credit calculated 330 / 66 giving the answer 5 s instead of 66 / 330 making the answer 0.2 s.

Question 7

(a) Knowledge of the physical states of the halogens was correctly recalled by a few candidates.

(b) (i) The labels of anode, cathode and electrolyte were correctly selected from the list of words by the higher-scoring candidates. Common misconceptions included responses from candidates who confused the anode with the cathode or named the electrolyte as water.

(ii) The correct positioning of **X** as the location for production of bromine was achieved by many candidates. The most common incorrect answers were the positioning of the **X** around the wrong electrode, or directly in the centre of the electrolyte.

(iii) The answer required by this question was the physical appearance of bromine as a brown vapour. Many candidates misinterpreted the question and gave descriptions of where the bromine was produced, giving statements such as 'The bromine appeared around the anode'. As a result of this, many candidates did not achieve credit on this question.

(c) (i) Knowledge of the trend of reactivity of the halogens was generally poor and as a result most candidates found all the questions in part **(c)** challenging. Very few candidates knew that sodium chloride is the other compound produced in the reaction.

(ii) A few candidates wrote the correct answer, taking their cue from the previous question. 'Sodium iodine' or 'iodine' were examples of incorrect responses from candidates who knew the chemical must contain iodine, but these could not be given credit.

(iii) Only a few candidates correctly identified the trend of reactivity of the halogens down the group. Candidates should be aware that differences in reactivity between the halogens explains these displacement reactions.

Question 8

(a) (i) This question was well answered by many candidates. One aspect of this equation about which candidates should be aware is that the conditions for photosynthesis are not reactants. Many incorrect responses included light and chlorophyll as the missing reactant instead of water. Either sugar or glucose was acceptable as the missing product but incorrect formulae did not gain credit.

(ii) This was generally answered well by all candidates.

(b) The addition of the hyena to the food chain to make a food web was successfully done by many candidates who gained full credit. Candidates should be reminded that the arrow corresponds to a flow of energy and it must be drawn to show this. Therefore, credit was not awarded if the arrows were the wrong way round. Several candidates drew a separate food chain and did not try to combine it with the original food chain. This did not reflect their knowledge of how a food web is constructed.

(c) (i) This was a straightforward question with a simple answer. The carbon atoms are transferred when the lion eats the zebra. This point was made by most candidates.

(ii) There were some very good answers to this question. The majority of candidates realised that the lion would leave some of the zebra carcass behind, and this would contain carbon. The second mark was more challenging. Some candidates correctly stated that some of the carbon atoms would be excreted by the zebra. References to carbon being breathed out by the zebra needed to mention the presence of carbon dioxide in the breath of the zebra.

Question 9

(a) (i) Generally well answered across the range of candidates who recognised that convection is the method of heat transfer through gases.

(ii) Generally well answered across the range of candidates who recognised that conduction is the method of heat transfer through solids.

(iii) Many candidates indicated in their answers that the use of an insulator around the tank would be used. They generally did not offer an explanation in terms of preventing heat loss by one of the methods, for example conduction. A common misconception was that a metal or a matt black container would keep the heat in. Candidates should be aware that in this case the heat source is inside the heater and the direction of heat loss is out of the container. Therefore, heat will be more readily lost from metal or matt black containers.

(b) Many higher-scoring candidates successfully completed the circuit to include the heaters in parallel with a switch in each branch. Many candidates only gained partial credit by drawing circuits that would successfully switch one heater off, but not both separately. Short circuits drawn by some candidates could not be given credit.

(c) This question proved very challenging for the vast majority of the candidates. The fact that a high resistance leads to a lower current was not understood by most candidates. Of those who attempted this question the vast majority said that the water-heating element had the higher resistance since it had the higher current. Candidates should be aware of the inverse relationship between resistance and current.

(d) This question was attempted by many candidates who produced acceptable answers which included faults with insulation of the wiring or the earth of the plug. It was not enough to say that the metal casing conducted electricity without providing a cause, since many metal appliances are quite safe.

COMBINED SCIENCE

Paper 0653/22

Core Theory

Key Messages

Candidates should attempt as many questions as possible. In the script there were some questions which requested candidates to select answers from information provided in the stem of the question. Some candidates omitted these questions. Credit cannot be awarded for questions that are not attempted.

Candidates should not write formulae if a word equation is requested in the question.

General Comments

There were some good scripts provided by many candidates who showed a very good understanding of the syllabus. There was no indication that candidates had insufficient time for completion of the examination.

The space provided for answers gives an indication of how long the responses should be. It is therefore wasteful to repeat the question as part of the candidate's response.

Teachers should read this report and the published mark scheme together.

Comments on specific questions

Question 1

(a) (i) Many candidates succeeded in providing the correct answer. The main reason for answers not receiving credit was writing 23 as the number of neutrons.

(ii) Many candidates gained credit on this question. They had to relate the atomic structure of sodium to its behaviour when reacting. It was not enough to provide the answer '1' without any supporting reason.

(b) (i) A small number of candidates described the chemical tests with cobalt chloride paper or anhydrous copper sulphate and so gained full credit. Many more candidates described the test for hydrogen with a burning splint providing water as shown in the stem of the question. This was not accepted since the water produced was not tested with either of the chemicals.

(ii) Many candidates successfully used the information provided in the rest of the question to produce the word equation. Some candidates attempted a symbol equation. Credit was not awarded for incorrect formulae.

(iii) Many candidates successfully named the covalent bond. Candidates who wrote 'chemical bond' should be aware that this term is not specific enough since it could refer to other types of bonding, for example an ionic bond.

Question 2

(a) (i) This question was successfully attempted by many candidates, who knew which small molecules joined together to make the large molecules. Several candidates did not attempt the drawings. Careful reading of the stem indicates that diagrams of the small molecules are all provided so this question could have been attempted by all candidates.

(ii) A description of respiration was required as an answer to this. Many candidates gave descriptions of respiration and gained some credit, but did not offer the further explanation required to show their understanding of what actually happens in cells. Some candidates described digestion to explain breaking down molecules. This was not accepted because respiration breaks down small nutrient molecules inside cells.

(b) (i) This question was answered well by many candidates who successfully described the pathway of water through the plant. Confusion of xylem with phloem tissue caused many candidates to lose credit.

(ii) Candidates who knew the seven characteristics of living things found this question straightforward and could select the correct two characteristics

(iii) The appearance of the open leaves was the point for consideration in this question. Therefore answers relating to smell were not acceptable. Many candidates correctly suggested the colour of the leaves would look like flowers and therefore gained some credit. Additional credit was available for a comparison of the shape or size of the leaves being similar to petals.

Question 3

(a) This question was generally well answered with many candidates recognising the constant speed shown by the horizontal line on the graph.

(b) The energy changes experienced by the pole-vaulter were generally correctly identified by many of the higher-scoring candidates. Several candidates wrote 'heat energy' for the first energy change. This did not gain credit because the question was asking for the main energy transfer.

(c) (i)(ii) Many candidates could correctly interpret the shape of the graph in terms of changes in speed and they related this to the man going over the pole. A common misconception was when candidates described the movement from **C** onwards as the moment when the man was at his highest, then falling down suddenly.

(d) The majority of candidates achieved full credit in this question, either by applying the correct equation or working out the area under the graph.

(e) This diagram was generally well answered. Candidates are reminded that there should be no spaces between the particles, which should also be in a regular pattern.

Question 4

(a) (i) Most **c**andidates could describe a physical change and a chemical change from the information provided.

(ii) The description of the difference between a physical change and a chemical change proved to be more problematic for most candidates. A minority of responses correctly described that a chemical change produces a new substance. Many candidates wrote that a physical change can be seen from the outside but a chemical change cannot be seen because it happens on the inside. This description was not accepted.

(b) Candidates used their knowledge of today's atmosphere to draw valid conclusions from the pie chart. Some candidates lost credit because they did not make their comparisons clear. Statements such as 'The carbon dioxide concentration increased' were not credited because the implication was that this may have happened over time, though this may not have been the intention of the candidate. Credit was also lost for incorrect values quoted, for example 'There is 2% of carbon dioxide today.'

(c) Candidates had to show their understanding that the increasing pH means that the acid is reacting and being neutralised. Very few candidates described the reaction of the copper oxide base as a neutralisation reaction with many of them saying that copper oxide is an alkali.

(d) (i) Many candidates gained credit in this question showing an understanding that reduction in this context is the removal of the oxygen from the copper oxide.

(ii) A few candidates answered this question correctly, describing a valid practical method of extracting copper. Many candidates described electrolysis as a method of extracting the copper but this was not accepted because it is insoluble in water and the melting point of the compound is too high to tackle this in a laboratory.

Question 5

(a) (i)(ii) Some candidates could provide the correct label for the pulmonary artery, and also successfully drew arrows showing the direction of blood flow through the heart. Many candidates drew incorrect arrows with many showing the blood coming into the heart through the arteries. Candidates should be able to demonstrate their knowledge of the blood vessels entering and leaving the heart and also the direction of blood flow into and through the heart.

(b) (i) Many candidates successfully answered this question about the function of valves in the heart. The main misconception by those candidates who did not gain credit was the idea that valves have an active pumping action.

(ii) Most candidates found this question challenging. Candidates should be aware that valves respond to the pressure of the blood around them. In this case the valve was responding to the increased pressure in the ventricle.

(c) Many candidates successfully recalled the function of haemoglobin in carrying oxygen.

(d) The function of platelets in facilitating the clotting of blood was known by some of the higher-scoring candidates. Those who then described the advantage of sealing wounds quickly gained full credit. A common misconception was that the function of platelets is to fight disease in the same way as white blood cells.

Question 6

(a) This question was well answered by the full range of candidates who chose an electromagnetic wave and its correct function. Some incorrect responses included descriptions of sound waves and water waves.

(b) (i) The description of wave motion was found to be challenging for most candidates. Candidates should appreciate that wave motion requires the oscillation of a medium producing the characteristic pattern of waves with identifiable wavelength and amplitude. Many candidates responded with wave motion just meaning the movement of a wave. This type of response was not awarded any credit.

(ii) Many candidates successfully identified the wavelength and speed as the factors that changed at point **P**. Other candidates wrote that the frequency changes. This was not accepted because the frequency does not change. The frequency of the waves is determined the speed of rotation of the motor attached to the board. The speed of rotation of the motor does not change.

(c) This question was understood well by many candidates who interpreted the number of vibrations per second as the frequency. Their knowledge of the frequency of the threshold of human hearing meant that they could gain credit for this question.

Question 7

(a) Many of the higher-scoring candidates successfully converted the description of the atoms in a compound to a formula. Candidates should be aware that in this formula the element symbols should be in capital letters and the numbers subscript form. Some candidates lost credit because they did not include the copper atom.

(b) (i) The answer gained credit in this question by describing the physical appearance of copper as a brown metal. Many candidates misinterpreted the question and gave descriptions of where the copper was produced, giving statements such as ‘The copper appeared around the cathode’. As a result of this many candidates did not achieve credit on this question.

(ii) Candidates found the question challenging with not many knowing the term *polarity*.

(iii) More candidates were able to score credit in this question than in part **(ii)**. However the lower-scoring candidates found it challenging, with 'carbon electrode' frequently being written as their answer.

(c) The ability to answer this question was made easier by candidates who had done the experiment in class. Therefore they had no difficulty in providing the description and the conclusion, gaining full credit. Candidates who had not seen the reaction made use of the periodic table and made predictions about which metal would be more reactive. These predictions were often unsuccessful because candidates said that magnesium was more reactive because it is higher up in Group II, instead of being less reactive.

(d) (i) The trend of reactivity in Group I was being tested in this question and many candidates answered it successfully. Candidates who did not gain credit for this question included those who wrote the list of elements starting with the least reactive, and those who wrote the last three members of the group in order of reactivity.

(ii) Those candidates who realised that potassium is more reactive than sodium made a reasonable attempt in this question and gained credit. Credit was not given for statements similar to 'It would react more.' A specific observation such as 'More bubbles were produced' or 'It produced a lilac flame' were examples of responses that gained credit.

Question 8

(a) The words needed were all provided in the list so all candidates should have attempted this question. Full credit was obtained by those candidates who understood the effects of carbon particles on the rate of photosynthesis, both in blocking the light falling on the leaf, and in blocking the stomata,

(b) Candidates were asked to describe either the increase in global warming, or one of the many environmental consequences of global warming. As a result there were many acceptable responses. Candidates should be aware that global warming does not affect the ozone layer and any responses referring to the ozone layer gained no credit.

(c) The main undesirable effects on the animal life in the forest are the loss of food and habitat. Several candidates made statements such as 'It interrupts the food chain.' This was not considered to be enough detail to gain credit, but 'The loss of trees would leave the herbivores without food' did gain credit because responses of this type explained a consequence of the loss of trees.

Question 9

(a) Many candidates gained credit for knowing the meaning of 'V', but the significance of the 12 (V) as a safe maximum was not explained by most candidates. Therefore only partial credit was achieved by most candidates.

(b) The need to have a parallel circuit was understood by many of the higher-scoring candidates. Some of the unacceptable responses included drawing the original series circuit again with the components placed in a different order, and any drawings including a short circuit.

(c) Candidates across the range found this question challenging with only a few gaining credit. The property, the resistance, was unfamiliar to most candidates in this context.

(d) Many candidates could describe the methods of heat transfer and their explanations successfully, therefore gaining credit.

COMBINED SCIENCE

Paper 0653/23
Core Theory

Key Messages

Candidates should attempt as many questions as possible. In the script there were some questions which required candidates to select their answers from information provided in the stem of the question. Some candidates omitted these questions. Credit cannot be awarded for questions that are not attempted.

Candidates should not attempt to write formulae if a word equation is requested in the question.

General Comments

There were some good scripts provided by many candidates who showed a very good understanding of the syllabus. There was no indication that candidates had insufficient time for completion of the examination.

The space provided for answers gives an indication of how long the responses should be. It is therefore wasteful to repeat the question as part of the candidate's response.

Teachers should read this report and the published mark scheme together.

Comments on Specific Questions

Question 1

(a) (i) Many higher-scoring candidates understood the meaning of subatomic particles. They should understand that neutrons are not present in a hydrogen atom. Other candidates should know that names of elements were not being requested by this question.

(ii) The correct answer was given by candidates across the range. Incorrect responses included ionic and chemical bonding.

(iii) Only a few candidates successfully answered this question. One of the main misconceptions of candidates was the association of combustion with carbon-containing compounds. Therefore many incorrect scripts had carbon dioxide as the product. Some candidates wrote incorrect formulae instead of words, so they could not be awarded credit for this. Candidates should understand that water is not described as 'hydrogen oxide'.

(iv) Many candidates successfully answered this in terms of a reaction giving out heat. The releasing of energy by a reaction was not considered specific enough to gain credit.

(v) Some higher-scoring candidates answered this question well and it was clear that they had laboratory experience of the topic. There was a wide range of incorrect responses including oxygen and helium. Candidates are reminded that they should be familiar with the reactivity series of metals and their displacement reactions.

(b) This question was correctly answered by candidates across the range.

(c) The correct formula was given by most candidates. Others would have gained credit if they had remembered to use capital letters for the symbols, and subscripts for the numbers.

Question 2

(a) (i) The answers to both this question and **(a)(ii)** were provided as a list in the stem of the question. Therefore, all candidates should have attempted these questions. A minority of candidates did not complete these questions, therefore losing the chance to score credit. In this question higher-scoring candidates correctly identified the elements in carbohydrates. Carbon and hydrogen were correctly given as two of the elements. The third element, oxygen, was less frequently given, with nitrogen often given instead.

(ii) This question was less successfully answered than **(i)** by candidates across the range. Careful reading of the stem indicated that elements from the list could be used more than once. Many candidates who answered well in **(i)** wrote three different incorrect elements from the remainder of the list as their response to this question.

(b) (i) This was well answered by the higher-scoring candidates. Candidates should remember that a cell wall and chloroplasts are only found in plant cells.

(ii) Candidates responded well to this more challenging question with most responses showing an understanding about the role of the blood in transport. More credit would have been obtained if diffusion of oxygen, either at the lungs or at the muscle cell, had been described by more candidates. Many responses correctly mentioned the function of red blood cells. Candidates who just wrote 'blood cells' did not gain credit for this part.

(c) This question was challenging for many candidates. The main misconception was to confuse tissue respiration with breathing. There were many incorrect answers referring to breathing and heart rates instead of focussing on the need for increased energy requirement of the cells in the exercising muscles.

(d) (i) The calculation was successfully done by most candidates across the full ability range.

(ii) Most candidates correctly related the information in **(i)** to this question, identifying Sarbjit as using more energy. Candidates would have gained full credit if they had related their findings to the breaking down of food stores in the body.

(iii) There was a range of correct possibilities given for this. Candidates should be aware that just repeating the question was not acceptable. An example of this was 'Everyone uses different amounts of energy'. More detail such as variation in body mass was needed.

Question 3

(a) This was correctly answered by the majority of candidates.

(b) Most candidates across the range answered this well. Candidates are reminded that the straight line between points **B** and **C** indicates that the man is moving at a constant speed and is not stationary as would be the case in a distance / time graph.

(c) This was well answered by candidates across the range, who successfully gave the equation, working and correct answer. Although formula triangles were written by some candidates, they were usually followed by the correct formula. Credit was not awarded for the triangle on its own instead of the equation.

(d) (i) Many candidates successfully identified the reduction of friction as the reason for adding wax to the underside of the snowboard. Responses such as 'to make it slippy' were not acceptable since it did not include a reference to a force. Lower-scoring candidates gave responses which were a rewording of the question and these did not gain credit. An example of this was 'to make it move faster'.

(ii) It was clear from candidates' responses that they understood the idea of why the man bent low on the board. Responses such as 'it makes him more aerodynamic' indicated their understanding, but the explanation did not explain the forces acting on the man. A common misconception by the lower-scoring candidates was that the man became heavier by bending low.

(e) This diagram was generally well answered. Candidates are reminded that there should be no spaces between the particles, which should also be in a regular pattern. Incorrect diagrams included ones with random arrangements of particles.

Question 4

(a) (i) Several candidates identified the colour change correctly. Candidates are recommended to learn the range of colours produced by full-range (Universal) indicator since this indicator is used in a variety of contexts.

(ii) Candidates across the range found this challenging. Most responses correctly said that the low pH of the soil indicates that it is acidic. Very few candidates mentioned that the sulfur dioxide has to dissolve in water to create an acidic solution. Most candidates just said that the acidic gas fell on the soil to make it acidic without the need for dissolving in water.

(iii) Some candidates correctly identified the products of the reaction as calcium chloride and water. Other candidates wrote hydrogen as one of the products, even though carbon dioxide as the gas product appears in the stem of the question.

(b) (i) There were many correct answers to this question indicating that candidates were familiar with the experiment. Statements such as 'Increasing the surface area increases the rate of reaction' were not accepted because candidates had not related this to the size of marble pieces.

(ii) Many candidates successfully described how increasing the temperature or concentration of acid would affect the rate. Candidates who said 'The temperature affects the rate of reaction' did not gain credit since they needed to describe how the rate of reaction is increased as the temperature increases. Answers describing the use of powdered calcium carbonate were not credited since this was not considered to be a different variable.

Question 5

(a) (i) There were many correct answers given by candidates who successfully identified the anther on flower **A** and the stigma on flower **B**.

(ii) This question proved to be challenging. Candidates were requested to use features visible in the diagram in their responses. This meant that answers such as scent and presence of nectar were not accepted. The presence of large petals, and the anther and stigma being inside the flower were the points being looked for in this response.

(b) (i) Most candidates could follow the information provided about the germination experiment and the results table. Acceptable responses had to include reference to the dishes that did not germinate in cold or dry conditions. The higher-scoring candidates usually managed to do this. Statements such as 'Warmth is needed because the seeds germinated at 20 °C' were not credited because not all of the dishes at 20 °C showed germination. A similar situation occurred with the requirement for water. Credit was also lost by those candidates who did not make any reference to the data provided.

(ii) This question was generally answered well by the full range of candidates. They correctly compared dish 4 with dish 1. Candidates who made statements such as 'Light is needed because it is necessary for photosynthesis' did not gain credit since the question clearly asked them to draw a conclusion from the data provided in the table.

(iii) A few candidates succeeded in providing oxygen as a necessary condition for germination. Unacceptable answers included spacing of the seeds, or the presence or absence of soil.

Question 6

(a) (i) This was generally well answered by most candidates who wrote the cello as their response.

(ii) Most candidates correctly named the harp as the instrument with the shortest wavelength.

(iii) The relationship between pitch and frequency was well known by many candidates who gained credit in this question.

(b) (i) The drawing of an acceptable diagram was found to be challenging by many candidates. The vibrating string had to be secured at both ends to gain credit.

(ii) Although only a minority of candidates achieved credit in **(i)** many more understood that a louder sound would have a bigger amplitude. 'Bigger waves' was not accepted since it was not clear which part of the wave was bigger.

(c) This was well done by many candidates. Many of those who did not achieve credit calculated 330 / 66 giving the answer 5 s instead of 66 / 330 making the answer 0.2 s.

Question 7

(a) Knowledge of the physical states of the halogens was correctly recalled by a few candidates.

(b) (i) The labels of anode, cathode and electrolyte were correctly selected from the list of words by the higher-scoring candidates. Common misconceptions included responses from candidates who confused the anode with the cathode or named the electrolyte as water.

(ii) The correct positioning of **X** as the location for production of bromine was achieved by many candidates. The most common incorrect answers were the positioning of the **X** around the wrong electrode, or directly in the centre of the electrolyte.

(iii) The answer required by this question was the physical appearance of bromine as a brown vapour. Many candidates misinterpreted the question and gave descriptions of where the bromine was produced, giving statements such as 'The bromine appeared around the anode'. As a result of this, many candidates did not achieve credit on this question.

(c) (i) Knowledge of the trend of reactivity of the halogens was generally poor and as a result most candidates found all the questions in part **(c)** challenging. Very few candidates knew that sodium chloride is the other compound produced in the reaction.

(ii) A few candidates wrote the correct answer, taking their cue from the previous question. 'Sodium iodine' or 'iodine' were examples of incorrect responses from candidates who knew the chemical must contain iodine, but these could not be given credit.

(iii) Only a few candidates correctly identified the trend of reactivity of the halogens down the group. Candidates should be aware that differences in reactivity between the halogens explains these displacement reactions.

Question 8

(a) (i) This question was well answered by many candidates. One aspect of this equation about which candidates should be aware is that the conditions for photosynthesis are not reactants. Many incorrect responses included light and chlorophyll as the missing reactant instead of water. Either sugar or glucose was acceptable as the missing product but incorrect formulae did not gain credit.

(ii) This was generally answered well by all candidates.

(b) The addition of the hyena to the food chain to make a food web was successfully done by many candidates who gained full credit. Candidates should be reminded that the arrow corresponds to a flow of energy and it must be drawn to show this. Therefore, credit was not awarded if the arrows were the wrong way round. Several candidates drew a separate food chain and did not try to combine it with the original food chain. This did not reflect their knowledge of how a food web is constructed.

(c) (i) This was a straightforward question with a simple answer. The carbon atoms are transferred when the lion eats the zebra. This point was made by most candidates.

(ii) There were some very good answers to this question. The majority of candidates realised that the lion would leave some of the zebra carcass behind, and this would contain carbon. The second mark was more challenging. Some candidates correctly stated that some of the carbon atoms would be excreted by the zebra. References to carbon being breathed out by the zebra needed to mention the presence of carbon dioxide in the breath of the zebra.

Question 9

(a) (i) Generally well answered across the range of candidates who recognised that convection is the method of heat transfer through gases.

(ii) Generally well answered across the range of candidates who recognised that conduction is the method of heat transfer through solids.

(iii) Many candidates indicated in their answers that the use of an insulator around the tank would be used. They generally did not offer an explanation in terms of preventing heat loss by one of the methods, for example conduction. A common misconception was that a metal or a matt black container would keep the heat in. Candidates should be aware that in this case the heat source is inside the heater and the direction of heat loss is out of the container. Therefore, heat will be more readily lost from metal or matt black containers.

(b) Many higher-scoring candidates successfully completed the circuit to include the heaters in parallel with a switch in each branch. Many candidates only gained partial credit by drawing circuits that would successfully switch one heater off, but not both separately. Short circuits drawn by some candidates could not be given credit.

(c) This question proved very challenging for the vast majority of the candidates. The fact that a high resistance leads to a lower current was not understood by most candidates. Of those who attempted this question the vast majority said that the water-heating element had the higher resistance since it had the higher current. Candidates should be aware of the inverse relationship between resistance and current.

(d) This question was attempted by many candidates who produced acceptable answers which included faults with insulation of the wiring or the earth of the plug. It was not enough to say that the metal casing conducted electricity without providing a cause, since many metal appliances are quite safe.

COMBINED SCIENCE

Paper 0653/31
Extended Theory

Key Messages

Those candidates who scored well on this paper ensured that:

- they expressed their answers using scientific words and phrases rather than everyday expressions, e.g. in Biology, *decomposers break down the bodies of dead animals* rather than *decomposers clean up dead bodies*;
- they recognised when questions required short, simple answers and so avoided lengthy, highly detailed but often irrelevant information;
- they recognised when a single word answer was not sufficient;
- in expressing formulae for use in Physics calculations they used correct words or symbols and not units e.g. I for current and not **A**; also in formulae they avoided vague expressions such as *acceleration = rise over run*;
- in chemical equations they paid attention to detail, writing subscripts properly and avoiding mistakes such as h2 instead of H_2;
- they ensured that they used or referred to data in tables or diagrams when instructed to do so;

General Comments

At the upper end of the range, many candidates completed excellent scripts that showed mastery of all sections of the syllabus and good examination technique. Candidates whose scores were towards the lower end of the range may have been more suited to entry for Paper 2. Candidates generally showed familiarity with all of the Science disciplines, and many were able to suggest sensible answers to questions that were set in unusual contexts. Organic Chemistry emerged as one of the least familiar parts of the syllabus, despite the fact that this is regularly examined. Candidates usually wrote answers of appropriate length although colleagues should continue to stress that the number of marks and the space allocated for answers are guides to the length and detail required. Only a very small number of candidates left questions at the end of the paper unanswered which confirms that most were able to complete the paper in the available time.

Comments on specific questions

Question 1

(a) (i) Credit was given for any valid method of representing shared electrons. Candidates were generally familiar with this part of the syllabus, although some drew the wrong molecule, usually water.

(ii) This question could be answered in a number of ways. Of those candidates who gained credit, most discussed electron sharing but some excellent answers describing the attraction of the nuclei for the shared electrons were seen. Candidates should avoid using unscientific terms such as electrons becoming *happy* when in a complete shell.

(iii) The word *combustion* appears in this question and many candidates suggested that the equation should contain carbon compounds as reactants and/or products. Answers revealed that the fundamental principle that elements are neither destroyed nor appear during chemical changes had in many cases not been mastered. Sometimes credit was lost because of mistakes such as h_2O.

(iv) Candidates needed to recognise that this question required an energy transformation rather than an explanation of the word exothermic. They also had to state that chemical energy was transformed.

(b) Full or partial credit was gained by the majority of candidates. Most had learned the characteristics of Group 0 elements and were able to connect the lack of reactivity with safety. Candidates were also generally familiar with the electronic structure of helium although some suggested that the outer shell of helium contained eight electrons. This slip was ignored only if they also stated that the outer shell was complete.

Question 2

(a) (i) The majority of candidates correctly labelled both the nucleus and cytoplasm. The most common mistake made, often by good candidates, was labelling the cell membrane instead of the nucleus.

(ii) The balanced equation summarising respiration had been learned by many candidates from across the mark range. Usually candidates gained full credit or none. There were no particularly common mistakes from those who did not gain credit.

(b) (i) Almost all of the candidates gained the credit for the addition sum required in this question.

(ii) The majority of candidates correctly identified cycling and swimming and were able to relate energy consumption to the breakdown of food. A minority attempted to justify their choices of activity by attempting to describe cycling and swimming in terms of exercise intensity or relevant muscle groups that would be used. Credit was not available for these types of explanations because the question points candidates towards using the data in Table 2.1.

(iii) Many candidates gained credit for describing the increased supply of oxygen. Candidates nearer the top of the mark range also referred to increased transport of glucose and energy release via respiration. Candidates did not gain credit for suggesting that increased blood flow would *carry more energy to the body*. Candidates should avoid the idea that *energy is produced* (in any context) and are advised to use phrases such as *energy is released* or *energy is transferred* or *converted.*

(iv) The majority of candidates gained credit for sensible suggestions. Candidates did not gain credit for restating the question with generalities e.g. *People are different and they do not all use the same amount of energy for exercise.* The most popular answers included references to intensity of exercising, fitness levels and body mass.

Question 3

(a) Most of the candidates recognised acceleration and constant speed from the speed/time graph. A minority lost credit because they used the word *motion* which, in this context, is not an alternative for *speed*. Some candidates gained full credit but wrote unnecessarily lengthy descriptions of the speed, and included an analysis of the forces acting on the snowboard.

(b) This calculation was answered very well by large numbers of candidates. Although a formula was not essential many chose to state one and this is to be encouraged. The most common mistake was to omit the factor of ½ from the formula ½ x length x breadth for the area of the graph underneath CD. Many candidates gained full credit by setting out clear working which led to the final answer of 125(m).

(c) Fewer candidates than in part **(b)** gained full or partial credit in this question. In this case candidates were required to state the formula on which the calculation was based. Candidates needed to state the right hand side of the formula as *change in speed / time*, and so those who suggested *speed / time* lost credit. Candidates also needed to show all their working leading to the final answer (–) 2.5 m/s^2. Candidates often lost credit for stating incorrect units.

(d) Full credit was available for a regular pattern of circles nearly all of which were in contact with those next to them. A surprising number of candidates seemed to ignore the circle that had been included as an example, and drew an array of shapes of widely differing sizes, many of which were not circular. In cases like this full credit was almost impossible to award. Candidates are advised to do their best to copy the size and shape of any example of a particle given in questions like this one.

Question 4

(a) (i) The use of litmus and full-range (Universal) indicator was familiar to many candidates. Most candidates who gained credit described the use of these indicators rather than a pH meter. Credit was lost by candidates who used the phrase *pH paper* rather than naming an indicator. Credit was also lost by candidates who named (blue) litmus but then suggested incorrect colours to show acidity. Partial credit was given for answers that suggested pH paper but then went on to state that the pH indicated would be below seven.

(ii) Completion of this type of chemical equation was familiar to reasonable numbers of candidates. Many gained partial credit for stating water as one of the missing products. A very wide variety of incorrect suggestions were made often including *hydrogen* and words transferred from the left hand side of the equation.

(b) (i) This question specifically tested the ability of candidates to deduce the rate of reaction from the time taken for the gas jar to fill. This meant that a direct statement about rate of reaction was required and that restating the time data from Table 4.1 did not gain credit.

(ii) The collision theory of reaction rate often appears in these papers and the wording that candidates use is marked quite strictly. In this question candidates should describe particles *moving faster* or *gaining kinetic energy,* rather than *vibrating faster, moving more* or *gaining energy*. When describing collisions, candidates should use phrases such as *increased collision frequency* or *increased chance of successful collisions* rather than *more collisions*. Although the concept of activation energy is not part of this syllabus, some candidates gained credit for correct discussion of this idea.

(c) (i) The majority of candidates gained credit here. Deforestation was allowed as an alternative.

(ii) Candidates are generally aware of the connection between carbon dioxide emissions and global warming and the majority gained credit. If answers showed that candidates were confusing ozone depletion or acid rain with global warming then credit was lost.

Question 5

(a) (i) Candidates needed to draw their arrows carefully. Arrows located vaguely between the flowers did not gain credit. The most common mistakes included reversal of the direction of the arrow between anther and stigma, and drawing arrows between two anthers or two stigmas.

(ii) Candidates had to use the correct terms, anther and stigma, rather than the general terms *male and female parts of the flower.* Answers needed to describe clearly how the anthers and stigma are located outside the petals. It was not enough for candidates to state that anthers were long or that stigmas dangled.

(b) (i)(ii) These questions ask candidates to describe the experimental evidence shown in Fig. 5.2 that temperature and pH are important variables in seed germination. This meant that general conclusions, however correct they were, did not gain credit. It also meant that candidates needed to refer directly to the difference in conditions between dishes 1 and 3 for temperature and dishes 1 and 4 for pH. Thus for example, the answer *The results clearly show that temperature is important because only seeds in dish 1 germinated* did not gain credit.

(iii) Most candidates suggested that the variable not investigated was light. Only a small minority gave the correct response of oxygen.

(iv) Answers which stated simply that the pH was not optimum for the enzymes within the germinating seeds did not give enough detail for credit here. Candidates needed to emphasise that the acidity was too high or pH too low for enzymes to function. It was also not enough simply to make statements such as *the acid rain affected the enzymes*. Candidates who gained full credit referred to enzyme denaturation and some were able to describe it.

Question 6

(a) (i) The majority of candidates correctly identified the harp.

(ii) Many candidates correctly identified the harp. Common incorrect answers were violin and cello.

(b) Most candidates realised that this question was referring to the audible range of human hearing, and worded their answer clearly enough to gain credit. Vague answers such as *it would be too low* or *people would not hear it* did not gain credit. Other mistakes included the ideas that the volume of the sound from the drum would either be too great or too small.

(c) This calculation was completed successfully by many candidates who stated the formula using proper symbols or words and then set out clear working leading to the numerical answer 0.33(m). By far the most common reason for loss of credit was the inversion of frequency and wave speed in the formula.

(d) This proved to be a fairly challenging question for most candidates and only a minority gained full credit. Candidates very often suggested sine waves rather than the way that the plucked string would vibrate when generating the fundamental note. Some candidates gained credit for a discussion of compressions and rarefactions and/or for referring to the need for a medium, air in this case. It was not uncommon for candidates to redraw the plucked violin string as a slinky showing longitudinal waves. These candidates often went on to try and describe the longitudinal motion of particles within the string itself.

Question 7

(a) (i) This part of the syllabus was unfamiliar to most candidates, and very few gained any credit. Candidates did not associate the term *conditions* with either high temperature, high pressure or the presence of a catalyst. Of those who did make this association many gave answers such as *heat* and *pressure* which were too vague to gain credit. Some aspect of organic Chemistry usually features in this examination and so candidates are advised to revise it thoroughly.

(ii) The majority of candidates were able to deduce that molecules of **X** and **Y** would be smaller than those of **D**. Any wording that suggested this unambiguously was accepted.

(iii) Although the bromine test for unsaturation is commonly tested in this examination, only a small number of candidates gained credit. The candidates who gained credit remembered to state that bromine turns *colourless* rather than *clear* when it reacts with alkenes.

(b) Full credit in this question was usually confined to those candidates at the higher end of the mark range. Candidates are advised to take note of the molecules specified in the organic Chemistry section of the syllabus since they may be asked to recall their details.

(c) (i) Many candidates gained credit for stating that bromide ions are negative. A common mistake was to suggest that bromine atoms are negative. Some candidates stated that the anode is positive which could not gain credit since it repeats information given in the question. Some candidates stated that bromine is a non-metal but this did not add quite enough information for credit to be awarded.

(ii) This question proved to be more challenging than part **(i)** and some candidates essentially repeated their answer to part **(i)**. Only a minority could describe the transfer of electrons from bromide to the anode. Credit was gained if candidates stated that bromide ions are oxidised at the anode. Some candidates lost credit by suggesting that at the anode the bromide ions gained electrons so that they could complete their outer shells. This type of reversal is often seen from candidates attempting electrolysis questions.

Question 8

(a) (i) Candidates needed to show their working for full credit and many successfully reached the correct numerical answer of **98.1**(%). Many calculated the percentage of energy not passed on from herbivores to carnivores or from producers to herbivores.

(ii) Most candidates had learned that there is a connection between light energy and chlorophyll molecules. They gained credit for the clear statement that chlorophyll traps or absorbs light but fewer went on to state that this energy is converted into chemical energy. Some made suggestions such as *chlorophyll changes light into glucose* or *chlorophyll uses light to make plant food,* ideas which show a partial degree of understanding but not enough for this extended Science examination. Candidates also lost credit if they referred to the sun's rays or the sun's energy without specifying light. Candidates towards the lower end of the mark range often stated that the role of chlorophyll was to make the plant look green.

(b) (i) Candidates needed to look very carefully at the diagram in Fig. 8.2. Many attempted to identify energy losses via route **X** in terms of respiration and death which were already listed in the diagram. The most familiar reason given for losses at **X** were excretion and egestion although it should be emphasised to candidates that correct biological words should be used to refer to animal waste. Many suggested energy loss as the result of movement or escaping from the lion. Some candidates suggested energy transfer processes that applied to the decomposers rather than the zebra.

(ii) Candidates often found it difficult to describe the role of decomposers. Candidates should be advised to use proper scientific terms rather than everyday expressions in Science examinations. Thus a candidate who wrote that *decomposers break down the animal carcases* gained credit but the candidate who suggested that *bugs in the soil clean up dead bodies* did not. One misconception often seen was the idea that decomposers have to remove carcases *before they rot*. The process of recycling nutrients to the ground or carbon dioxide to the air was known by many candidates.

Question 9

(a) (i) Most candidates correctly identified convection.

(ii) Many candidates gained partial credit for stating that warm air rises. Those towards the higher end of the mark range converted this into full credit by discussing the density difference between warm and cooler air. The most reasonable incorrect response was diffusion.

(iii) The question required an answer that made some attempt to describe thermal insulation. It was considered insufficient if a candidate simply wrote *insulation* or *insulate it*. Candidates who gained credit here added more detail such as a description of a named material surrounding the tank, or naming a suitable insulating material and stating that this would hinder the conduction of heat from the water.

(b) This circuit diagram question was fairly well-answered and very many candidates gained at least partial credit. Any version of the circuit that fulfilled the specification in the question gained full credit although the inclusion of ammeters and/or voltmeters was penalised. Most candidates produced a circuit in which the air and water heater were in parallel with the power supply. Some simply reproduced Fig. 9.2 and so could not gain credit. Some added one extra switch to control either the air or the water heater and so gained partial credit.

(c) (i) Many candidates recognised that this question required the application of Ohm's Law and stated the law clearly using proper symbols or words. Many candidates were able to use Ohm's Law and could state the correct units of the answer. Only a minority realised that that they should be applying Ohm's Law only to the water heater for which both resistance and current are known. The common mistake was to use a value of current which was the sum of 4A and 8A leading to an answer of 360V rather than **240 V.**

(ii) Even though candidates were given the formula to use in this power calculation some still attempted to use some other relationship, often Ohm's Law. For those who approached this question correctly an error carried forward from part **(i)** was allowed. The required numerical answer is **960(W)**.

COMBINED SCIENCE

Paper 0653/32
Extended Theory

Key Messages

Those candidates who scored well on this paper ensured that:

- they ensured that they used or referred to data in tables or diagrams when instructed to do so;
- they gave appropriate detailed information rather than general statements;
- in expressing formulae for use in Physics calculations they used correct words or symbols and not units e.g. ***I*** for current and not **A**
- in chemical equations they paid attention to detail, writing subscripts properly and avoiding mistakes such as h2 instead of H_2;

General Comments

At the upper end of the mark range, many candidates completed excellent scripts that showed mastery of all sections of the syllabus and good examination technique. Candidates whose scores were towards the lower end of the range may have been more suited to entry for Paper 2. Candidates generally showed familiarity with all of the Science disciplines, and many were able to suggest sensible answers to questions that were set in unusual contexts. Organic Chemistry emerged as one of the least familiar parts of the syllabus, despite the fact that this is regularly examined. Candidates usually wrote answers of appropriate length although colleagues should continue to stress that the number of marks and the space allocated for answers are guides to the length and detail required. Only a very small number of candidates left questions at the end of the paper unanswered which confirms that most were able to complete the paper in the available time.

Comments on specific questions

Question 1

(a) The link between the number of outer shell electrons and group number had been learned well by large numbers of candidates. Of the incorrect responses one of the most common was to suggest 85 and this was usually accompanied by the explanation that the proton and electron numbers in an atom are equivalent. This suggests that the problem lay in reading the question rather than any lack of understanding. Some other candidates attempted to allocate 85 electrons to shells using rules which are limited to elements up to atomic number 20. All candidates should be advised that they will never have to answer questions about the complete electron configuration in atoms beyond calcium in the Periodic Table.

(b) (i) The use of either cobalt chloride or anhydrous copper(II) sulfate was quite well-known and many candidates gained full credit. The term white copper sulfate was accepted. The more common mistakes included measurement of boiling point and pH.

(ii) Candidates from across the mark range found this question rather challenging and only a minority of candidates gained full credit. Some candidates lost credit by adding the state symbol (aq) for water, although most of the candidates who attempted the state symbols did so successfully.

(iii) Dot and cross bonding diagrams of familiar molecules are usually drawn very well by candidates from the higher part of the mark range. Several acceptable ways of indicating shared electron pairs gained credit.

Question 2

(a) Candidates generally had learned the function of root hair cells. Some candidates lost credit by stating only the function rather than concentrating on how the shape of the cell helped the cell to function. The ideas of large surface area and increased absorption of a named nutrient or water were discussed by many candidates. There was a noticeably smaller number of candidates this year who confused the function of root hairs with the root as a whole.

(b) Digestion had to be described in terms of molecules. Candidates who gained credit in this question either described large molecules being broken down into small ones or discussed soluble being formed from insoluble molecules. Candidates lost credit if they confused chewing of food with digestion. The idea that the products of digestion were then in a form that could be absorbed was mentioned by a minority of candidates.

(c) (i) Nearly all candidates gained the available mark.

(ii) Partial credit was easily gained by candidates who stated that as temperature increased to 30°C the rate of digestion increases and that above 50°C it decreases. Some excellent answers were seen from many candidates who then went on to gain full credit. In the first part, as temperature was increasing, it was not enough for candidates to state that *the activity of the enzyme increased. A*n explanation of this statement in terms of kinetic theory was required. In the second part, the terms *killed* or *destroyed* are not alternatives to the correct term *denatured*.

Question 3

(a) (i) The majority of candidates made the correct connection between point **A** and the constant speed of the athlete.

(ii) This was an unusual context but large numbers of candidates did very well with it. They showed understanding of how to interpret the speed/time graph and gained credit by describing either that the athlete was slowing down, was moving at a low speed or that they were about to have zero speed because they were near the bar.

(b) Many candidates gained full or partial credit in this question. For the first energy change, the terms *gravitational* and *potential* were both accepted although future candidates should be advised to use the term *gravitational potential*. *Movement* or *motion* was not accepted as an alternative for *kinetic*. A minority of candidates focused their attention on the pole rather than the athlete and went on correctly to state *elastic* or *strain* for the first change and then *gravitational potential* for the second. This pair of answers gained full credit.

(c) Some candidates allowed the complex motion of a person doing the pole vault to turn what was intended as a simple question into a detailed description of the final stages of the event. Despite this many gained the available credit for any suggestion that during this stage the athlete experiences acceleration.

(d) Large numbers of candidates gained full credit in this calculation. The most common mistake was the omission of the factor ½ from the formula. The final answer is **2**(m).

(e) Many candidates showed that they understood the theory that explains why solids expand when their temperature increases. The idea that the metal atoms in the pole suddenly start to vibrate when the pole is used on a hot day was frequently seen. Answers to questions like this should always be expressed using comparative terms e.g. *the atoms vibrate more quickly* or *the atoms' kinetic energy increases* or *the atoms move faster.* The idea that the increased particle movement results in greater separation of the atoms was not so well understood, but fair numbers of candidates achieved full credit. A minority of candidates made the mistake of suggesting that individual atoms became larger.

Question 4

(a) (i) Candidates were expected to choose their examples of physical and chemical changes from the statements given in the question. Many did this and certain other correct answers also gained credit. Reactions which seemed to suggest that *metallic iron* could be involved when this rock formed were not accepted.

(ii) Success in this question rather depended on whether candidates had learned some standard definitions of physical and chemical changes. This question has occasionally been asked previously and candidates are always advised to avoid the incorrect statements that *physical changes are reversible and chemical changes are irreversible.* A qualified version of these statements such as *chemical changes are not easily reversed using physical methods* is acceptable. Another incorrect answer which was frequently seen was that *physical changes can be seen but chemical changes are invisible*.

(b) Candidates needed to write more than simply *carbon dioxide amount* for the difference and *nitrogen amount* for the similarity. If they suggested that the difference lay in the additional gases (other than oxygen) present today they needed to name a specific example. The question was generally quite well answered and large numbers of candidates gained credit, showing that they could interpret a pie chart and that they had learned the details of the present day atmosphere.

(c) (i)(ii) Success in these questions depended entirely on whether the candidates had learned details of the blast furnace. The wide range of suggestions for both of these questions suggests that the blast furnace was not very familiar to most candidates. The formula *CO* was accepted for carbon monoxide but the term *carbon oxide* was not.

(iii) Many candidates gained credit for stating the reactivity difference between iron and copper. Only a relatively small number could give a consequence of this that explains why iron oxide is more difficult to reduce than copper oxide. An idea that was frequently seen was that this was connected to melting and boiling points of the oxides.

(iv) Similarly to parts **(i)** and **(ii)** this question required candidates to be familiar with the details of the processes occurring inside the blast furnace. If they were, then mention of either slag or calcium silicate gained credit. Very few candidates were able to answer this question but it must be stated that faced with an unfamiliar context, some made suggestions that showed sense e.g. by describing processes that used the principles of fractional distillation.

Question 5

(a) (i) Many candidates successfully identified the pulmonary artery and vena cava on the diagram in Fig. 5.1. There were no particular mistakes that were more common than others.

(ii) Candidates needed to be precise in how they described coronary heart disease (CHD). If they discussed blockage then this had to be in the coronary arteries and had to refer to fat, cholesterol or plaque. If they chose to discuss lack of oxygen or blood supply this had to be to the heart muscle. It was a lack of precision that caused many candidates to lose credit rather than unfamiliarity with the causes of CHD.

(b) (i) Some candidates did not realise that the phrase *Use the data in Table 5.1* meant that the question was asking them to draw a conclusion from data. Quite a large number described, often in some detail, the harmful substances in cigarette smoke, and the effect these could have on the heart or even the body more generally. The majority did realise that a conclusion was required. They needed to be careful to avoid suggesting that the data contains any proof of cigarette smoke as the cause of CHD. The safest way to make appropriate reference to data was to select at least two countries from the table and refer to the actual figures for those countries.

(ii) Many candidates gained at least partial credit for their suggestions. Any reasonable suggestion in addition to those shown in the published mark scheme was accepted. Vague answers such as *the environment in country **E** is super-clean* or *country **E** has better hospitals* did not gain credit nor did answers casting doubt on the reliability of the data.

(c) A common misconception is that the role of cilia is to filter out or trap foreign particles or micro-organisms. This suggests that some candidates are unfamiliar with the role of cilia and are guessing an answer based on the appearance of the diagram in Fig. 5.2. Similarly the action of mucus is frequently stated as blocking the airways and causing coughing. Many candidates did not mention bacteria or other pathogens.

Question 6

(a) (i) The main difficulty that candidates found here was to define transverse waves without using the word *wave* twice. Hence many candidates made suggestions such as *the wave is perpendicular to the direction of the wave.* Candidates who gained credit made it clear that the motion of the water or water molecules was perpendicular to the direction of travel of the wave. Another acceptable form of the answer was to state that the oscillation of the water was perpendicular to the direction of the wave.

(ii) Large numbers of candidates gained credit here with sound waves being the most popular answer. Earthquake waves were also accepted even if the type of earthquake wave was not specified.

(b) The only answers that gained credit here were frequency and direction of travel. Despite the wording of the question some candidates still suggested amplitude.

(c) (i) Most candidates realised that this question was referring to the audible range of human hearing, and worded their answer clearly enough to gain credit. Answers such as *the frequency is below 20 Hz* were accepted although candidates needed to give an accurate lower limit of the audible range if they chose to answer the question in this way. Common mistakes included answers based on volume or vague statements such as the sound being *difficult to hear*.

(ii) Large numbers of candidates were familiar with the relationship between speed, frequency and amplitude and worked their way through to gain full credit. A mistake that was seen several times was the use of the formula distance = speed x time with consequent confusion over what to substitute into the formula. The speed unit was marked independently so many candidates gained at least partial credit. The required numerical answer was **30 cm/s**

(iii) There were a number of acceptable statements that candidates could make in answering this question and many gained at least partial credit. The question states that the sound waves travel through air and so candidates needed to say more than *the air is the medium through which the sound travels*. They had to discuss vibrating particles and the general form of the sound waves.

Question 7

(a) (i) Most candidates had no difficulty in stating the molecular formula of ethane and a larger number would have gained full credit if they had been able to recall the name.

(ii) Credit for stating the relationship between boiling point and molecular size was very frequently gained. Candidates should be advised to be careful about using the term *directly proportional* when describing a relationship that is not this precise. It is expected that candidates entered for this extension paper should have learned the meaning of *directly proportional* and when they should and should not use it. Many candidates understood that larger molecules would experience higher intermolecular forces of attraction. A smaller number went on to gain full credit by relating higher attractive forces with greater thermal energy to separate the molecules. Candidates needed to be careful to describe attractive forces between molecules and any suggestion that chemical bonds needed to break for boiling to occur was penalised.

(b) Many candidates found the explanation of the details of this electrolysis challenging. They needed to take care in expressing ideas accurately and so suggestions that chlorine molecules were negatively charged did not gain any credit. Similarly they had to make it clear that chloride ions and not chlorine lost electrons to the anode. Other candidates were distracted into giving detail about processes involving copper ions.

Question 8

(a) (i)(ii) Many candidates gained full credit for both **Questions (i)** and **(ii)**. Some gave essentially the same answer for both parts, but generally these questions were well-answered. Part **(ii)** saw more incorrect answers than part **(i)** because candidates were distracted into suggesting that the problem with blocked stomata would be related to hindrance of transpiration or ingress of oxygen. While this may be the case the question asked candidates to focus on problems the ash layer would cause in relation to photosynthesis.

(b) The key phrase in the main stem of part **(b)** is *A few days after the fire.*

(i) Answers discussing the oxygen removed by combustion did not gain credit. Many candidates identified the reduced levels of photosynthesis caused by the loss of trees and provided they stated clearly that this would result in less oxygen *being produced* then they gained credit. Few candidates made the additional point that although less oxygen was produced, respiration of remaining organisms would still be removing oxygen.

(ii) Many candidates described issues relating to respiration and gained credit. Although organisms remaining shortly after the fire would be unlikely to include larger animals, credit was given for answers that described breathing issues linked to low oxygen. Vague answers such as *breathing problems* did not gain credit.

(c) Candidates generally are familiar with environmental issues associated with increased carbon dioxide and many gained credit here. Any suggestion of confusion with other atmospheric problems such as ozone depletion or acid rain lost credit even if global warming was stated. Candidates discussing the greenhouse effect without mentioning global warming needed to qualify the term by stating that carbon dioxide is increasing the effect. Credit was available even if global warming was not mentioned directly by discussing a known consequence such as rising sea levels or increased frequency of extreme weather events.

(d) This was well-answered and a variety of correct substances were stated. One incorrect suggestion that occurred more than others was the formation of hydrocarbons, often methane.

Question 9

(a) Two quite easy answers were to identify the symbol V as volts, voltage or potential difference and the symbol W as watts, wattage or power. This many candidates did and gained credit. It was less common for candidates to gain the other available marks. The idea of safe maximum was more relevant to the heater than the bulb. In the case of the bulb candidates needed to identify 6V as the voltage needed to make the bulb work properly i.e. not too dim or so bright that it breaks. Candidates should be advised to avoid using phrases such as *the power needed to make the heater work*, and should think of power as the rate of energy transfer within the device.

(b) Full credit was gained by candidates who connected both pairs of lamps and the heater in parallel with the battery. Many candidates simply redrew the series circuit in Fig. 9.1 with components in a slightly different sequence. Some candidates introduced extra wires that would cause a short circuit. Partial credit was given for circuits in which the pairs of lamps but not the heater were in parallel with the battery.

(c) Many candidates were able to state the relationship $P=VI$ and use it to calculate the current through the heater. Credit was lost if candidates used unit symbols such as A for current when stating the formula. The numerical answer was 10(A).

(d) The majority of candidates correctly identified *convection*.

COMBINED SCIENCE

Paper 0653/33
Extended Theory

Key Messages

Those candidates who scored well on this paper ensured that:

- they expressed their answers using scientific words and phrases rather than everyday expressions, e.g. in Biology, *decomposers break down the bodies of dead animals* rather than *decomposers clean up dead bodies*;
- they recognised when questions required short, simple answers and so avoided lengthy, highly detailed but often irrelevant information;
- they recognised when a single word answer was not sufficient;
- in expressing formulae for use in Physics calculations they used correct words or symbols and not units e.g. ***I*** for current and not **A**; also in formulae they avoided vague expressions such as *acceleration = rise over run*;
- in chemical equations they paid attention to detail, writing subscripts properly and avoiding mistakes such as h2 instead of H_2;
- they ensured that they used or referred to data in tables or diagrams when instructed to do so;

General Comments

At the upper end of the range, many candidates completed excellent scripts that showed mastery of all sections of the syllabus and good examination technique. Candidates whose scores were towards the lower end of the range may have been more suited to entry for Paper 2. Candidates generally showed familiarity with all of the Science disciplines, and many were able to suggest sensible answers to questions that were set in unusual contexts. Organic Chemistry emerged as one of the least familiar parts of the syllabus, despite the fact that this is regularly examined. Candidates usually wrote answers of appropriate length although colleagues should continue to stress that the number of marks and the space allocated for answers are guides to the length and detail required. Only a very small number of candidates left questions at the end of the paper unanswered which confirms that most were able to complete the paper in the available time.

Comments on specific questions

Question 1

(a) (i) Credit was given for any valid method of representing shared electrons. Candidates were generally familiar with this part of the syllabus, although some drew the wrong molecule, usually water.

(ii) This question could be answered in a number of ways. Of those candidates who gained credit, most discussed electron sharing but some excellent answers describing the attraction of the nuclei for the shared electrons were seen. Candidates should avoid using unscientific terms such as electrons becoming *happy* when in a complete shell.

(iii) The word *combustion* appears in this question and many candidates suggested that the equation should contain carbon compounds as reactants and/or products. Answers revealed that the fundamental principle that elements are neither destroyed nor appear during chemical changes had in many cases not been mastered. Sometimes credit was lost because of mistakes such as h_2O.

(iv) Candidates needed to recognise that this question required an energy transformation rather than an explanation of the word exothermic. They also had to state that chemical energy was transformed.

(b) Full or partial credit was gained by the majority of candidates. Most had learned the characteristics of Group 0 elements and were able to connect the lack of reactivity with safety. Candidates were also generally familiar with the electronic structure of helium although some suggested that the outer shell of helium contained eight electrons. This slip was ignored only if they also stated that the outer shell was complete.

Question 2

(a) (i) The majority of candidates correctly labelled both the nucleus and cytoplasm. The most common mistake made, often by good candidates, was labelling the cell membrane instead of the nucleus.

(ii) The balanced equation summarising respiration had been learned by many candidates from across the mark range. Usually candidates gained full credit or none. There were no particularly common mistakes from those who did not gain credit.

(b) (i) Almost all of the candidates gained the credit for the addition sum required in this question.

(ii) The majority of candidates correctly identified cycling and swimming and were able to relate energy consumption to the breakdown of food. A minority attempted to justify their choices of activity by attempting to describe cycling and swimming in terms of exercise intensity or relevant muscle groups that would be used. Credit was not available for these types of explanations because the question points candidates towards using the data in Table 2.1.

(iii) Many candidates gained credit for describing the increased supply of oxygen. Candidates nearer the top of the mark range also referred to increased transport of glucose and energy release via respiration. Candidates did not gain credit for suggesting that increased blood flow would *carry more energy to the body*. Candidates should avoid the idea that *energy is produced* (in any context) and are advised to use phrases such as *energy is released* or *energy is transferred* or *converted.*

(iv) The majority of candidates gained credit for sensible suggestions. Candidates did not gain credit for restating the question with generalities e.g. *People are different and they do not all use the same amount of energy for exercise.* The most popular answers included references to intensity of exercising, fitness levels and body mass.

Question 3

(a) Most of the candidates recognised acceleration and constant speed from the speed/time graph. A minority lost credit because they used the word *motion* which, in this context, is not an alternative for *speed*. Some candidates gained full credit but wrote unnecessarily lengthy descriptions of the speed, and included an analysis of the forces acting on the snowboard.

(b) This calculation was answered very well by large numbers of candidates. Although a formula was not essential many chose to state one and this is to be encouraged. The most common mistake was to omit the factor of ½ from the formula ½ x length x breadth for the area of the graph underneath CD. Many candidates gained full credit by setting out clear working which led to the final answer of 125(m).

(c) Fewer candidates than in part **(b)** gained full or partial credit in this question. In this case candidates were required to state the formula on which the calculation was based. Candidates needed to state the right hand side of the formula as *change in speed / time*, and so those who suggested *speed / time* lost credit. Candidates also needed to show all their working leading to the final answer (–) 2.5 m/s^2. Candidates often lost credit for stating incorrect units.

(d) Full credit was available for a regular pattern of circles nearly all of which were in contact with those next to them. A surprising number of candidates seemed to ignore the circle that had been included as an example, and drew an array of shapes of widely differing sizes, many of which were not circular. In cases like this full credit was almost impossible to award. Candidates are advised to do their best to copy the size and shape of any example of a particle given in questions like this one.

Question 4

(a) (i) The use of litmus and full-range (Universal) indicator was familiar to many candidates. Most candidates who gained credit described the use of these indicators rather than a pH meter. Credit was lost by candidates who used the phrase *pH paper* rather than naming an indicator. Credit was also lost by candidates who named (blue) litmus but then suggested incorrect colours to show acidity. Partial credit was given for answers that suggested pH paper but then went on to state that the pH indicated would be below seven.

(ii) Completion of this type of chemical equation was familiar to reasonable numbers of candidates. Many gained partial credit for stating water as one of the missing products. A very wide variety of incorrect suggestions were made often including *hydrogen* and words transferred from the left hand side of the equation.

(b) (i) This question specifically tested the ability of candidates to deduce the rate of reaction from the time taken for the gas jar to fill. This meant that a direct statement about rate of reaction was required and that restating the time data from Table 4.1 did not gain credit.

(ii) The collision theory of reaction rate often appears in these papers and the wording that candidates use is marked quite strictly. In this question candidates should describe particles *moving faster* or *gaining kinetic energy,* rather than *vibrating faster, moving more* or *gaining energy*. When describing collisions, candidates should use phrases such as *increased collision frequency* or *increased chance of successful collisions* rather than *more collisions*. Although the concept of activation energy is not part of this syllabus, some candidates gained credit for correct discussion of this idea.

(c) (i) The majority of candidates gained credit here. Deforestation was allowed as an alternative.

(ii) Candidates are generally aware of the connection between carbon dioxide emissions and global warming and the majority gained credit. If answers showed that candidates were confusing ozone depletion or acid rain with global warming then credit was lost.

Question 5

(a) (i) Candidates needed to draw their arrows carefully. Arrows located vaguely between the flowers did not gain credit. The most common mistakes included reversal of the direction of the arrow between anther and stigma, and drawing arrows between two anthers or two stigmas.

(ii) Candidates had to use the correct terms, anther and stigma, rather than the general terms *male and female parts of the flower.* Answers needed to describe clearly how the anthers and stigma are located outside the petals. It was not enough for candidates to state that anthers were long or that stigmas dangled.

(b) (i)(ii) These questions ask candidates to describe the experimental evidence shown in Fig. 5.2 that temperature and pH are important variables in seed germination. This meant that general conclusions, however correct they were, did not gain credit. It also meant that candidates needed to refer directly to the difference in conditions between dishes 1 and 3 for temperature and dishes 1 and 4 for pH. Thus for example, the answer *The results clearly show that temperature is important because only seeds in dish 1 germinated* did not gain credit.

(iii) Most candidates suggested that the variable not investigated was light. Only a small minority gave the correct response of oxygen.

(iv) Answers which stated simply that the pH was not optimum for the enzymes within the germinating seeds did not give enough detail for credit here. Candidates needed to emphasise that the acidity was too high or pH too low for enzymes to function. It was also not enough simply to make statements such as *the acid rain affected the enzymes*. Candidates who gained full credit referred to enzyme denaturation and some were able to describe it.

Question 6

(a) (i) The majority of candidates correctly identified the harp.

(ii) Many candidates correctly identified the harp. Common incorrect answers were violin and cello.

(b) Most candidates realised that this question was referring to the audible range of human hearing, and worded their answer clearly enough to gain credit. Vague answers such as *it would be too low* or *people would not hear it* did not gain credit. Other mistakes included the ideas that the volume of the sound from the drum would either be too great or too small.

(c) This calculation was completed successfully by many candidates who stated the formula using proper symbols or words and then set out clear working leading to the numerical answer 0.33(m). By far the most common reason for loss of credit was the inversion of frequency and wave speed in the formula.

(d) This proved to be a fairly challenging question for most candidates and only a minority gained full credit. Candidates very often suggested sine waves rather than the way that the plucked string would vibrate when generating the fundamental note. Some candidates gained credit for a discussion of compressions and rarefactions and/or for referring to the need for a medium, air in this case. It was not uncommon for candidates to redraw the plucked violin string as a slinky showing longitudinal waves. These candidates often went on to try and describe the longitudinal motion of particles within the string itself.

Question 7

(a) (i) This part of the syllabus was unfamiliar to most candidates, and very few gained any credit. Candidates did not associate the term *conditions* with either high temperature, high pressure or the presence of a catalyst. Of those who did make this association many gave answers such as *heat* and *pressure* which were too vague to gain credit. Some aspect of organic Chemistry usually features in this examination and so candidates are advised to revise it thoroughly.

(ii) The majority of candidates were able to deduce that molecules of **X** and **Y** would be smaller than those of **D**. Any wording that suggested this unambiguously was accepted.

(iii) Although the bromine test for unsaturation is commonly tested in this examination, only a small number of candidates gained credit. The candidates who gained credit remembered to state that bromine turns *colourless* rather than *clear* when it reacts with alkenes.

(b) Full credit in this question was usually confined to those candidates at the higher end of the mark range. Candidates are advised to take note of the molecules specified in the organic Chemistry section of the syllabus since they may be asked to recall their details.

(c) (i) Many candidates gained credit for stating that bromide ions are negative. A common mistake was to suggest that bromine atoms are negative. Some candidates stated that the anode is positive which could not gain credit since it repeats information given in the question. Some candidates stated that bromine is a non-metal but this did not add quite enough information for credit to be awarded.

(ii) This question proved to be more challenging than part **(i)** and some candidates essentially repeated their answer to part **(i)**. Only a minority could describe the transfer of electrons from bromide to the anode. Credit was gained if candidates stated that bromide ions are oxidised at the anode. Some candidates lost credit by suggesting that at the anode the bromide ions gained electrons so that they could complete their outer shells. This type of reversal is often seen from candidates attempting electrolysis questions.

Question 8

(a) (i) Candidates needed to show their working for full credit and many successfully reached the correct numerical answer of **98.1**(%). Many calculated the percentage of energy not passed on from herbivores to carnivores or from producers to herbivores.

(ii) Most candidates had learned that there is a connection between light energy and chlorophyll molecules. They gained credit for the clear statement that chlorophyll traps or absorbs light but fewer went on to state that this energy is converted into chemical energy. Some made suggestions such as *chlorophyll changes light into glucose* or *chlorophyll uses light to make plant food,* ideas which show a partial degree of understanding but not enough for this extended Science examination. Candidates also lost credit if they referred to the sun's rays or the sun's energy without specifying light. Candidates towards the lower end of the mark range often stated that the role of chlorophyll was to make the plant look green.

(b) (i) Candidates needed to look very carefully at the diagram in Fig. 8.2. Many attempted to identify energy losses via route **X** in terms of respiration and death which were already listed in the diagram. The most familiar reason given for losses at **X** were excretion and egestion although it should be emphasised to candidates that correct biological words should be used to refer to animal waste. Many suggested energy loss as the result of movement or escaping from the lion. Some candidates suggested energy transfer processes that applied to the decomposers rather than the zebra.

(ii) Candidates often found it difficult to describe the role of decomposers. Candidates should be advised to use proper scientific terms rather than everyday expressions in Science examinations. Thus a candidate who wrote that *decomposers break down the animal carcases* gained credit but the candidate who suggested that *bugs in the soil clean up dead bodies* did not. One misconception often seen was the idea that decomposers have to remove carcases *before they rot*. The process of recycling nutrients to the ground or carbon dioxide to the air was known by many candidates.

Question 9

(a) (i) Most candidates correctly identified convection.

(ii) Many candidates gained partial credit for stating that warm air rises. Those towards the higher end of the mark range converted this into full credit by discussing the density difference between warm and cooler air. The most reasonable incorrect response was diffusion.

(iii) The question required an answer that made some attempt to describe thermal insulation. It was considered insufficient if a candidate simply wrote *insulation* or *insulate it*. Candidates who gained credit here added more detail such as a description of a named material surrounding the tank, or naming a suitable insulating material and stating that this would hinder the conduction of heat from the water.

(b) This circuit diagram question was fairly well-answered and very many candidates gained at least partial credit. Any version of the circuit that fulfilled the specification in the question gained full credit although the inclusion of ammeters and/or voltmeters was penalised. Most candidates produced a circuit in which the air and water heater were in parallel with the power supply. Some simply reproduced Fig. 9.2 and so could not gain credit. Some added one extra switch to control either the air or the water heater and so gained partial credit.

(c) (i) Many candidates recognised that this question required the application of Ohm's Law and stated the law clearly using proper symbols or words. Many candidates were able to use Ohm's Law and could state the correct units of the answer. Only a minority realised that that they should be applying Ohm's Law only to the water heater for which both resistance and current are known. The common mistake was to use a value of current which was the sum of 4A and 8A leading to an answer of 360V rather than **240 V.**

(ii) Even though candidates were given the formula to use in this power calculation some still attempted to use some other relationship, often Ohm's Law. For those who approached this question correctly an error carried forward from part **(i)** was allowed. The required numerical answer is **960(W)**.

COMBINED SCIENCE

Paper 0653/04

Coursework

General Comments

The majority of Centres that entered candidates for this component have been doing so for several years now, and have gradually built up highly suitable sets of tasks, together with well-constructed mark schemes that enable appropriate and reliable assessment. There were examples of excellent work from many candidates, demonstrating high levels of achievement in even the more difficult skill areas such as evaluation and planning.

Not all Centres provided evidence for their assessment of C1. These tasks do not provide written evidence from the candidates, and so the assessors need to provide such evidence that can be seen by the external moderators. Most Centres provide tick lists that show how each individual candidate has met the criteria used during the assessment task.

The majority of Centres used a range of tasks covering topics from the biology, chemistry and physics areas of the syllabus. Although there is no specific requirement to do this, it was disappointing to see some Centres failing to use any assessment tasks covering one of these areas: for example, using tasks that were all based on physics and chemistry, with no biology.

Another issue with some Centres was the wide variation in the style of tasks, mark schemes and assessment between the different subject areas. Where the biology, chemistry and physics components of the course are taught and assessed by different teachers, it is very important for them to work together to ensure that the ways in which learners are assessed is comparable across all tasks. Similarly, if there is more than one teaching group, teachers should work closely together to ensure comparability of assessment.

COMBINED SCIENCE

Paper 0653/51
Practical Test

Key message

Drawings should be as accurate as possible and clear enough to show essential features.

General comments

Candidates were able to complete the three exercises in the one hour thirty minutes allocated. The standard of graph plotting was high. Measuring of gradients could be improved significantly.

Comments on Specific Questions

Question 1

The quality of drawings varied enormously and some were sketched so roughly that it was difficult to make out essential features. Labels need to be precise and relate to the question.

The table was generally completed in an understandable way. Answers of 'no change' were accepted where correct but it would have been better to say 'the solution remains blue' for biuret or 'the solution remains brown' for iodine. In **(b) (ii)** it was quite common to see 'sugar' rather than 'reducing sugar' and some candidates convinced themselves that starch should also be present despite the absence of a blue-black colour in the iodine test. The function of the stained areas in **(c) (ii)** was well understood. It was important here to communicate the idea that the water is transported or moved through the plant. The plan in part **(d)** proved to be a difficult end to the question. Candidates should consider variables to change and variables to keep constant, as well how observations will be made and subsequently used.

Question 2

Cloudy is still used to describe inadequately a white precipitate. Milky is an accepted alternative for white precipitate but cloudy simply describes turbidity, haziness or a precipitate. So cloudy needs a colour with it such as, in this case, cloudy white. Many candidates carried out what was the limewater test in **(a) (i)** and successfully measured the pH in **(a) (ii)** but far less were able to identify or classify **A**.

More marks were scored in part **(b)** which was essentially qualitative analysis of copper(II).

Question 3

Completed tables were the norm in this question. Some candidates need instruction on how to record times from electronic stopclocks. In most cases the period of the pendulum was calculated as instructed although some candidates had clearly attempted to time one swing of the pendulum**.** It is important that candidates pay attention to the number of significant figures or decimal places required for data or calculations. In this case T^2 had to be given to 2 significant figures.

For graphs, candidates should be encouraged to choose scales on which one little square is a more manageable figure, such as 0.10, 0.20, 0.50, as this can avoid unnecessary errors in plotting.

Candidates should always mark clearly on the graph the points or the triangle used to calculate the gradient and this should be based on at least half of the best straight line to improve accuracy. Plotted points should not be used unless the best straight line passes through them. Most were able to calculate the gradient once they had chosen the points or triangle. In part **(b) (iii)** the candidates had to calculate the spring constant, *k* and at this point a sensible number of significant figures was expected in the answer.

The last part proved to be difficult, perhaps because candidates did not understand the question which related to parallax errors. In the past candidates have often given parallax errors as sources of error but this question required them to state how such an errors can be minimised.

COMBINED SCIENCE

Paper 0653/52

Practical Test

Key message

Responses to questions requiring candidates to compare their own results to explain something must include at least one reference to the relevant results.

General comments

Candidates were able to complete the three exercises in the one hour thirty minutes allocated. The standard of graph plotting was high. Measuring of gradients could be improved significantly.

Comments on Specific Questions

Question 1

It is vital that confidential instructions are followed carefully by laboratory staff as hydrogen peroxide of greater concentration than specified resulted in very short times. One Centre reported this error and a revised mark scheme was applied so that the candidates were not disadvantaged. Once again this emphasises the importance of the Supervisor's Report as a means of communication.

Full sets of results were usually seen in Table 1.1. Some were not to the nearest second as requested. It is important that candidates pay attention to the number of significant figures or decimal places required for data or calculations. Some candidates need instruction on how to record times from electronic stopclocks. Most candidates obtained the correct trend in their results although some recorded shorter rather than longer times in experiment 2. This did not affect the marks in **(a)** but may have confused them when answering **(e)**. Averaging seemed to be a well-known skill.

Some candidates continue to choose awkward scales when plotting graphs which inevitably leads to plotting errors. Candidates should be encouraged to choose scales on which one little square is a more manageable figure such as 0.10, 0.20, 0.50 and so on. Even if points do not seem to support the drawing of a straight line through the origin, it is important to draw such a line when the instructions require it to gain the mark.

Part **(d)** was a comparatively simple exercise. To gain the mark, candidates had to record the time and draw lines on the graph to show how they worked this out. Relatively few drew the lines.

Part **(e)** proved to be difficult and in particular many candidates omitted to compare their results from the two experiments.

Question 2

Cloudy is still used to describe inadequately a white precipitate. Milky is an accepted alternative for white precipitate but cloudy simply describes turbidity, haziness or a precipitate. So cloudy needs a colour with it such as cloudy white. Apart from this Table 2.1 was completed successfully.

Part **(b)** was a less familiar exercise in which candidates had to choose which solid to test. This in itself did not cause many problems but the tests were often not carried out carefully enough and not enough attention was paid to describing the observations. Consequently correct answers in **(c)** from incorrect observations in **(b)** were not credited. If candidates did not eliminate the correct solid in **(a)** they were not penalised for testing solid **B** in part **(b)**.

Question 3

This question was constructed around a lens of focal length f = 15 cm which is why Cambridge should be contacted well before the examination if specific items listed in the Confidential Instructions cannot be sourced. In particular a lens of different focal length may have resulted in data that could not be plotted on the scales provided. This optical experiment was carried out well by many candidates and produced meaningful data. Consequently part **(a)** and **(b)** attracted high marks. Candidates should always mark clearly on the graph the points or the triangle used to calculate the gradient and this should be based on at least half of the best straight line to improve accuracy. Plotted points should not be used unless the best straight line passes through them. Most were able to calculate the gradient once they had chosen the points or triangle.

COMBINED SCIENCE

Paper 0653/61
Alternative to Practical

Key Messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques. Candidates should have performed identification tests on the range of substances detailed in the specification.

General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard. but candidates need to take care when rounding calculated values. The standard of graph drawing was high. Knowledge of identification tests for ions needs improvement. Circuit diagrams need to be executed with care so that there are no gaps in the circuits drawn.

Comments on Specific Questions

Question 1

This experiment investigates plant transport systems in celery.

(a) (i) Most candidates drew the outline correctly. The more able candidates identified two stained areas.

(ii) More able candidates recognised xylem and water transport. Others incorrectly gave phloem and nutrient transport.

(b) The conclusion for Benedict's solution was well known but only the more able appreciated that the other two nutrients were not present.

(c) Candidates found planning this experiment challenging. The need to a minimum number of temperatures was appreciated by a significant number of candidates; measuring the distance moved by a coloured liquid in a set time was given by only the most able candidates. The control of other named conditions was well done.

Question 2

The spring constant of a spring is investigated in this question.

(a) Most candidates correctly recorded the time to the nearest second.

(i) Many candidates correctly calculated T and T^2 and gave the answer to two decimal places..

(ii) Many candidates plotted the points correctly with some drawing a line of best fit. The question asks the candidates to draw the best fit straight line through the origin; a few candidates did not draw the line through the origin.

(iii) The more able candidates were able to calculate the gradient of the line; candidates needed to take care as the scales on the two axes are different. The question asks that the candidates show on the graph how they calculated the gradient; the lines or coordinates used for the calculation need to be shown on the graph and more than half of the graph line should be used.

(iv) The calculation was performed accurately by many candidates. The question requested that the answer be given to two significant figures; candidates need to take care to follow such instructions.

Question 3

In this experiment a mixture of three metal oxides is investigated.

(a) (i) Most candidates gave an alkaline colour and most went on to give a pH greater than 7.

(ii) The most able candidates named the filtrate as limewater. A minority named A as calcium oxide.

(**b**) **(i)** More able candidates identified a pale blue precipitate in at least one of the tests and the most able described the dissolving and solution colour in excess.

(ii) Candidates needed to state the formula (CuO) rather than the name of the compound.

(c) A very small number of candidates appreciated that the zinc oxide was insoluble in water and so the first step here was to dissolve the ions by reacting the oxide with an acid such as hydrochloric acid. The tests for zinc ions was recalled by more able candidates.

Question 4

Blood and pulse rates are examined in this question.

(a) (i) The most able candidates could name all 4 components correctly. A significant number confused red and white blood cells. Platelets and plasma were less well known.

(ii) Many candidates measured the line correctly.

(iii) More able candidates divided by one thousand to correctly calculate the actual diameter; a significant number multiplied by a thousand.

(b) (i) The majority of candidates calculated accurately the average heart rate in beats per minute.

(ii) A correct reason for pulse rate increasing such as the requirement for more oxygen was given by the majority of candidates.

(iii) Most able candidates appreciated that an average could be calculated or that anomalies could be spotted or that similar results could be confirmed.

Question 5

This question examined the structure of electrical circuits.

Through the question there were many examples of large gaps left in the circuit diagrams drawn by candidates in answer to the different parts. Candidates should be encouraged to draw circuit diagrams carefully, to exclude accidental gaps.

(a) Many candidates were able to draw a circuit which could be used but many did not go on to outline how the results would show which bulbs were working and which were not. A significant number of candidates put the bulbs into a parallel circuit, so that they could test them all at once. A small number put all of the bulbs incorrectly into one series circuit

(b) Many candidates connected the ammeter in series but only the more able candidates connected the voltmeter in parallel across the bulb.

(c) Candidates found the construction of the table very challenging. Many candidates had columns or rows for current and potential difference but some also included extra columns such as voltage and resistance. Many candidates had the unit A but had Ohms or Joules instead of V for potential difference. Few candidates drew 5 columns / rows for the results of the 5 lamps.

(d) The equation R = V/I was quite well known but significant number of candidates gave the inversion.

Question 6

This experiment investigates the reaction between magnesium and hydrochloric acid.

(a) Many candidates know that the gas is hydrogen and the test for hydrogen was well known.

(b) More able candidates appreciated that the reaction vessel needed to be a conical flask containing a bung and a delivery tube where the delivery tube was above the level of the liquid. As the rate at which the gas evolves is being measured, the collection vessel must be have a scale to enable the measurement of volume of gas collected e.g. a measuring cylinder or a syringe. There were many collection vessels which also contained no graduations and were also sealed. More able candidates drew either the gas syringe or collection over water with a measuring cylinder.

(c) (i) Interpreting the graph in terms of the rate of reaction proved to be very challenging. More able candidates appreciated that the reaction was slowing down and then it stopped.

(ii) More able candidates appreciated that one or both of the reagents had been used up.

(d) Many candidates drew the line to the left of the original showing the increased rate of reaction for the higher temperature but only the more able stopped the graph at the same level as the original.

COMBINED SCIENCE

Paper 0653/62
Alternative to Practical

Key Messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques. Candidates should have performed identification tests on the range of substances detailed in the specification.

General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments/use of rulers was of an excellent standard but candidates need to take care when rounding calculated values and when entering data into tables. Knowledge of identification tests for ions needs improvement.

Comments on Specific Questions

Question 1

This is an investigation into enzyme activity.

(a) Averages were usually calculated correctly.

(b) The majority of candidates labelled the axes with the correct variable but many did not include the correct unit on both axes. Many candidates plotted the points correctly and drew a line of best fit but some missed the wording in the question asking for the line to go through the origin.

(c) Most candidates could correctly use their graph to estimate the average time but some candidates did not draw the lines on the graph and so could not score both marks for this part.

(d) More able candidates appreciated a slower reaction for a lower temperature and no reaction after boiling the enzyme. However, there was a common misconception that cooling would denature the enzyme and that the higher temperature of boiling would speed the enzyme activity.

(e) The test for oxygen was well known by the majority of candidates.

Question 2

In this experiment four solids are identified by a series of reactions and tests.

(a) (i) Most candidates identified the reagent as hydrochloric acid and the gas as carbon dioxide.

(ii) The test for carbon dioxide was well known.

(b) More able candidates correctly named compound A as sodium chloride.

(c) The white precipitate produced for the sulfate test was known by more able candidates. The reactions of ammonia solution with zinc ions and copper ions was not generally well known. Most of the more able candidates appreciated that the ammonia need to be added until in excess giving both of the required observations correctly.

Question 3

This experiment involves measuring the focal length of a converging lens.

(a) and **(b)** The majority of candidates measured the distances correctly.

(c) The calculation was generally performed well but many candidates did not give all of the data to two decimal places and so 1.00 was seen rarely. Many candidates rounded their calculator values incorrectly.

(d) (i) Many candidates plotted the points correctly and drew a line of best fit

(ii) More able candidates were able to calculate the gradient of the line. The lines or coordinates used for calculation need to be shown on the graph; more than half of the line should be used.

(iii) Focal length calculation was executed correctly by most candidates.

(e) Few candidates gave a precaution which would ensure accuracy.

Question 4

This is an investigation into the effect of various solutions on the heart rate of Daphnia.

(a) (i) The use of repition to increase reliability was well known.

(ii) Use of the data to identify the anomalous result in Experiment 1 was generally well answered.

(iii) More able candidates appreciated that the anomalous result should either be discarded or repeated,

(b) Many candidates appreciated that pond water was used as a control.

(c) (i) Most candidates correctly used the data and appreciated the increase in heart rate.

(ii) Most able candidates correctly compared the heart rate in decaffeinated coffee with that in pond water.

(d) Few candidates included the label “beats per minute” on the vertical axis. Most correctly drew four labelled bars.

(e) (i) The majority of candidates measured the line correctly.

(ii) More able candidates divided by 40 to calculate the actual size of the Daphnia.

Question 5

This experiment looks at some features of Group V elements

(a) (i) The test for ammonia was generally well known.

(b) Many candidates correctly named an indicator and the effect that acid would have on that indicator.

(c) Properties of non-metals were well known.

(d) (i) Many candidates correctly placed a sample of bismuth into a circuit with a power supply but did not include either a lamp or ammeter so they were unable to tell whether the sample conducted or not.

(ii) Candidates found planning this experiment to be very challenging. A significant number thought that higher electrical conductivity equated to higher reactivity. Some candidates reacted the bismuth with cold water only, some reacted with acid only, the most able candidates who chose this method correctly added water first and if the reaction was not vigorous then went on to add acid and looked at rate of hydrogen production as a measure of reactivity. Some candidates looked at displacement reactions but few candidates had the metal salts in solution and many added bismuth to other metals rather than to the salt solutions. A few candidates correctly described putting bismuth and another metal into a cell but only the most able could use the size of the voltage produced to indicate the difference in reactivity between the two metals.

Question 6

This is an investigation into factors affecting the period of a pendulum.

(a) The idea of timing a number of swings and dividing by the number was not well known.

(b) and **(d)** The balance was read correctly by the majority of candidates

(c) Many candidates appreciated that the mass did not affect the period but only more able candidates gave creditworthy explanations, including no trend/pattern and the results being very close together.

(e) Most candidates measured the length correctly.

(f) Many candidates described the trend correctly but only the more able candidates commented on the anomalous result.

(g) Whilst many candidates appreciated the need to repeat only the more able also included the need to average these repeated results. A small number of candidates specified repetition of the anomalous result.

COMBINED SCIENCE

Paper 0653/63
Alternative to Practical

Key Messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques. Candidates should have performed identification tests on the range of substances detailed in the specification.

General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of an excellent standard but candidates need to take care when rounding calculated values. The standard of graph drawing was high. Knowledge of identification tests for ions was generally poor.

Comments on Specific Questions

Question 1

This question is about an investigation into yeast cells.

(a) Many candidates knew that boiling denatures enzymes or kills yeast cells.

(b) More able candidates entered the correct colours into the table and the most able headed the first column with time and mins

(c) (i) Very few candidates appreciated that the addition of water was to maintain a constant volume or concentration.

(ii) Many candidates knew that the change in A was faster but only some realised that it was the sugar which brought this about.

(d) Very few candidates understood that oxygen from the air would re-enter the solution and so the tube would change back to blue.

Question 2

This question involves tests for identifying three ions..

(a) The test for Fe^{2+} ions was not well known. Candidates needed to know that an aqueous solution is made of the solid; a few added sodium hydroxide or ammonia solution. Very few candidates knew that a green precipitate would form.

(b) Very few candidates added sodium hydroxide in order that ammonia gas to be given off so that it can be tested with damp red litmus paper. A small number of candidates added the litmus paper to the solid.

(c) Candidates needed to explain that an aqeuos solution is made of the solid and then hydrochloric acid added. A small number of candidates went on to add barium chloride solution and only a few of these knew that a white precipitate was formed.

Question 3

This is an investigation into the resistance of lamps in various circuits.

(a) Most candidates used the correct symbol for a voltmeter but only the most able correctly connected it across X and Y.

(b) (i) The majority of candidates read both meters correctly.

(ii) The units were not well known. Many candidates rewrote the quantity i.e. voltage, current and resistance.

(iii) Many candidates calculated the correct values but then some did not give the value to two decimal places or rounded the calculator value incorrectly.

(c) The higher achieving candidates used the two values in their answer but few were able to give a justification.

(d) More able candidates recognised that the resistances of the lamps may have been different.

Question 4

This is an investigation into the effect of temperature on enzyme activity.

(a) (i) and **(ii)** Most candidates read the temperature and time correctly.

(iii) Most candidates calculated the rate correctly.

(b) (i) Most candidates plotted the points correctly and a few drew a smooth curve.

(ii) The majority of candidates could correctly read the value from the graph.

(iii) The most able appreciated that there would need to be more experiments performed either side of their optimum temperature.

(d) Few candidates appreciated that the experiment needed repeating with water instead of acid and that this experiment remaining cloudy would prove that acid is needed.

Question 5

This question involves the electrolysis of brine.

(a) (i) The higher achieving candidates realised that this would be a lamp or an ammeter.

(ii) The more able candidates drew the correct symbol for a cell or a battery. Many candidates drew circuits with short circuited batteries or no connections.

(iii) Some candidates knew that the electrodes should be unreactive and gave graphite or platinum as a suitable material.

(b) (i) Few candidates knew that a red-brown precipitate would form.

(ii) Few candidates knew the test for chlorine.

(iii) The test for hydrogen was quite well known.

Question 6

This was an investigation into the thermal conduction of five metal rods.

(a) (i) Many candidates read both stop-clocks correctly.

(ii) Many candidates labelled the axes and drew the points correctly.

(iii) On the most able candidates used the data to explain how they knew that there was no correlation between the percentage of magnesium and the time.

(b) More able candidates were able to choose either one or two changes that the candidate could make and these were usually to use same-sized rods of each material, and the same amount of wax on each rod.

(c) Very few candidates could explain how a change affected the reliability or accuracy of the experiment.