COMBINED SCIENCE

Paper 0653/11
Multiple Choice

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

Biology

General comments

The biology section of the paper represented a very fair test of candidates' ability.

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

Comments on specific questions

Question 2 The more able candidates knew that cellulose is found in the cell wall, but a significant minority chose option **C**, chloroplast.

Question 3 Very few candidates chose options **A** and **B**.

Question 4 A number of candidates believed that it is palisade rather than epidermal cells that surround stomata.

Question 5 The term 'digestion' appeared not to be fully understood by a number of candidates.

Question 7 Candidates were clear on the directions of gaseous diffusion during photosynthesis and the majority chose the correct answer.

Question 8 Although many candidates answered this correctly, a minority thought that a $3\,g/dm^3$ of alcohol in the blood would not be likely to have any effect at all.

Question 9 The value of condoms in preventing contact between the sexual organs of partners, and thus reducing the risk of transfer of disease-causing organisms was not clear to a significant number of candidates who suggested that IUDs and sterilisation might have this effect.

Question 11 Although most candidates knew that the environment causes the skin to turn darker in sunlight, many omitted to factor-in the need for possessing genes to create the ability to react in this way.

Chemistry

General Comments

Questions 18 and **25** These proved to be easiest of the chemistry questions, being answered correctly by a large majority of the candidates. **Questions 22** and **24** were the most challenging, with only a minority answering correctly.

Comments on specific questions

Question 15 Many candidates correctly worked out the formula but did not realise the atoms were bonded together and hence chose option **D**.

Question 16 Candidates clearly did not realise that the spot of dye needs to be above the solvent level at the beginning of the process. The most frequent incorrect answer was option **A**.

Question 17 Some candidates opted for an equation which they recognised instead of working out which equation was balanced correctly and chose option **D**.

Question 19 Candidates were familiar with two of the alloys, but those choosing option **D** did not realise that two non-metals cannot form an alloy.

Question 20 A number of candidates chose option **B**, not realising that sulfur dioxide, being an acid, is also corrosive.

Question 22 Candidates who chose option **B** either did not realise that KOH was an alkali or they missed the 'not' in the question stem.

Question 24 Options **A** and **C** were both more popular than the correct answer. This was a challenging question. Some candidates did not realise that metals are always discharged at the cathode, others did not realise that lead chloride is insoluble and many did not know that bromine fumes are brown.

Physics

General comments

Physics questions which proved most challenging were **31**, **33**, **34** and **38**. Others that caused some difficulty were **28**, **29**, **35**, **36**, **37** and **40**.

Comments on specific questions

Question 28 A significant number of candidates chose option **D**, the widest tube, without calculating the volume.

Question 29 Confusion between mass and weight was evident in the fact that many chose **C**.

Question 30 This question concerned density and most candidates extracted and used correctly the required information from the table.

Question 31 This question involved a speed calculation, and most candidates found it difficult, many dividing distance in kilometres by time in minutes to produce a speed measured in m / s.

Question 32 This question on energy sources was much better answered than previous years.

Question 33 About half of the candidates believed that a fuse prevents short circuits.

Question 34 Some difficulty was encountered in this electrical circuit question.

Question 35 This question on transformers was tackled rather more effectively.

Question 36 A significant minority of candidates believed air currents to be caused by radiation.

Question 37 About half of the candidates linked a large sound wave amplitude to a quiet sound, and a low frequency to a high-pitched sound.

Question 38 This lens question proved to be challenging, with many candidates appearing to have guessed the answer.

Question 39 This question on the electromagnetic spectrum was correctly answered by about half of the candidates. As it involved simple recall, it was expected that more would have been able to answer correctly.

Question 40 Approximately half of the candidates chose the distractor, option **B**, which was the exact opposite of the correct answer.

COMBINED SCIENCE

Paper 0653/12

Multiple Choice

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

Biology

General comments

The biology section of the paper represented a very fair test of candidates' ability. Two questions failed to be correctly answered by less than half the candidates.

Comments on specific questions

Question 1 A little confusion over leaf structure lead to a number of candidates believing that it is palisade rather than epidermal cells that surround stomata.

Question 3 The more able candidates knew that cellulose is found in the cell wall, but a significant minority chose option **C**, chloroplast.

Question 4 Very few candidates chose options **A** and **B**.

Question 5 Candidates were clear on the directions of gaseous diffusion during photosynthesis and the majority chose the correct answer.

Question 6 The term 'digestion' appears not to be fully understood by a number of candidates.

Question 8 The value of condoms in preventing contact between the sexual organs of partners, and thus reducing the risk of transfer of disease-causing organisms was not clear to a significant number of candidates who suggested that IUDs and sterilisation might have this effect.

Question 10 Although many candidates answered this correctly, a minority felt that a $3\,g/dm^3$ of alcohol in the blood would not be likely to have any effect at all.

Question 13 Although most candidates knew that the environment causes the skin to turn darker in sunlight, many omitted to factor-in the need for possessing genes to create the ability to react in this way.

Chemistry

General Comments

The easiest of the chemistry questions was **Question 27** which was answered correctly by the vast majority of candidates. **Questions 17** and **23** were the most challenging, with only a minority answering correctly.

Comments on specific questions

Question 14 Many candidates correctly worked out the formula but did not realise the atoms were bonded together and hence chose option **D**.

Question 16 A number of candidates clearly did not realise that the spot of dye needs to be above the solvent level at the beginning of the process. The most frequent incorrect answer was option **A**.

Question 17 A number of candidates chose option **B**, not realising that sulfur dioxide, being an acid, is also corrosive.

Question 18 Some candidates opted for an equation which they recognised instead of working out which equation was balanced correctly and chose option **D**.

Question 20 Candidates were familiar with two of the alloys, but those choosing option **D** did not realise that two non-metals cannot form an alloy.

Question 22 Options **A** and **C** were both more popular than the correct answer. This was a challenging question. Some candidates did not realise that metals are always discharged at the cathode, others did not realise that lead chloride is insoluble and many did not know that bromine fumes are brown.

Question 23 Candidates who chose option **B** either did not realise that KOH was an alkali or they missed the 'not' in the question stem.

Physics

General comments

Physics questions which proved most challenging were **Questions 32** and **35**. The easiest were **Questions 28** and **31**.

Comments on specific questions

Question 28 This question concerned density and most candidates extracted and used correctly the required information from the table.

Question 29 A significant number of candidates chose option **D**, the widest tube, without calculating the volume.

Question 30 Confusion between mass and weight was evident in the fact that many chose **C**.

Question 31 This question on energy sources was much better answered than previous years.

Question 32 This question involved a speed calculation, and most candidates found it difficult, many dividing distance in kilometres by time in minutes to produce a speed measured in m / s.

Question 33 A significant minority of candidates believed air currents to be caused by radiation.

Question 34 Some difficulty was encountered in this electrical circuit question.

Question 35 A significant number of candidates believed that a fuse prevents short circuits.

Question 36 This question on transformers was tackled rather more effectively.

Question 37 This lens question proved to be challenging, with many candidates appearing to have guessed the answer.

Question 38 This question on the electromagnetic spectrum was correctly answered by almost half of the candidates. As it involved simple recall, it was expected that more would have been able to answer correctly.

Question 39 A higher level of knowledge was shown in this question about waves.

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COMBINED SCIENCE

Paper 0653/13
Multiple Choice

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

Biology

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The biology section of the paper represented a very fair test of candidates' ability. Two questions failed to be correctly answered by less than half the candidates.

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Question 1 The more able candidates knew that cellulose is found in the cell wall, but a significant minority chose option **C**, chloroplast.

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Question 4 Very few candidates chose options **A** and **B**.

Question 6 Candidates were clear on the directions of gaseous diffusion during photosynthesis and the majority chose the correct answer.

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Question 9 Although many candidates answered this correctly, a minority felt that a $3\,g/dm^3$ of alcohol in the blood would not be likely to have any effect at all.

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Chemistry

General Comments

The easiest of the chemistry questions was **Question 25** which was answered correctly by the vast majority of candidates. **Questions 18** and **24** were the most challenging, with only a minority answering correctly.

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Question 21 A number of candidates clearly did not realise that the spot of dye needs to be above the solvent level at the beginning of the process. The most frequent incorrect answer was option **A**.

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Question 24 Candidates who chose option **B** either did not realise that KOH was an alkali or they missed the 'not' in the question stem.

Physics

General comments

Physics questions which proved most challenging were **Questions 31** and **34**. The easiest were **Questions 29** and **32**.

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COMBINED SCIENCE

Paper 0653/21

Core Theory

Key Message

Teachers and candidates are reminded that this Paper examines only the Core curriculum, not the Supplement. One of the advantages of entering candidates for this Paper is they need only learn what is in the Core, so that they can concentrate on developing their understanding and knowledge of this to as high a level as possible.

General Comments

A wide range of performance was shown on this Paper. A small number of candidates answered a high proportion of questions very competently, demonstrating good knowledge and understanding across the whole of the Core curriculum.

Candidates need only be prepared for the Core curriculum for examination on this paper. For example, questions on this Paper about resistance will never involve calculating the sum of resistors in parallel, only in series. Many candidates tried to answer **Question 9(a)(ii)** as if the resistors were in parallel.

When a question asks for a formula to be stated, this should be shown using either complete words, or symbols as listed in the syllabus. Formula triangles are not credited, although of course candidates are free to use them help them to remember the formula. Formulae including only units, such as volts = amps x ohms, are also not credited. The correct formula in this case would be volts = current x resistance, or $V = IR$.

Comments on Specific Questions

Question 1

(a)

(i) Many candidates correctly stated that a catalyst speeds up a reaction. Relatively few also stated that the catalyst remains unchanged at the end of the reaction. Many answers stated that a catalyst is an enzyme. This is not correct – although all enzymes are catalysts, most catalysts are not enzymes.

(ii) Many candidates knew that these are transition metals.

(iii) Relatively few answers were correct. By far the most common answer was 9, suggesting that candidates may have added up the subscripts without recognising the meaning of the large 4 in front of the H_2.

(iv) More candidates answered this successfully than **(iii)**. However, there were many incorrect responses. The most common wrong answer was 2, and numerous examples of 6, 8 and 18.

(v) Good understanding of the term ‘redox’ was rare. A very small number of candidates attempted to explain it in terms of loss and gain of electrons, rather than loss or gain of oxygen; these answers almost always went astray.

(b)

(i) This was quite well answered. A common error was to show the additional hydrogens joined to the hydrogen atom, rather than the nitrogen atom. Numerous candidates did not know what a displayed formula is, and tried to write an equation, or added subscripts to the H and N already given. Some added a triple bond between the N and H.

(ii) A number of candidates gave good answers, explaining that the student is correct because this involves bonding between two non-metals, or that electrons are shared.

Question 2

(a)

(i) Very few candidates recognised that more than one of the diagrams showed a car that is slowing down. Many correctly gave either **C** or **D** as the answer, with a small number giving both.

(ii) A few candidates correctly explained that the backward force is greater than the forward force, or that the backward-pointing arrow is longer than the forward-pointing arrow. Many found it difficult to put their ideas into words. For example, some said that the force 'at the back' is greater than the force 'at the front', without saying in which direction these forces are acting.

(iii) Most candidates identified gravity, or weight. Some simply wrote 'vertical', or gave a horizontally-acting force such as friction.

(b)

(i) The correct answer, conduction, was relatively rare. Numerous answers gave convection, while others did not understand the question and gave answers such as 'through pipes'.

(ii) The great majority of answers stated that black is a good absorber of heat, which – while correct – is not relevant in this context. The best candidates stated that black is a good emitter of heat.

(c) This was well answered. Most candidates knew the relationship between speed, distance and time and wrote down the formula appropriately. A few had difficulty dividing 330 by 1.5. Some changed the hours to minutes, therefore arriving at a wrong answer, as the unit was already given as km/h.

(d) This was also well answered. The majority of candidates correctly stated that the car is moving at a constant speed during section **B**, and decelerating or slowing down in section **C**. A few thought that the car was not moving during section **B**.

Question 3

(a)

(i) Only a tiny number of candidates recognised that all three of these nutrients can provide energy. The majority chose just one of them, normally carbohydrate.

(ii) This was also poorly answered. Only a small number of candidates recognised the importance of protein in the diet of a growing child.

(iii) Quite a few answers correctly mentioned Benedict's solution, and some also stated the colour that would be seen if the rice contained reducing sugar. Many forgot that heating would be required. Some candidates described the test for starch, which gained no credit.

(b)

(i) Few candidates could describe how plants make food by photosynthesis. The best answers gave a word equation, or stated simply that carbon dioxide and water are combined, or react together, to produce glucose. Some also mentioned the provision of energy from sunlight. Many answers simply stated that the production of food happens 'in the presence of' carbon dioxide and water, without stating that the two substances react together. The role of sunlight in providing energy was frequently not mentioned. Many candidates wrote at some length about how carbon dioxide and water are supplied to the leaf, which did not answer the question.

(ii) This was rather better answered than **(i)**. Many answers referred to the broad or spreading leaves having a large surface area for absorption of sunlight. Others did not answer the question, writing about the roots rather than the leaves.

Question 4

(a)

(i) This was quite well answered.

(ii) Many candidates were able to give a suitable use for at least one of these types of electromagnetic radiation, and some gave two.

(b)

(i) The term 'ionising radiation' was understood by only a very tiny number of candidates.

(ii) This was well answered; many answers correctly mentioned cancer or mutation. Other suitable responses included killing cells, causing radiation burns or radiation sickness.

(c)

(i) Many candidates recognised that the gamma radiation would be able to penetrate the boxes.

(ii) Correct responses stated that the concrete stops the gamma radiation from getting out, or that it protects people outside the concrete walls. Statements that the concrete stops the radioactive source getting out were not credited. Many answers simply said that concrete does not allow gamma radiation to pass through, which does not go quite far enough to answer the question.

Question 5

(a)

(i) Many candidates correctly stated that bubbles or fizzing would be seen, and some also mentioned that the magnesium would disappear or dissolve, or that the beaker would get hot. There were many incorrect suggestions about colour changes. Some thought that the magnesium would catch fire.

(ii) Most candidates had trouble with this question; only a small number gave an entirely correct response. Some knew that hydrogen would be produced, but had difficulty naming the salt, giving answers such as 'magnesium sulfur', 'magnesium sulfuric' and 'magnesium oxide'. Some wrote magnesium in one box and sulfate in the other, which was not credited. Some wrote formulae, which were also not credited as the question specifically asked for a word equation.

(iii) A minority of candidates correctly named hydrogen.

(b)

(i) There were numerous correct answers, generally relating to the fact that poly(ethene) would not react with the sulfuric acid. Many candidates appeared not to know the meaning of the term 'property'.

(ii) Many answers gave one correct compound, but only a small minority gave two. Many answers were not compounds, such as carbon or hydrogen.

(iii) A few candidates recognised that burning would completely get rid of the poly(ethene), reducing litter or the need to dispose of it by landfill. Very few suggested using the heat energy in some way.

Question 6

(a) This was well answered. There was some confusion between the spinal cord and the spine.

(b)

(i) A minority of candidates knew the term 'receptor' or 'sensory neurone'. 'Detectors', which is not correct, appeared quite frequently. Many answers were totally incorrect, such as 'red blood cells'.

(ii) This was not as well answered as **(i)**. Numerous candidates wrongly gave 'brain' or 'muscle' as an answer, and 'receptors' also appeared frequently.

(c)

(i) A good proportion of candidates correctly named red blood cells. The most common incorrect answers were white blood cells and brain cells.

(ii) Few candidates were able to give a function of DNA similar to that stated in the syllabus. Many thought that its function is to allow us to distinguish between different people, or to determine someone's blood group.

(iii) This was much better known than **(ii)**. Some candidates wrongly stated that the membrane controls what enters and leaves the body, rather than the cell.

Question 7

(a) This was almost always answered correctly.

(b)

(i) While many candidates correctly identified the element as magnesium, they found an explanation of why this ion has a positive charge very challenging. Very few compared the numbers of electrons and protons. Many referred to the fact that the ion had lost two electrons, but without reference to the proton number, or the charge on these two particles, this does not answer the question. Numerous responses concentrated on the equal number of protons and neutrons, which is irrelevant.

(ii) Some candidates correctly named neon.

(iii) This was quite well answered, with a sizeable minority of candidates able to state that the outer electron shell of noble gases is complete.

(c)

(i) Most candidates knew that this diagram represents electrolysis.

(ii) This proved to be a difficult question. Common incorrect responses were sodium, hydrogen, sodium chloride and gas. Of those who recognised that chlorine would be formed here, some incorrectly gave the name as chloride, rather than chlorine.

Question 8

(a)

(i) Most candidates were able to gain at least partial credit for their food web, and many got this entirely correct. A common error was to show the three predators linked to each other and not to the monkey. Numerous responses showed the predators linked to the trees, and then the monkeys at the top of the web, seemingly feeding on the predators. Some candidates did not draw arrows on the lines linking the monkey to its predators, and some drew them pointing in the wrong direction.

(ii) This was well answered, most candidates correctly circling the trees, fruit or nectar.

(b)

(i) Many candidates could name at least one of these two structures, and some both.

(ii) This was very well answered.

(iii) This was also well answered.

(iv) Many candidates gave good answers, explaining that the nectar attracts insects (or other animals) that then carry out pollination. A frequent error was to suggest that the nectar itself is what is carried from flower to flower.

Question 9

(a)

(i) Most answers gained at least partial credit for showing 6 x 2. Some also wrote a correct formula. The formula, however, was often missing, or was given wrongly; for example volts = ohms x amps, or volts = ammeter x resistor.

(ii) Once again, a formula was often missing or incorrect. Many tried to do the calculation using a formula for adding resistors in parallel. Another common error was to multiply the two values together rather than add them.

(b) Many candidates correctly explained that fossil fuels are likely to run out. Some also mentioned pollution caused by them, such as the release of carbon dioxide or an effect such as global warming. Numerous answers incorrectly suggested that burning fossil fuels affects the ozone layer. A few appeared to misread the question, writing about reasons for using fossil fuels, rather than for finding alternatives to them.

COMBINED SCIENCE

Paper 0653/22
Core Theory

Key Message

Candidates need to read each question carefully, particularly with reference to the specific instructions included. There is a glossary of terms used in science papers at the back of the syllabus, and candidates should be made familiar with all of these terms.

General Comments

Candidates should be reminded to look carefully at the word that tells them what they have to do in the question. In particular, they should appreciate the difference between 'describe' and 'explain'. Further reference to this is made in the context of **Questions 3(c)(ii)** and **9(b)(ii)** below.

Comments on Specific Questions

Question 1

(a)

(i) Many candidates correctly identified the gas as carbon dioxide. The most common incorrect response was hydrogen.

(ii) A minority of candidates were able to give a correct formula for hydrochloric acid. Care needs to be taken when writing the letters of a formula; the 'l' in HCl sometimes looked more like a capital letter than a small letter. Some candidates did not know what a formula is, and wrote an equation. Some appeared to be attempting to write the formula of a different acid, such as sulfuric acid.

(iii) Many candidates misunderstood what was happening, and their answers referred to gas held in spaces in the rock being released from it. They thought that the gas stopped forming because it had all been let out. Those who did recognise that the gas was being formed by a chemical reaction frequently did not use the information that some of the rock remained in the tube, and suggested that all the rock had reacted. Relatively few recognised that the reaction stopped because all the hydrochloric acid had been used up.

(ii) A small minority of candidates recognised that this flame test indicated the presence of calcium. Several suggested iron.

(b)

(i) Very few candidates recognised that carbon dioxide is an oxide of a non-metal, which would produce an acidic solution when dissolved in water. Those who did get that far sometimes stated that an increase in acidity of the sea water would cause an increase in pH.

(ii) Only a very small number of answers included a relevant suggestion. The most frequently seen correct response followed from a correct answer to **(i)**, and suggested that the acidic sea water would react with the calcium carbonate in the reef.

Question 2

(a)

(i) Some candidates wrote a suitable word in the space provided on the diagram, such as air resistance, friction or drag. Wind resistance was also accepted, but just ‘resistance’ or ‘wind’ was not, and neither was ‘pulling force’. A number of candidates did not answer, perhaps because they had not noticed the question.

(ii) Most candidates had great difficulty in explaining the meaning of the term ‘balanced forces’. While some did correctly state that this means that forces are equal, very few also stated that they act in opposite directions. Only answers implying both ‘equal’ and ‘opposite’ were credited.

(iii) The best answers stated that, if the horizontally-acting forces are balanced, then the aircraft moves at a steady speed. Many said that it would be stable, or that it would move in a straight line, or that it would not move. A large number wrote about the aircraft taking off.

(b) The formula speed = distance / time was well known. Many candidates did not convert one hour to seconds, and so arrived at a very small number for their answer. Candidates need to examine the reasonableness of the sizes of their answers when reviewing their work towards the end of an examination. It is not very likely that a moving aircraft would travel at, for example, 80 m in one hour.

(c)

(i) The effects of ionising radiation were quite well known, and many answers included at least one harmful effect, such as mutation or cancer. Some candidates were distracted by the context and wrote about various other hazards or discomforts of travelling in an aeroplane.

(ii) Very few candidates could state a natural source of background radiation.

(d) The most common correct responses named X-rays and gave a suitable use for them. Many candidates were unable to name another kind of wave. Sound appeared quite frequently, as did GPS.

Question 3

(a) A small minority of candidates could complete the word equation for aerobic respiration. Carbon dioxide or water often appeared as reactants, while glucose was a frequent product. ‘Energy’ often featured, and occasionally ‘light’.

(b) Most candidates did not appear to know that oxygen is carried in the blood.

(c)

(i) This was well answered, most answers correctly giving 0.4 as the value read from the graph.

(ii) Candidates who answered the question as asked, describing the difference between the oxygen usage in the fast run and slow run, usually gained at least partial credit, and many gave enough detail in their answer to receive full credit. Many candidates attempted to *explain* the results rather than describing them; these answers generally did not contain any relevant statements.

(iii) Many answers simply said that you need more oxygen when you are running fast than when you are running slowly, which did not gain any credit. A few candidates mentioned that more energy is used for running fast, and some referred to muscles and respiration.

(d) Very few candidates knew that emphysema is caused when the walls of the alveoli break down.

Question 4

(a)

(i) A minority of candidates recognised that both switches must be closed in order for the heater to work.

(ii) Few correct circuits were drawn. The best answers showed the voltmeter in parallel with the heater, and the current in series. Short circuits were common.

(b)

(i) This was well answered, most candidates naming coal, oil or gas. Commonly seen incorrect responses were ‘crude oil’ and ‘wood’.

(ii) The use of high voltages to reduce energy losses was not well known. Most were not confident in the correct usage of the terms ‘current’, ‘power’ and ‘energy’.

(iii) The calculation was sometimes done correctly. A few candidates used the correct method but ended up with the wrong number of zeros in their answer.

(iv) Very few candidates knew that the transformers are used to reduce the voltage, although slightly more recognised that the use of transformers is related to safety. Many candidates incorrectly suggested that the transformers provided a back-up supply if there is a power cut.

Question 5

(a)

(i) Most candidates gave a correct function for at least one of these parts of a flower. A common given incorrect function for petals was ‘to protect the flower’.

(ii) The development of a seed from an ovule was quite well known, but fewer candidates knew that a fruit develops from an ovary. ‘Ovary wall’ was accepted, as this is what was labelled on the diagram.

(b) Quite a few candidates answered this question entirely correctly, and most got at least partial credit. Many thought that only sexual reproduction produces new individuals.

Question 6

(a)

(i) A minority of candidates were able to work out the per cent by mass of copper in Nordic gold as 89 %. Most did not understand how to do this, and made a guess at something similar to the percentages given for the other metals, such as 1 or 2.

(ii) Although many candidates recognised that Nordic gold would be made by mixing the four metals together, relatively few explained that they would be melted together.

(iii) Some candidates picked out the symbol Fe from the list of compounds in the table, and correctly named this as iron. The symbol Fe alone was not credited, as the question specifically asked for the name.

(iv) A variety of responses was accepted here, such as being unreactive or being hard. Candidates need to be familiar with the meaning of the term 'property' in a chemical context.

(b)

(i) Some candidates attempted to use the information appropriately, but quite often tin was missing from the right hand side of the equation. Many attempted to write balanced equations using formulae, which can only be credited if the equation is entirely correct, as the question asked for a *word* equation. Some candidates simply wrote a formula; candidates need to be made aware of what is meant by an *equation* in a chemical context.

(ii) Some candidates recognised that carbon has been oxidised, and some of these were able to explain their answer.

(c)

(i) The best candidates knew that the cathode is the negative electrode. Candidates need to be made familiar with the meaning of the term 'electrolyte'.

(ii) Numerous candidates correctly stated that aluminium is in Group III. A common incorrect response was that it is in period 3.

Question 7

(a) The formula *work = force x distance* was quite well known, and many candidates showed this formula and did the calculation correctly. The most common incorrect answer was to divide the force by the distance.

(b)

(i) Some candidates correctly wrote 'kinetic' in the space. Wrong answers, especially 'gravitational' or 'potential', were more common.

(ii) This was well answered.

(iii) Most candidates had difficulty with this question, offering responses such as 'into the boy' or 'at the top'. Any response that suggested the energy is dissipated into the surroundings was credited, such as 'into the air'.

(c)

(i) This part of the question had a maximum of one mark, and it was very well answered.

(ii) This part of the question had a maximum of two marks. Candidates were asked to show the formula and their working. Many candidates, who would probably have been comfortable calculating density, given mass and volume, found it difficult to calculate volume using the same formula. A significant number divided 1020 by 40, rather than dividing 40 by 1020.

Question 8

(a)

(i) Many candidates could name the process as digestion.

(ii) This was poorly answered. A small number of candidates understood that digestion is necessary so that nutrients can be absorbed from the alimentary canal. Most answers were very general, for example 'so that the frog does not choke', or 'so that it has energy to jump high'.

(ii) Most candidates were able to complete at least one of the spaces correctly, and a significant minority made correct choices for all three. A common error in the first space was 'cells'. 'Dissolved' or 'killed' was often chosen for the last space

(b)

(i) The majority of answers were given in the context of tropical rain forests, stating that they have a high number of species, and this was accepted. Some gave answers such as 'the number of different species of animals', and this was not accepted.

(ii) This was well answered. Many answers referred to effects on the populations of the frogs' predators or prey, and some mentioned both. Some candidates simply stated that, for example, the frogs would no longer eat the insects, without taking the next step and stating that therefore the population of insects would increase. In this case no credit could be awarded.

Question 9

(a)

(i) Various correct answers were seen, often referring to the decay of organic material (for example, faeces or other biological waste) or to the digestive system of cows or other ruminants. Some candidates also recognised that methane is found in association with other fossil fuels.

(ii) This was often answered correctly. Some candidates did not understand what a displayed formula is and either omitted this question, or wrote a formula or equation.

(iii) There was much confusion between the effects of carbon dioxide and carbon monoxide; for example, it was often stated that carbon dioxide is toxic, or that carbon monoxide causes global warming. Numerous other irrelevant effects were often given, particularly damage to the ozone layer.

(b)

(i) Many candidates correctly gave distillation, or fractional distillation. Diffusion was quite often seen.

(ii) The best answers simply stated that the higher the molecular mass, the higher the boiling point. Many incorrectly wrote that the more molecules, the higher the boiling point. Some tried to explain the relationship, rather than describe it, and these answers generally did not gain any credit. This is another example of where candidates needed to read the question carefully to make sure that they were answering the question asked.

COMBINED SCIENCE

Paper 0653/23
Core Theory

Key Message

Candidates need to read each question carefully, particularly with reference to the specific instructions included. There is a glossary of terms used in science papers at the back of the syllabus, and candidates should be made familiar with all of these terms.

General Comments

Candidates should be reminded to look carefully at the word that tells them what they have to do in the question. In particular, they should appreciate the difference between ‘describe’ and ‘explain’. Further reference to this is made in the context of **Questions 3(c)(ii)** and **9(b)(ii)** below.

Comments on Specific Questions

Question 1

(a)

(i) Many candidates correctly identified the gas as carbon dioxide. The most common incorrect response was hydrogen.

(ii) A minority of candidates were able to give a correct formula for hydrochloric acid. Care needs to be taken when writing the letters of a formula; the ‘l’ in HCl sometimes looked more like a capital letter than a small letter. Some candidates did not know what a formula is, and wrote an equation. Some appeared to be attempting to write the formula of a different acid, such as sulfuric acid.

(iii) Many candidates misunderstood what was happening, and their answers referred to gas held in spaces in the rock being released from it. They thought that the gas stopped forming because it had all been let out. Those who did recognise that the gas was being formed by a chemical reaction frequently did not use the information that some of the rock remained in the tube, and suggested that all the rock had reacted. Relatively few recognised that the reaction stopped because all the hydrochloric acid had been used up.

(ii) A small minority of candidates recognised that this flame test indicated the presence of calcium. Several suggested iron.

(b)

(i) Very few candidates recognised that carbon dioxide is an oxide of a non-metal, which would produce an acidic solution when dissolved in water. Those who did get that far sometimes stated that an increase in acidity of the sea water would cause an increase in pH.

(ii) Only a very small number of answers included a relevant suggestion. The most frequently seen correct response followed from a correct answer to **(i)**, and suggested that the acidic sea water would react with the calcium carbonate in the reef.

Question 2

(a)

(i) Some candidates wrote a suitable word in the space provided on the diagram, such as air resistance, friction or drag. Wind resistance was also accepted, but just 'resistance' or 'wind' was not, and neither was 'pulling force'. A number of candidates did not answer, perhaps because they had not noticed the question.

(ii) Most candidates had great difficulty in explaining the meaning of the term 'balanced forces'. While some did correctly state that this means that forces are equal, very few also stated that they act in opposite directions. Only answers implying both 'equal' and 'opposite' were credited.

(iii) The best answers stated that, if the horizontally-acting forces are balanced, then the aircraft moves at a steady speed. Many said that it would be stable, or that it would move in a straight line, or that it would not move. A large number wrote about the aircraft taking off.

(b) The formula speed = distance / time was well known. Many candidates did not convert one hour to seconds, and so arrived at a very small number for their answer. Candidates need to examine the reasonableness of the sizes of their answers when reviewing their work towards the end of an examination. It is not very likely that a moving aircraft would travel at, for example, 80 m in one hour.

(c)

(i) The effects of ionising radiation were quite well known, and many answers included at least one harmful effect, such as mutation or cancer. Some candidates were distracted by the context and wrote about various other hazards or discomforts of travelling in an aeroplane.

(ii) Very few candidates could state a natural source of background radiation.

(d) The most common correct responses named X-rays and gave a suitable use for them. Many candidates were unable to name another kind of wave. Sound appeared quite frequently, as did GPS.

Question 3

(a) A small minority of candidates could complete the word equation for aerobic respiration. Carbon dioxide or water often appeared as reactants, while glucose was a frequent product. 'Energy' often featured, and occasionally 'light'.

(b) Most candidates did not appear to know that oxygen is carried in the blood.

(c)

(i) This was well answered, most answers correctly giving 0.4 as the value read from the graph.

(ii) Candidates who answered the question as asked, describing the difference between the oxygen usage in the fast run and slow run, usually gained at least partial credit, and many gave enough detail in their answer to receive full credit. Many candidates attempted to *explain* the results rather than describing them; these answers generally did not contain any relevant statements.

(iii) Many answers simply said that you need more oxygen when you are running fast than when you are running slowly, which did not gain any credit. A few candidates mentioned that more energy is used for running fast, and some referred to muscles and respiration.

(d) Very few candidates knew that emphysema is caused when the walls of the alveoli break down.

Question 4

(a)

(i) A minority of candidates recognised that both switches must be closed in order for the heater to work.

(ii) Few correct circuits were drawn. The best answers showed the voltmeter in parallel with the heater, and the current in series. Short circuits were common.

(b)

(i) This was well answered, most candidates naming coal, oil or gas. Commonly seen incorrect responses were 'crude oil' and 'wood'.

(ii) The use of high voltages to reduce energy losses was not well known. Most were not confident in the correct usage of the terms 'current', 'power' and 'energy'.

(iii) The calculation was sometimes done correctly. A few candidates used the correct method but ended up with the wrong number of zeros in their answer.

(iv) Very few candidates knew that the transformers are used to reduce the voltage, although slightly more recognised that the use of transformers is related to safety. Many candidates incorrectly suggested that the transformers provided a back-up supply if there is a power cut.

Question 5

(a)

(i) Most candidates gave a correct function for at least one of these parts of a flower. A common given incorrect function for petals was 'to protect the flower'.

(ii) The development of a seed from an ovule was quite well known, but fewer candidates knew that a fruit develops from an ovary. 'Ovary wall' was accepted, as this is what was labelled on the diagram.

(b) Quite a few candidates answered this question entirely correctly, and most got at least partial credit. Many thought that only sexual reproduction produces new individuals.

Question 6

(a)

(i) A minority of candidates were able to work out the per cent by mass of copper in Nordic gold as 89 %. Most did not understand how to do this, and made a guess at something similar to the percentages given for the other metals, such as 1 or 2.

(ii) Although many candidates recognised that Nordic gold would be made by mixing the four metals together, relatively few explained that they would be melted together.

(iii) Some candidates picked out the symbol Fe from the list of compounds in the table, and correctly named this as iron. The symbol Fe alone was not credited, as the question specifically asked for the name.

(iv) A variety of responses was accepted here, such as being unreactive or being hard. Candidates need to be familiar with the meaning of the term 'property' in a chemical context.

(b)

(i) Some candidates attempted to use the information appropriately, but quite often tin was missing from the right hand side of the equation. Many attempted to write balanced equations using formulae, which can only be credited if the equation is entirely correct, as the question asked for a *word* equation. Some candidates simply wrote a formula; candidates need to be made aware of what is meant by an *equation* in a chemical context.

(ii) Some candidates recognised that carbon has been oxidised, and some of these were able to explain their answer.

(c)

(i) The best candidates knew that the cathode is the negative electrode. Candidates need to be made familiar with the meaning of the term 'electrolyte'.

(ii) Numerous candidates correctly stated that aluminium is in Group III. A common incorrect response was that it is in Period 3.

Question 7

(a) The formula *work = force x distance* was quite well known, and many candidates showed this formula and did the calculation correctly. The most common incorrect answer was to divide the force by the distance.

(b)

(i) Some candidates correctly wrote 'kinetic' in the space. Wrong answers, especially 'gravitational' or 'potential', were more common.

(ii) This was well answered.

(iii) Most candidates had difficulty with this question, offering responses such as 'into the boy' or 'at the top'. Any response that suggested the energy is dissipated into the surroundings was credited, such as 'into the air'.

(c)

(i) This part of the question had a maximum of one mark, and it was very well answered.

(ii) This part of the question had a maximum of two marks. Candidates were asked to show the formula and their working. Many candidates, who would probably have been comfortable calculating density, given mass and volume, found it difficult to calculate volume using the same formula. A significant number divided 1020 by 40, rather than dividing 40 by 1020.

Question 8

(a)

(i) Many candidates could name the process as digestion.

(ii) This was poorly answered. A small number of candidates understood that digestion is necessary so that nutrients can be absorbed from the alimentary canal. Most answers were very general, for example 'so that the frog does not choke', or 'so that it has energy to jump high'.

(ii) Most candidates were able to complete at least one of the spaces correctly, and a significant minority made correct choices for all three. A common error in the first space was 'cells'. 'Dissolved' or 'killed' was often chosen for the last space.

(b)

(i) The majority of answers were given in the context of tropical rain forests, stating that they have a high number of species, and this was accepted. Some gave answers such as 'the number of different species of animals', and this was not accepted.

(ii) This was well answered. Many answers referred to effects on the populations of the frogs' predators or prey, and some mentioned both. Some candidates simply stated that, for example, the frogs would no longer eat the insects, without taking the next step and stating that therefore the population of insects would increase. In this case no credit could be awarded.

Question 9

(a)

(i) Various correct answers were seen, often referring to the decay of organic material (for example, faeces or other biological waste) or to the digestive system of cows or other ruminants. Some candidates also recognised that methane is found in association with other fossil fuels.

(ii) This was often answered correctly. Some candidates did not understand what a displayed formula is and either omitted this question, or wrote a formula or equation.

(iii) There was much confusion between the effects of carbon dioxide and carbon monoxide; for example, it was often stated that carbon dioxide is toxic, or that carbon monoxide causes global warming. Numerous other irrelevant effects were often given, particularly damage to the ozone layer.

(b)

(i) Many candidates correctly gave distillation, or fractional distillation. Diffusion was quite often seen.

(ii) The best answers simply stated that the higher the molecular mass, the higher the boiling point. Many incorrectly wrote that the more molecules, the higher the boiling point. Some tried to explain the relationship, rather than describe it, and these answers generally did not gain any credit. This is another example of where candidates needed to read the question carefully to make sure that they were answering the question asked.

COMBINED SCIENCE

Paper 0653/31
Extended Theory

Key Message

Candidates need to consider carefully what is being asked for in each question, and make sure that their answer is relevant and of appropriate length, answering the question asked, and providing relevant detail.

General Comments

Some excellent scripts were seen from candidates who had mastered all aspects of the syllabus, and who demonstrated good examination technique. Candidates tended to write answers of appropriate length but some candidates, often those who had prepared themselves very well, ignored the number of answer lines. These candidates all too often gave answers which contained much correct but irrelevant detail. In physics questions involving the use of a formula leading to a numerical answer, full credit cannot be awarded if incorrect symbols or symbols reserved for units are used to represent the formula. Candidates should also avoid using a mixture of words and symbols when they are writing formulae. Care should also be taken to provide numerical answers with appropriate and correct units. This paper contained some questions which required candidates to apply their knowledge in relatively unfamiliar contexts, and it is likely that questions like this will feature in future papers. This caused difficulties even for well-prepared candidates who had clearly acquired good factual knowledge.

Comments on Specific Questions

Question 1

(a)

(i) Most candidates stated that catalysts increase reaction rate and many gained further credit for going on to state that the catalyst remains unchanged. There was much evidence that candidates' experience of catalysis was restricted to enzymes, but this did not prevent the award of credit. Some candidates described how catalysts provide an alternative reaction pathway of lower activation energy. This lies outside this syllabus but such answers were awarded full credit.

(ii) Most candidates gained credit here.

(iii) The symbol equation was successfully balanced by many candidates.

(iv) Although it was generally stated that iron had been reduced in this reaction, the explanation in terms of electron gain was not quite so well known. Some candidates made no reference to electrons and stated text book definitions of reduction including gain of hydrogen.

(v) The majority of candidates were able to calculate the relative formula mass of iron oxide, 232. Some candidates included units, usually grams, but this was not penalised on this occasion. A small number of candidates used proton numbers in otherwise correct calculations and were awarded partial credit for a correct method.

(b) Many candidates received full credit for their bonding diagrams of ammonia. Common mistakes included adding additional electrons to the electron shells of the hydrogen atoms, and adding extra electrons around the nitrogen atom.

Question 2

(a)

(i) Candidates in general had learned very well how to construct food webs, and many were awarded full credit. The better presented webs showed the three trophic levels clearly, the three predators separately, and showed all energy transfers in the correct directions. Candidates could not be awarded full credit if they did not show three separate connections between the golden lion tamarins and the three predators. Some candidates wasted time and over-complicated their food webs by including other organisms which were not mentioned in the question. Although connections between one predator and another were not penalised, candidates should be advised that constructed food webs should be based on only the organisms and feeding relationships shown in the question.

(ii) Although candidates were guided by the wording of the question to explain the relatively low owl population in terms of energy flows through the food web, many did not do this. The loss of energy between trophic levels is commonly tested and in this question, credit was available for a reference to the reduced energy available for top predators, or a reference to the ways in which energy is lost between levels.

(b)

(i) Most candidates were able to interpret the bar graph and gained credit for a suitable statement describing the general trend shown. Further credit was available for some additional numerical detail such as stating that the maximum distance from the tree that any faeces were found was 400 m.

(ii) Many candidates were able to describe how dispersed seedlings would suffer less competition and have better access to nutrients, water and sunlight. Some candidates recognised that the faeces would act as fertiliser, although they needed to make it clear that this was relevant to the young plants and not to the ungerminated seeds. A third marking point related to the colonisation of new areas in the forest, but this was mentioned by only a small number.

Question 3

(a) Some candidates attempted to answer this question without reference to any scientific principles, and there was also evidence that many candidates may have misread the question. Credit was available for reference to car **B**'s lower centre of mass and wider base. In addition, candidates could also have described car **B** as being much lower to the ground. Unfortunately many candidates from across the ability range wrote that car **A** would be less likely to overturn and then went on to assign the attributes of car **B** to car **A**.

(b) Candidates in general are skilled in answering calculations of this type. Many stated an acceptable version of the relationship between speed, distance and time and went on to give the correct answer.

(c)

(i) Most candidates were able to interpret the speed/time graph, although they needed to take care to describe the motion of the car in terms of its speed. Unfortunately, several candidates incorrectly described section **B** of the graph as 'constant motion', 'steady motion' or 'neither accelerating nor decelerating'.

(ii) In general, candidates had learned that the answer to this type of question is obtained by calculating the area under the relevant sections of the speed/time graph. Many did this successfully and received full credit for their answer. In cases where the correct numerical answer was not seen, it was still possible for a candidate to gain credit for their method for a clear attempt to use the graph to calculate an area. Candidates who had actually written a statement such as *distance is given by the area under the graph* generally gained at least partial credit. The most common incorrect response was 400 m. It should be highlighted to candidates the importance of including the units in this type of calculation.

(iii) This calculation was also reasonably well done although not quite as well as **(ii)**. A specific formula was not required in this case and any clear reference to *change in speed ÷ time* was accepted for the method. Candidates completing the calculation yet not receiving full credit had either omitted units or written incorrect ones.

(iv) This calculation of force was done very well by many candidates. An error carried forward from **(iii)** was allowed, irrespective of how inaccurate the value from **(iii)** happened to be.

Question 4

(a)

(i) Some candidates successfully identified the receptor and sensory neuron. There was no particular pattern to the incorrect responses.

(ii) Some flexibility was allowed in the positioning of the arrows on the sensory and relay neurons. Many candidates might have been awarded credit here if they had taken more care to locate the arrows unambiguously. Many candidates drew a correct arrow on the sensory neuron but then did not draw anything on the relay neuron.

(iii) Some flexibility was allowed in the positioning of either a label line or an arrow which needed to point to part of the spinal cord. In general, this question proved to be more challenging than had been expected for extension paper candidates.

(iv) It was essential that candidates answered this question by comparing reflex and voluntary actions in the context given. Large numbers of candidates answered with simple statements such as 'its quick' or 'it keeps you from harm' or 'it's to protect you from burning yourself' or 'you do not have to think about it'. Answers like these did not gain credit. Candidates needed to state, for example, that a reflex action 'is faster' or 'occurs in less time' than a voluntary action

(b)

(i) This was generally well known. The phrases 'red cells' or 'blood cells' were not sufficient to be awarded credit.

(ii) A great variety of figures were suggested in answer to this question. The most common incorrect response was 23, and there were quite a few candidates who suggested a figure of 11.5.

Question 5

(a)

(i) Most candidates gained credit here although some of the more able wrote unnecessarily long descriptions of particle speeds without actually referring to reaction rate. They then repeated their words in answer to **(ii)**.

(ii) The accuracy of candidates' responses to this commonly asked question continues to improve. Many candidates gained full credit with their clear descriptions of increasing particle speed which causes an increase in collision frequency or an increase in the chances of successful collisions. A significant minority of candidates described the particle interpretation of solid expansion on heating and described increased vibration and separation of the atoms in the piece of magnesium.

(b)

(i) Credit was awarded here relatively rarely. Reference to the lack of general reactivity or, more specifically, the lack of reaction with acids was needed for credit to be given. The fact that poly(ethene) containers are not brittle was also credited but very few candidates gave this as an answer.

(ii) Most candidates were acquainted with cracking but this question was concerned with the process in context, rather than the general chemical changes involved. Thus a relatively small number, who referred to heating of the saturated alkanes and then either contact with a catalyst or the application of high pressure, gained full credit. .

Question 6

(a)

(i) This proved to be fairly challenging for many candidates. It was not uncommon to see 6 A suggested for $\mathbf{A_4}$ although a majority gained partial credit for recognising that $\mathbf{A_1}$ would read 8 A.

(ii) Many candidates gave the required answer and also gave an acceptable version of the relationship between energy, power and time. A common mistake made by candidates was dividing power by time.

(iii) The award of full credit for a fully correct formula, working and a final answer of 1.5 Ω was relatively uncommon. Many candidates who clearly had practised parallel resistor calculations became distracted by the 4 Ω and 2 Ω resistors in series in the upper branch. It was very common to see all three resistors being treated as three resistors in parallel.

(b)

(i) Very few candidates stated that this is done to reduce energy losses during transmission. Some candidates were clearly aware of why high voltage is used but gave vague statements such as 'because there are energy losses' without any qualifying explanation that high voltage reduces these. Weaker candidates continue to think that voltage is stepped up so that 'there is enough electricity to go round all the houses' or 'so that the electricity is able to get through the whole length of the cables'.

(ii) Candidates generally were able to use the transformer equation to show that the ratio of primary to secondary turns was 1:24. Candidates were expected to reduce the ratio to its simplest form.

Question 7

(a) Most candidates gained at least partial credit for this question. Carbohydrate was not accepted as an alternative to starch and the product of amylase action on starch had to be maltose and not glucose or sugar. The majority of candidates had learned protein digestion very well and successfully identified protease, stomach and amino acids.

Alternative answers were pepsin and trypsin, but if these were given then the site of action had to match. An alternative to amino acids was polypeptide.

(b)

(i) Candidates needed to notice that only one advantage of white rice was required and that their answer had to be relevant particularly to growing children. Thus candidates needed to be selective in their answer and refer only to increased protein in white rice and then go on to state that this is important for growth. For this reason, some well-prepared candidates who spent time discussing all three food types and their general importance, did not answer the question asked, and were not able to gain credit. This question highlights how important it is that candidates realise that the number of lines provided for their answers is an indication of how much they should write.

(ii) Large numbers of fully correct accounts of Benedict's test were seen, although a common omission from Benedict's test was the requirement to heat the mixture. Frequently seen mistakes were descriptions, often fully correct but irrelevant, of the iodine and biuret tests.

(iii) The majority of candidates gained credit for reference to phloem. Very few went on to state that carbohydrate is transferred in the form of sugar, which, if named, had to be sucrose.

Question 8

(a)

(i) Most candidates gave a correct answer here.

(ii) This was an unusual question which most candidates seemed to think was far more difficult than it was. Only a minority gave the correct answer 89 followed by a reasonable explanation for their choice. A reasonable explanation in this case was one that referred to the Periodic Table and made some correct reference to information shown in it. The incorrect answers and reasons were rather revealing, and often suggested that the four alternative values in the question had been matched to the four sectors of the pie chart. Thus some candidates suggested 89 'because it was the third highest number'. Other candidates carried out some kind of calculation based on the way that some pie charts are constructed. Some candidates suggested 139 or 1089 'because the Periodic Table is incomplete; there may be some elements that remain to be discovered'. Some candidates may have understood what was required but their answers did not show it. Thus some made the unsupported statement that 'there are 92 elements so take away the three shown in the chart makes 89'.

(b)

(i) Many candidates correctly referred to the need for ionic mobility in the molten aluminium oxide and they had to state ions rather than particles, atoms or molecules. Alternatively, candidates were awarded credit if they stated that aluminium has to be molten if it is to become a conductor or electrolyte. Some candidates incorrectly suggested that electrons flow through the melt.

(ii) This was answered well by many candidates who discussed the attraction between opposite electrical charges. Candidates needed to state clearly that the anode is positively charged.

(iii) This was a challenging question; yet some of the more able candidates showed mastery of electrolysis theory and were awarded full credit. Credit was available for the following; for stating that aluminium (ions) gained electrons and oxygen/oxide (ions) lost electrons, for associating the correct number of electrons with the elements and for any reasonable logical connection with the six electrons. Many other candidates made excellent attempts and gained some credit. Some attempted to answer as if it was a bonding question concerned with explaining why the formula of aluminium oxide is Al_2O_3. Others could not quite adapt their knowledge to the context and simply wrote, for example, about oxygen 'needing two electrons'.

Question 9

(a)

(i) Most candidates made an acceptable reference to the high penetration of gamma radiation. A relatively common mistake was to develop the way in which gamma killed microbes in the food.

(ii) This question presented few difficulties and the majority of candidates gained credit. Some candidates changed their minds after having made their initial deletions and their final answers were often very difficult to interpret.

(iii) Most candidates correctly discussed the importance of containing the radiation to protect the workforce. Statements such as 'so the radioactive source does not get out' or 'so radiation cannot get out of the source' suggested that the candidate understood the general idea of the question but that they needed to be more careful in their choice of words.

(b)

(i) This question was reasonably well answered with candidates being awarded credit for correct references to any suitable method of detecting radiation. There were a disturbing number of examples of candidates suggesting that the scientist should conduct an experiment either on themselves or on laboratory animals.

(ii) Credit was available for a discussion of the lack of unstable nuclei/atoms within the food. Most candidates stated that gamma passes straight through the food and does not remain inside it.

COMBINED SCIENCE

Paper 0653/32
Extended Theory

Key Message

Candidates need to consider carefully what is being asked for in each question, and make sure that their answer is relevant and of appropriate length, answering the question asked, and providing relevant detail.

General Comments

Some good scripts were seen from candidates who had mastered all aspects of the syllabus, and who demonstrated good examination technique. Candidates tended to write answers of appropriate length but some, often those who had prepared themselves very well, ignored the number of answer lines and the mark allocation. These candidates all too often gave answers which contained much correct but irrelevant detail. In physics questions involving the use of a formula leading to a numerical answer, credit cannot be awarded if incorrect symbols or symbols reserved for units are used to represent the formula. Candidates should also avoid using a mixture of words and symbols when they are writing formulae or chemical equations. Credit cannot be awarded if numerical answers have inappropriate or missing units. This paper contained some questions which required candidates to apply their knowledge in relatively unfamiliar contexts, and it is likely that questions like this will feature in future papers.

Comments on Specific Questions

Question 1

(a)

(i) The majority of candidates correctly identified carbon dioxide.

(ii) Candidates gaining full credit stated that the test with acid shows the presence of a carbonate of some kind but the presence of calcium would also need to be confirmed. Some gained credit for recognising that carbonate is present but then suggested that this would be enough to identify limestone. Answers such as 'there is not enough evidence because there may be other rocks which give the same result' were not accepted.

(b)

(i) Credit was awarded if candidates referred to increased acidity of seawater. Further credit was more rarely awarded but was available for explaining that the acidity was caused by the reaction between carbon dioxide and water. Candidates could state that carbon dioxide dissolved in water to cause acidity but 'mixing' was not accepted as an alternative to dissolving or reacting. Another way that candidates could gain credit was to state that non-metal oxides are acidic, but this was rarely seen.

(ii) Candidates needed to come up with a reasonable idea which involved scientific principles. General statements such as 'the acidity kills fish and plants' were not accepted. Creditworthy answers involved the chemical damage to the material of the reef or the biological harm to the living coral.

Question 2

(a) The equation for respiration was well known. Although the question clearly asks for the word equation, some candidates from across the ability range gave the balanced equation complete with +38 ATP on the product side. This was accepted but candidates should always be advised to answer the question as is set, as credit will only be given for a completely correct symbolic equation in this situation. Candidates should also avoid writing a mixture of words and formulae. The terms 'carbohydrate' or 'sugar' were not accepted as alternatives for 'glucose'.

(b) The role of blood, red blood cells, haemoglobin, arteries and capillaries had been very well learned and if candidates made a sensible reference to two of these they received full credit. Use of the term 'blood vessels' or 'veins' was not accepted, and neither were 'blood cells' or 'red cells'.

(c)

(i) For full credit, candidates needed to refer to the evaporation of sweat and the idea that it is evaporation that uses or takes heat from the body. Some candidates described a process in which sweat picks up body heat and conveys it out of the body simply by moving through pores, but unless their answers were firmly based on the role of evaporation no credit could be awarded.

(ii) It was common to award partial credit to candidates who stated that in the absence of drinking during the race, the body temperature got higher. Answers had to be comparative. Thus candidates needed to state that the absence of drinking caused body temperature to be higher rather than simply high. A minority of candidates correctly stated that in the absence of drinking, the body temperature rose at a faster rate. Sensible use of numerical data taken from the graph could also have secured credit. Thus candidates who made statements similar to 'when the athlete drank fluids her body temperature rose to a higher value, it was a maximum of 40 °C without drinking and only 38.7 °C with drinks' received full credit. Candidates often expressed their answers in a way that contradicted the data available from the graph. For example several stated the idea that 'when she did not drink fluids her body temperature increased, but with drinks her temperature decreased'.

(iii) The award of full credit for answers to this question was very rare. Some candidates gained partial credit for making the connection between drinking fluids and increased levels of sweating. Further credit was available for reasoning, based on the principle of homeostatic maintenance of water levels in the body, explaining why sweating would be much reduced in the absence of drinking. Many candidates made no connection between this question and sweating. They assumed that the drinks referred to were energy drinks and then tried unsuccessfully to match up increased temperature with the effect such drinks would have on respiration rates.

Question 3

(a) Candidates needed to refer to the air layer trapped within the yak's fur and that this air layer provides insulation or prevents convection currents removing the warm air layer. Only a minority mentioned the air layer but many gained credit for reference to the insulation provided by the fur. A number of candidates ignored the fur altogether and discussed the insulation provided by fat layers. As the question asked about yak hair, this reference to insulation did not score. Less well-prepared candidates gave answers that lacked any reference to scientific principles.

(b) Credit was available for stating that the use of yak dung as a fuel would reduce fossil fuel use, and that yak dung is renewable. Candidates could also have stated that the burning of yak dung would not lead to a net increase in atmospheric carbon dioxide. However, many simply suggested that yak dung does not produce carbon dioxide, or that it produces less carbon dioxide than kerosene. Others suggested that kerosene would be more prone to incomplete combustion with release of carbon monoxide, or more likely to produce sulfur dioxide leading to increased amounts of acid rain. These ideas did not gain credit.

(c)

(i) The allowed range here was 20 Hz to 100 Hz. Credit was not awarded if the unit was missing, but the great majority of candidates did state correct units. If a candidate suggested ‘below 20 Hz’ or ‘above 20 Hz’, again credit was not awarded.

(ii) A simple reference to sound waves was not enough. Candidates needed to discuss the passing on of vibrations via air particles. A clear diagram accompanied by a reference to compression and rarefaction would also have been awarded credit.

Question 4

(a) Most candidates gained credit here. The relatively small number of incorrect answers included some elements that were not present in the tabulated data.

(b)

(i) In general, candidates were successful in constructing and then balancing this equation.

(ii) It was very important that candidates answered this question comparatively. Thus the statement ‘aluminium is very reactive’ did not receive credit, but ‘aluminium is more reactive than carbon’ did gain credit. The better prepared candidates received full credit, without the need for extended writing, by stating simply that ‘aluminium is more reactive than carbon and tin is less reactive than carbon’. Partial credit was allowed for the single statement that ‘aluminium is more reactive than tin’. A few candidates referred to the stronger bonds between aluminium and oxygen and this also gained credit.

(iii) Better prepared candidates had learned the process of aluminium extraction very thoroughly and large numbers of them gave complete answers. A number of candidates wasted time and answer space by including the formation of oxygen atoms at the anode. Any suggestion that the electrolysis involved an aqueous electrolyte was not credited.

(c)

(i) Candidates generally were able to calculate the relative formula mass of this unfamiliar compound. Candidates should be reminded that relative formula mass carries no units or could be followed by a.m.u. although this is not required. Many candidates wrote g or g/mol but these were ignored and not penalised on this occasion.

(ii) This simple percentage calculation presented few problems for most candidates although some omitted the units.

Question 5

(a)

(i) Stigma and anther were recognised by a majority of candidates. Stamen was accepted as an alternative for anther, but filament was not.

(ii) Candidates could have described the feathery appearance of the stigma or the exposed position of the stigma and anther on the outside of the flower. They could also have referred to the absence of or small size of petals. In general, this part of the syllabus had been learned very well and a majority of candidates received credit here.

(iii) This question was well answered by many candidates. References to sexual reproduction involving gametes, fertilisation and a zygote all gained credit. Candidates needed to be careful in the way they referred to variation in sexual reproduction or the lack of variation in asexual reproduction. It was essential that they discussed 'genetic variation', or used the term 'clone'. Many candidates discussed differences in the number of parents / parent organisms required, but this was not accepted. A number of candidates strayed outside the plant context of the question and suggested answers that included references to animal genitals.

(b) This was well answered by many candidates who referred to the formation of acid rain when nitrogen oxides reacted with water in the atmosphere. They needed to make it clear that acid rain formation was the result of a reaction between the nitrogen oxides and water in order to receive full credit. The environmental effects of acid rain were well known. A few candidates had learned of some of the harmful effects of gaseous nitrogen oxides in respiratory systems and where appropriate, credit was given for these.

Question 6

(a) Most candidates had learned how to define the term *tissue*.

(b)

(i) Most candidates were able to state that protease digests protein and that amino acids are the result of that process. Polypeptide was an alternative for protein but not amino acid.

(ii) Many candidates correctly used the term 'diffusion' in their answers, but the award of further credit for a reference to a concentration gradient was much less common. Osmosis was not accepted as an alternative to diffusion.

(c) Most candidates realised that the answer to this question involved referring to the characteristics of cells. The differences between animal and plant cells had been well learned and large numbers of candidates were awarded full credit.

Question 7

(a)

(i) The most common mistake, which was made by many, was to state that only switch 2 needed to be closed.

(ii) A surprising number of candidates simply re-drew the incorrect circuit diagram given in the question. Some of these candidates included additional components such as switches and, more seriously, lamps in their circuits.

(b)

(i) This was generally answered very well. Candidates should avoid stating that high voltage is used to reduce ‘power losses’ or ‘electricity losses’. They need to state clearly that ‘energy’ or ‘heat energy’ losses have to be kept low. Less well-prepared candidates suggested that high voltage ensures that there will be enough electricity to go round all the users, or that ‘it’ will move quickly enough to get through all of the cable.

(ii) The majority of candidates had been very well prepared for this transformer calculation and large numbers were awarded full credit. The required answer was 800 000 (turns) although this had to be accompanied by relevant, clear working. Vague, or incorrect versions of the formula used to calculate the answer were not awarded credit; neither was vague working.

(iii) Some candidates wrote remarkably well-expressed and fully correct summaries of the principles involved in transformer operation. Most others found it either very difficult or impossible to explain the science of what happens. Many candidates did not receive credit on this question. Candidates were prompted in the question to use the phrases, ‘magnetic field’ and ‘induced voltage’, but these had to be part of a broadly correct sequence of events. Candidates who gained full credit referred to the need for alternating current in the primary, which set up a changing magnetic field in the core which then induced a voltage in the secondary coil. Candidates could also gain credit by linking the size of the induced voltage to the number of turns on the secondary coil.

Question 8

(a)

(i) A good selection of the many ways that methane occurs was seen. Acceptable suggestions could refer to petroleum (crude oil) and natural gas, decomposition of organic matter, emissions from animals and volcanism although no candidates showed awareness of the latter. Responses that were not accepted included the single words ‘oil’ or ‘waste’.

(ii) This was slightly different from the usual dot/cross diagram question in that candidates were asked to state the number of outer electrons of carbon within the methane molecule. Many forgot to do this and many others gave the number of outer electrons in an uncombined carbon atom. Their fully correct dot/cross diagrams could only then be awarded partial credit.

(b)

(i) Both of the words in the term ‘fractional distillation’ were required. Common mistakes were ‘cracking’ and ‘heating’.

(ii) There were two possible responses to this question. Of those candidates who gained credit, most referred to the relationship between molecular size and boiling point. A minority noticed that unsaturated molecules had lower boiling points than similarly sized saturated compounds and were credited for this. Molecular size was often expressed in terms of number of bonds in the molecule. This was usually accepted but very often these candidates then incorrectly stated that the higher temperature would be needed to break the bonds.

(iii) Many candidates were familiar with the use of bromine although fewer explained that hydrocarbon **D** was unsaturated. ‘Bromide’ was not accepted as an alternative for bromine but ‘bromination’ was. A common mistake was the perfectly logical suggestion of measuring the boiling point, but the question asked for a chemical test.

Question 9

(a) A reasonable number of candidates wrote the correct formula but many then went on to obtain an incorrect answer because they forgot to calculate the force provided by all four of the jet engines.

(b)

(i) Candidates were required here to make a reasonable attempt to answer the question using scientific detail. They needed to include a clear statement about the need to avoid reactions involving the potato chips. Thus answers such as 'to prevent chips going stale' or 'to extend the sell-by date' did not score.

(ii) All that candidates needed to state was that the pressure inside the packet was greater than the pressure outside. Some well-prepared candidates wrote lengthy answers about the gas laws but never quite explained why the packet in this context would expand. Others wrote rather vague statements which involved the term 'atmospheric pressure'. Statements such as 'the pressure in the aircraft is not atmospheric' are simply repeating the question context.

(c)

(i) Many candidates had learned the text-book statements, 'speed is a scalar and velocity is a vector'. Some able candidates also wrote that 'speed has magnitude but velocity has both magnitude and direction'. Any reasonable attempt to convey these ideas was accepted.

(ii) Candidates could either have given **A** – **B** or **C** – **D**, although the great majority of opted for **A** – **B**. It was important for candidates to identify a <u>region</u> of the graph and so single letter answers such as **A** or **B** did not score.

(iii) Candidates had to recognise that the curved rather than linear nature of the graph over their stated region in **(ii)** showed that acceleration was not constant. Many candidates gained credit although it was not uncommon to see answers such as 'the acceleration is not constant because the speed is changing'.

(iv) The majority of candidates correctly identified point **C**.

(v) Most candidates correctly identified 50 as the numerical value required, but many omitted the units.

(vi) Many candidates knew that the scientific principle involved in this question concerned balanced forces. However, candidates need to be aware that it is not sufficient to make statements such as 'the air resistance equals gravity' or 'the air resistance forces become the same as the force of gravity'. It is essential that they find a way to explain that these forces are operating in opposing directions. The simple idea that the forces are balanced, or equal and opposite, received credit. Further credit was for explaining that as the speed of fall increased, the air resistance would also increase. Many stated that the forces would eventually balance but this was not sufficient for the award of further credit.

(vii) All that candidates needed to state here was that the open parachute increased air resistance. Many candidates described how an open parachute has a larger surface area without going on to explain the effect this has on the forces involved.

COMBINED SCIENCE

Paper 0653/33
Extended Theory

Key Message

Candidates need to take care that they do not spend valuable examination time repeating parts of the question in their responses.

General Comments

Some excellent scripts were seen from candidates who demonstrated sound knowledge of the syllabus sections tested, and also demonstrated good examination technique. The majority of candidates had clear handwriting and provided answers of appropriate length. Some candidates needlessly repeated parts of the question in their response, resulting in them running out of space. There is adequate space provided on the exam paper for written answers. Some candidates responding to the physics questions used incorrect symbols in answers requiring a formula. The omission of units from the final answers of physics calculations was also evident, but fewer candidates than previous years did this. Candidates should be reminded that labelling lines on biological diagrams should touch the structures concerned and leave no space.

Comments on Specific Questions

Question 1

(a)

(i) Diagrams showing random and sparsely arranged particles of the same size in a gas were drawn correctly by the majority of candidates. Some candidates across the ability range gave good responses in their diagram of a liquid. The liquid particles had to be of the same size, in an irregular arrangement, with the majority of particles touching. Some candidates did not achieve full credit due to particles showing a wide variation in size, not enough of the particles touching, or a regular arrangement of particles.

(ii) Candidates across the range were able to state that the forces between liquid molecules are stronger than between gas molecules. Fewer elaborated on this point to describe the attractive nature of these forces. Many candidates also included information about the particles in a solid. This was not required.

(b)

(i) The vast majority of candidates correctly stated that the colour white reflects radiation well, or is a poor absorber of radiation. Incorrect responses included answers that referred solely to light, or referred to white surfaces as poor emitters of radiation.

(ii) Most candidates correctly described either the good conducting qualities of the metal in the base of the saucepan, or the insulating properties of the pan handle. Candidates should be reminded to use the terms conductor or insulator correctly in their responses.

(iii) This was a well answered question. Most candidates gained full credit, indicating a good understanding of convection and its causes.

Question 2

(a)

(i) Most candidates labelled the cells correctly. Candidates should be reminded to make labelling lines touch the structures concerned. In this case the lines had to touch both the cell and the correct part of the plant. A significant number of candidates from across the full range did not answer this question, though perfect responses were given to **(a)(ii)**. Careful reading of the question might have enabled candidates to avoid errors.

(ii) This question was answered well, with most candidates correctly identifying the chloroplast and its function to trap light energy and carry out photosynthesis. The fact that the root is underground, and therefore not in the light was a further marking point.

(iii) This section was well answered across the range. An incorrect identification of the cell in **(a)(i)** meant credit could not be gained in this section.

(b)

(i) Candidates generally knew the correct answer for this but some incorrectly gave the answer for phenotype in symbols rather than words. The allele **R** is showing complete dominance over the allele **r** so 'pink' was not a correct response for the heterozygous phenotype.

(ii) This part was answered well by most candidates.

(iii) Most candidates correctly predicted the ratio of 3:1 red to white.

(c) The idea that asexual propagation produces offspring that are genetically identical was correctly given in many cases. Candidates could also mention the variation that results from sexual propagation as well as the uncertainty and time taken for germination of seeds to gain further credit, enabling most candidates to score well in this section.

Question 3

(a)

(i) Most candidates wrote the names of the two gases, oxygen and hydrogen, and many identified them correctly. Candidates should be reminded that a formula is not acceptable when a name is requested in the question. The gases produced must arise from the available chemicals, therefore carbon dioxide, a response given by many candidates, was clearly incorrect.

(ii) An error carried forward was allowed here for those candidates who answered **(a)(i)** incorrectly provided the gas and the test were correct. Candidates should be reminded that the test for hydrogen involves the use of a lighted splint; the test for oxygen needs a glowing splint.

(b)

(i) Many candidates provided a correct word equation. Other candidates wrote the equation as a formula and therefore did not gain credit. They should be reminded that when a word equation is requested, formulae are not acceptable. Although most candidates correctly gave sulfuric acid as a reactant there were many who incorrectly gave potassium oxide as the name of the alkali.

(ii) A description of a practical method was needed here. An error carried forward was allowed for those candidates who had written potassium oxide in **(b)(i).** Excellent answers were seen from some candidates. Candidates are expected to know that when both reactants are contained in aqueous solutions, neutrality is not achieved by adding excess of one reactant as might be the case when neutralising an acid with an insoluble carbonate. Addition of a suitable indicator and careful addition of one reactant to another is the appropriate method. There is, of course, no solid reactant to filter as suggested by some candidates.

(iii) The ionic equation was given correctly by the more able candidates. Candidates should be reminded that only the hydrogen and hydroxyl ions are needed to react to produce water.

Question 4

(a)

(i) Most candidates answered this correctly, naming beta radiation.

(ii) Three types of radiation were needed to obtain the credit available, namely gamma radiation, infra-red radiation and ultraviolet radiation. Many candidates correctly identified only two of these.

(iii) The uses for gamma radiation were generally well known. The wide range of correct answers included sterilising applications, radiotherapy and use as tracers. Most candidates gained credit here.

(iv) This question was answered well by the majority of candidates, showing good knowledge of the properties of the three types of radiation.

(b) Most candidates answered correctly that the pattern showed a decrease in radiation over time. Further explanation, identifying the half-life as 14 days, would have enabled full credit to be scored.

Question 5

(a)

(i) Most candidates responded correctly, stating that there was no hydrogen present. It was not sufficient to say that fluorine was present in the molecule.

(ii) The bonding diagram was successfully completed by most candidates. Candidates should remember that, in order to gain full credit, the non-bonding electrons in the outer shells of the fluorine atoms should be included in the diagram in addition to the electrons in the covalent bond.

(iii) Candidates generally found this question challenging. It was necessary to draw the C_4F_8 section of the molecule showing all the single bonds, and include some detail to indicate that the molecule continued at either end of the section. Many candidates omitted this last point.

(b)

(i) Most candidates correctly predicted that fluorine would be a gas but a description of the trend of increasing boiling point down the group was needed in addition, to gain full credit. A description of the trend was frequently omitted by candidates across the full range of ability.

(ii) About half of the candidates correctly predicted that no displacement reaction would take place because bromine is less reactive than fluorine. As in **(b)(i)** a general statement about the reactivity trend down the complete halogen group, in addition to a simple comparison of the reactivities of fluorine and bromine, would have received full credit.

Question 6

(a) The stomach was labelled correctly by almost all candidates. Some candidates were less familiar with some the position of the colon.

(b) The pancreas, the liver and the salivary glands were the most popular correct answers, though other correct responses were credited. The most frequently seen incorrect response was a labelling of the lung.

(c) Many candidates gained full credit, referring to the action of pepsin on protein and the role of hydrochloric acid in providing the acidic environment for this to take place. Responses relating to the churning action of the stomach, the role of hydrochloric acid in killing bacteria and general reference to enzymes were not credited. Candidates should aim to select the most relevant points and avoid writing everything they know about the topic being tested.

(d)

(i) The majority of candidates understood the meaning of biological control and, by making the suggestion to add more predatory wasps, correctly used the information in the given food web to provide their answer.

(ii) Most candidates provided correct answers. Candidates that gave two variations of the harmful effects of pesticides on other organisms were only credited once; for full credit, the examples given had to be substantially different to each other.

Question 7

(a) Most candidates gave good answers in this question, stating that calcium oxide and water react exothermically. Further credit was available for describing the subsequent heat transfer to the coffee. Many candidates simply stated that heat given out by the reaction made the coffee hot, which was not enough to gain credit.

(b)

(i) Most candidates correctly stated that calcium is in Group 2, or has two outer electrons and that these are lost during chemical reaction. Fewer developed this to mention that there are then two more protons than electrons to produce the positive charge.

(ii) Most candidates correctly showed the need for charge balance in the compound therefore giving OH^- as the correct answer. Candidates should be reminded that 'swap and drop' is not credited as an explanation in this type of question.

Question 8

(a)

(i) Most candidates correctly identified **X** as the voltmeter and **Y** as the ammeter. It should be emphasised to candidates that certain misspellings of technical terms cannot be ignored by the Examiner. Thus the words voltameter and ampmeter were not credited.

(ii) Many candidates found this challenging. The obvious response 'To vary the resistance of the circuit' is simply a repetition of the name of the component, and was not credited. Neither was the idea that the variable resistor is a safety device. Credit was given to those candidates who stated that the role of the variable resistor is to vary the current in the circuit or to cause the voltage across **R** to vary; the statement 'To change the voltage running through the resistor' rather than 'To change the voltage across the resistor' was not credited.

(iii) This question produced many excellent responses. Candidates are reminded to provide the correct symbols when writing formulae. Thus $V = IR$ received credit, but $V = AR$ and $V = CR$ were not acceptable. The correct units are required in the answer. An answer alone was not credited; the correct calculation had to be shown along with the correct numerical answer.

(b) Some candidates received only partial credit here because they calculated the reciprocal of the combined resistance and did not complete the calculation.

(c)

(i) The majority of candidates correctly responded that the coil would spin in the opposite direction.

(ii) The vast majority of candidates correctly responded that the coil would rotate faster.

(iii) This question was well answered only by the most able candidates. Many candidates confused the motor with the generator in their responses. Credit was given for responses describing the need to maintain the coil spinning in the same direction. Further explanation, including making the current change direction in the coil, or keeping the force on the coil in the same direction, enabled full credit to be obtained. Candidates had to make it clear that it was the current in the coil that was being reversed, and not in the main circuit.

Question 9

(a) This question was well answered by the majority of candidates who correctly identified walking along the road, walking across the road and crossing the road more quickly as voluntary actions and jumping in response to the car horn as the only reflex action.

(b) Most candidates gained credit for describing the speed of reflex actions as an advantage. 'They are safer' or 'They happen without thought' were not credited without further explanation in this part of the question. Many candidates then correctly described a disadvantage of reflex actions as being that they are not controlled and can have undesirable or unsafe consequences.

(c) The main role of a receptor as detecting the stimulus was correctly given by many candidates. An environmental change was required here and 'collects information' was not credited.

Many candidates correctly stated the role of the motor neurone as transmitting the nerve impulse to the effector. Use of the term 'impulse' was required, though 'signal' was allowed; 'message' was not credited.

COMBINED SCIENCE

Paper 0653/51
Practical Test

Key Messages

- Candidates should be able to read the display of a timing device and convert the display into seconds.

General Comments

Only a very small number of candidates did not complete the paper. The level of English in the responses was generally very good and there were few instances of a candidate misunderstanding a question.

Comments on Specific Questions

Question 1

This question worked well and candidates obtained useful results. The discrepancy between the test in the Centre Instructions and the Question Paper, regarding the volume of hydrogen peroxide solution, did not affect the results.

Many candidates simply copied the display of their stopwatch or stop clock without converting to seconds as instructed. This is an essential skill which was required in all questions on this paper. A pop sound was sometimes reported in **(a)(i)**; this was accepted along with relighting of the splint but the conclusion that this was due to hydrogen gas was not accepted. Averaging the times in **(a)(iii)** was usually done well, as was the completion of the table. Many candidates were able to compare the difference between the results for the fresh yeast and boiled yeast in **(b)(ii)**; fewer could explain this in terms of the enzyme being denatured by boiling. Reliability of the results in **(c)(i)** was not always well understood; some candidates erroneously tried to explain reliability in terms of fair testing whilst others did not realise that if their results were similar then they were reliable. The most common errors quoted in **(c)(ii)** were associated with timing and the amount of detergent not being controlled. Other acceptable responses about errors were rarely seen and an error in measuring the volume of a liquid was only accepted if accompanied by a discussion of the accuracy of the scale of the measuring device.

Question 2

The order of decomposition of the three carbonates varied from Centre to Centre but the mark scheme allowed for this and candidates were in no way penalised for an unusual order. Recording of the time for decomposition was an issue in some cases as in **Question 1** and a small number of candidates recorded the changes in the limewater rather than any colour change to the carbonate as instructed. Parts **(a)(iii)** and **(a)(iv)** proved straightforward for most. Due to unreacted acid in **(b)(i)**, it was necessary to add plenty of dilute sodium hydroxide to obtain a blue precipitate. Some candidates obtained a blue precipitate and then recorded it in an inappropriate way, such as “blue mass” although they often mentioned a blue precipitate as evidence in **(b)(iii)**. The displacement reaction in **(b)(ii)** worked well allowing many to use the brown colour on the zinc as a piece of evidence for the identification of copper in **(b)(iii)**. The metal **X** was often given as copper(II) or copper carbonate.

Question 3

The majority of candidates produced all fifteen results in the results table. Recording of the time for 10 oscillations was an issue in some cases as in **Question 1**, resulting in marking point 5 in **(a)** not being awarded. In addition many candidates gave the time to hundredths of a second when the instruction in **(a)(i)** told the candidates to record the time to 0.1 second. Averaging of the time for 10 oscillations was generally good. The calculation of the period, **T**, only required the average to be divided by ten; many candidates produced odd answers here and there were a number of rounding errors too. The calculation in **(c)** was not carried out as well as expected: the main errors were the use of 30 cm instead of 0.30 m for the length, using a length not equal to 0.30 m, not squaring the period, **T**, or not rounding the value of $\mathbf{T}^2$ appropriately. In **(d)**, most candidates understood the reason for timing 10 oscillations rather than 1 oscillation.

COMBINED SCIENCE

Paper 0653/52
Practical Test

Key Messages

- Candidates should be prepared to use their results and calculations to describe and explain general conclusions.

General Comments

Only a very small number of candidates did not complete the paper. The level of English in the responses was generally very good and there were few instances of a candidate misunderstanding a question. Measurements were made to a suitable level of accuracy and graph plotting was usually well done.

Comments on specific questions

Question 1

Centres and candidates coped well with how agar's properties can vary under different conditions of temperature. Candidates were expected to be able to read the display of a timing device and convert the display into seconds. Calculations of volumes and ratios generally presented no difficulties; a few candidates did not calculate the ratios as instructed. Many understood that the acid had neutralised the alkali but fewer included diffusion in their answer. In **(a)(v)** candidates were expected to use the results and calculations in **Table 1.1** to describe and explain the relationship between volume and time. There was some confusion between time and speed with frequent use of the phrase *faster time*. *Faster speed* was allowed as an alternative to *lower time*. It was pleasing that many candidates were able to suggest a source of error in **(b)**.

Question 2

Test **(a)** worked well to give ammonia gas in the majority of cases. Test **(b)(i)** required careful addition of sodium hydroxide to produce a precipitate before it dissolved in excess reagent. Descriptions of the precipitate as *milky* or *cloudy* were not accepted, especially as the correct terminology is given in the Chemistry Practical Notes on the last page of the Question Paper. However, such descriptions did not prevent candidates from being awarded credit for identifying zinc as the ion. The same marking system was applied to **(b)(ii)** and **(b)(iii)**, which were well done. Surprisingly many candidates were unable to convert their conclusions into the names of the 2 salts. Often 2 zinc salts or 2 ammonium salts were given. Sometimes the name of a cation and an anion were given and, if correct, this was awarded credit; 2 cations or 2 anions were not credited.

Question 3

This exercise required perhaps greater precision than many practicals. Consequently it was relatively rare to see outstanding sets of results. There were many examples of sound results and this allowed most candidates to plot good graphs. The reading with an angle of incidence of 80^{o} was the most challenging one and in some cases this resulted in too low a displacement which had an effect on the value of $\boldsymbol{d_{90}}$. There were very few graphs with non-linear axes although several candidates did not allow for the extrapolation to 90^{o} when constructing the vertical scale for displacement. The instructions made it clear that candidates should draw the best curve through their points and many did this; some drew straight lines which were not credited and others drew a series of curves which were credited if the points had sufficient spread to justify this. It was felt that this was fair as candidates would not know the relationship between the angle of incidence and the displacement. Extrapolation was usually carried out competently and only in some cases was the extrapolation "forced" to give a particular value of $\boldsymbol{d_{90}}$. The most common sources of error quoted were the 80^{o} reading being hard to carry out and lining up of the pins being difficult. Vague answers describing bent or leaning pins were only credited if they also stated that this would make lining up of the pins inaccurate.

COMBINED SCIENCE

Paper 0653/61

Alternative to Practical

Key Message

This paper is firmly associated with experience at the laboratory bench so candidates need to be able to demonstrate practical skills.

General Comments

Many candidates demonstrated their practical knowledge. Others showed poor appreciation of the principles and practice of science, especially in the chemistry questions, **2** and **5**. Candidates need to be reminded to read each question carefully; otherwise they may use incorrect units or give irrelevant information in their answers.

The number of significant figures is an area where candidates need to consider their answer, in general it should be the same as in the question or table, so, if 1.75 was already in the table all other answers should be similar e.g. 2.40 or 2.00. Zeros are important as they are a sign of accuracy. Rounding must also be correct; the calculator readout of 1.666666666 may be written as 1. 667, 1.67, 1.7 or even 2, depending on the precedent, but never as 1.66 or 1.6.

Comments on Specific Questions

Question 1

(a)

(i) Most candidates correctly converted the time to seconds.

(ii) Many identified the gas as oxygen.

(iii) Given the closeness of the times an answer of 57.67 or 57.7 was expected.

(iv) Many candidates realised that the enzyme had been denatured, expressions such as the enzyme was 'killed' or 'was not working properly' were not credited.

(b)

(i) Answers suggesting that the liver had not been heated thoroughly or that not all the enzyme had been denatured were credited.

(ii) Surface area of the liver, volume of detergent used or concentration of hydrogen peroxide solution were credited.

Question 2

(a) The reading of the stopclock dials and the subsequent listing of carbonates in their speed of decomposition were both done well.

(b)

(i) The minimum required for the diagram was a funnel with a filter paper lining and a receptacle of some kind to catch the filtrate. Some candidates diagrams had a piece of filter paper hanging in mid-air with no funnel to support it. A significant minority drew distillation apparatus.

(ii)(iii) Candidates familiar with chemical analysis had no difficulty in identifying copper and its compounds. Some candidates appeared to have little laboratory experience and gave incorrect answers.

(c) A number of candidates drew the bubbles above the level of the liquid rather than from the metal; however credit was given if the correct comparisons were stated.

(d) The question asked if the reactivity of the metals could be used to predict the speed of thermal decomposition of the carbonates, many candidates said 'no' instead of noting the inverse relationship; the more reactive the metal the slower the decomposition of the carbonate.

Question 3

(a) Candidates were required to read protractors for three angles and transfer them with the corresponding times to a table. Most candidates did this correctly however some ignored the labelling of the angle to be measured and read the protractor incorrectly. The times recorded were for ten swings, the final row of the table required these numbers to be divided by 10 to find the time for one swing. Most candidates did this correctly, but a significant number had answers that Examiners were unable to work out how they were calculated. Candidates are reminded that they should show their working. Most candidates then went on to calculate the average for their figures.

(b) The times in the table showed no pattern and were all within expected experimental error. Some candidates tried to see patterns that were not there.

(c) Most candidates realised the need to repeat the experiment to make the result more reliable, but taking the average was also required.

(d) Candidates had to convert the length of the pendulum, in centimetres, to metres. Although most candidates did this correctly, some candidates gave an answer of 30 000 m.

(e) The acceleration due to gravity was calculated using a formula supplied. Most candidates did this, although some did not square the denominator value shown by the formula.

Question 4

(a) Brown and blue / black were well known, although some candidates wrote these in the incorrect order.

(b) After reading the stopclocks candidates had to plot a graph on a grid with the scales already chosen and axes labelled. Most graphs were plotted correctly and smooth curves drawn as instructed. Some candidates drew a straight line or a series of straight lines and these were not credited. The enzyme was most active when the time was the lowest, a pH range of 6 to 7.

(c) Two improvements to the experiment in order to find a more accurate pH value were asked for. Answers that suggested taking readings more frequently, for example every 10 seconds, and using pH values between 6 and 7, for example 6.5 were credited with the explanation that either improvement would allow narrowing down the endpoint.

Question 5

(a) Some candidates could not picture what would happen if a gas-jar of soluble gas was opened in water as shown in the diagram. The expected answer, that some of the water would rise up the gas-jar, was not often seen. The explanation of resulting pressure difference being responsible was rarely seen.

(b) Use of an indicator to identify acidic and alkaline gases was reasonably well known, but as there are a number of indicators, any colours given for an unnamed indicator cannot receive credit. Similarly red litmus paper turning blue is acceptable as a test for an alkaline gas; red litmus staying red will not test for acidic gases as neutral substances would not change the colour either.

(c)(d) The tests for oxygen and hydrogen are reasonably well known, but it must be a glowing splint for oxygen and a lighted splint for hydrogen.

(e) By careful study of the original key, more able candidates could name ammonia and sulfur dioxide.

Question 6

(a) Candidates had to measure the lengths of two pieces of resistance wire. Most candidates gave correct answers within the required +/-0.1 mm tolerance.

(b)

(i) Almost all candidates knew that the ammeter should be in series and the voltmeter in parallel.

(ii) Most candidates were able to correctly read two analogue dials showing voltage and current, however a significant number gave 0.45 V instead of 4.5 V.

(iii) Candidates had to remember that resistance is found by dividing the voltage by the current, or they may have worked it out by looking at the example given, either way, this question presented few problems.

(c) Candidates answers indicated that they were sometimes confused by the comparative resistances of thick and thin wires, and long and short wires. Candidates should be aware that the thinner and longer the wire a greater resistance.

COMBINED SCIENCE

Paper 0653/62
Alternative to Practical

Key Message

This paper is firmly associated with experience at the laboratory bench so candidates need to be able to demonstrate practical skills.

General Comments

Many candidates demonstrated their practical knowledge. Others showed poor appreciation of the principles and practice of science, especially in the chemistry questions, **2** and **5**. Candidates need to be reminded to read each question carefully; otherwise they may use incorrect units or give irrelevant information in their answers.

The number of significant figures is an area where candidates need to consider their answer, in general it should be the same as in the question or table, so, if 1.75 was already in the table all other answers should be similar e.g. 2.40 or 2.00. Zeros are important as they are a sign of accuracy. Rounding must also be correct; the calculator readout of 1.666666666 may be written as 1. 667, 1.67, 1.7 or even 2, depending on the precedent, but never as 1.66 or 1.6.

Comments on Specific Questions

Question 1

(a)

(i) A significant number of candidates did not convert the readings to seconds even though the instruction, in seconds, was emboldened.

(ii) Most candidates understood that neutralisation had taken place, but very few mentioned that the acid had to travel into the block.

(iii) Using the volumes and surface areas already in the table candidates were given a formula to calculate the surface area to volume ratio. Candidates were expected to use this formula, and give the answer as a decimal number.

(iv) Most candidates noted that the time similarly decreased, but few explained that the distance the acid had to travel was less.

(b) Candidates had to use the practical results obtained to explain the role of diffusion in the real world of the human ileum, a diagram was provided to remind them of the structure of the villi in the ilium. A number of points were credit-worthy; a large blood supply, thin cell walls, a large surface area, the large number of villi present and the diffusion distance being small.

Question 2

(a)(b) The tests described in **Question 2** are standard chemical analysis tests, and it is expected that candidates have experience of carrying them out in the laboratory. A significant number of candidates described unlikely colours and gave unlikely outcomes. Candidates should be aware that ammonia is an alkaline gas that turns red litmus blue and that zinc ions will form a white precipitate with aqueous sodium hydroxide that dissolves in excess. The standard tests for sulfate ions with acidified barium chloride solution and chloride ions with acidified aqueous silver nitrate should also be known.

(c) Candidates had already been informed that zinc ions and ammonia, hence ammonium ions were present, but most were unable to name these.

(d) Very few candidates were able to give the correct equation using standard chemical symbols.

Question 3

(a) Candidates were required to measure distances and angles on the diagram; almost all candidates measured accurately. There were a small minority who did not appear to have the equipment to do this.

(b) Examiners note that graph plotting is a skill that has been mastered by most candidates. Errors of plotting are few and far between, but some candidates are not correctly labelling axes or supplying units. When asked to show on the graph how a value was obtained, candidates are reminded to draw proper construction lines.

(c) Many candidates completed the sentence with the required word, width. Some candidates gave actual values, and this often meant the sentence then made no sense when read.

Question 4

(a) Candidates were required to measure the field of view of a microscope. A ruler was shown and had to be used. Some candidates incorrectly used their own ruler.

(b) Candidates drawing more than one cell did not receive credit. Some candidates added features not visible in the original figure, and this was also not creditworthy. Some incorrectly copied the cell diagram from part **(c)**. Subsequent calculations were well done by many candidates.

(c) Given a diagram of a cell, candidates were asked to label a structure not in an onion cell. Most were able to identify a chloroplast and gave the correct reason, onion cells do not photosynthesise, for their absence. Similarly many identified the vacuole as being the structure present in onion cells but not visible in the earlier figure.

Question 5

(a) Some candidates did not name an indicator that could be used to investigate the neutralisation of sodium hydroxide by fruit juices. Incorrect answers of sodium hydroxide, iodine and Benedicts were the most common seen. Universal Indicator was not allowed as it has no distinct end point. Litmus, methyl orange and phenolphthalein were the most common accepted answers. Many did not name sodium citrate as the name of the salt produced.

(b) Candidates were shown three burettes with the level of acid remaining shown, and had to read off how much acid had been used. Following some simple calculations candidates were asked to put the fruit juices in order of the amount of acid they contained and this was carried out well.

(c) Two values were required, the volume of juice used and the concentration of the sodium hydroxide solution. The words volume and concentration were required in the candidates answers to gain credit as the word 'amount' is too vague and imprecise.

Question 6

(a) Four metals were heated and the expansion measured. Candidates had to read scales and complete a table; most did this correctly.

(b) Candidates had to explain why the expansion of the bar is actually one tenth of the value on the scale. Candidates had to realise that when the zero adjuster moves 1 mm, the scale will move 10 mm, or that the pointer arm is 10 times as long as the zero adjuster arm, and that movement of the pointer is 10 times larger.
Candidates who did not score here could still gain credit in part **(ii)**. As the scale read in cm was ten times the actual increase then the same numerical value, but now in mm, gives the expansion.

(c) The order was well understood by stronger candidates, however some weaker candidates did not realise that 0.07 is smaller than 0.1.

(d) Most candidates realised that particles vibrate in a solid, but few could explain that heating gives energy to the atoms thus they collide with each other more, thus pushing the particles further apart.

COMBINED SCIENCE

Paper 0653/63
Alternative to Practical

Key Message

This paper is firmly associated with experience at the laboratory bench so candidates need to be able to demonstrate practical skills.

General Comments

Many candidates demonstrated their practical knowledge. Others showed poor appreciation of the principles and practice of science, especially in the chemistry questions, **2** and **5**. Candidates need to be reminded to read each question carefully; otherwise they may use incorrect units or give irrelevant information in their answers.

The number of significant figures is an area where candidates need to consider their answer, in general it should be the same as in the question or table, so, if 1.75 was already in the table all other answers should be similar e.g. 2.40 or 2.00. Zeros are important as they are a sign of accuracy. Rounding must also be correct; the calculator readout of 1.666666666 may be written as 1. 667, 1.67, 1.7 or even 2, depending on the precedent, but never as 1.66 or 1.6.

Comments on Specific Questions

Question 1

(a)

(i) Many candidates correctly identified the bubbles to be made of oxygen or carbon dioxide and that they were passing through the pores or stomata, fewer however mentioned that the heat from the water was making the gas expand thus being forced out.

(ii) It was evident from the answers written that some candidates had not followed the instructions and therefore had difficulty in telling which squares had been counted and which not.

(iii) Many candidates were unable to correctly convert cm^2 to mm^2.

(iv) Candidates who wrote answers relevant to stomata and water loss gained credit, for example the upper surface is hotter, in direct sun, with more wind movement, it is less humid, there is more water loss, therefore more wilting. References to photosynthesis were not credited.

(b) The xylem was shown as a series of circles, but many candidates shaded other areas leaving the circles blank. Candidates are reminded that while perfection is not expected, care is required when drawing or annotating diagrams.

Question 2

(a) Many candidates were able to give the colour change from green to yellow / orange, however some did not read 'weak' and gave red as the end colour. Few were able to name the acid as carbonic.

(b)

(i)(ii) When carbon dioxide is bubbled into limewater a white precipitate forms; as more gas is bubbled through, the precipitate disappears and the liquid becomes colourless. It appears that few candidates have witnessed this reaction as even though the equations were given later on in the question, only a small number gained credit for this part.

(iii) The state symbols are well known to many. No credit was given when 'liquid' was given for the symbol **(aq)**. Others incorrectly gave answers such as 'gram' and 'sulfur' for **(g)** and **(s)** respectively.

(iv) Given the information in the question, very few candidates completed the sentence using the word 'precipitate'.

(c) The two correct statements, **B** and **C**, were identified by most.

Question 3

(a) Candidates were required to read ammeter and voltmeter dials and to calculate the resistance produced when 1, 2, 3 and 4 wires were connected in parallel. This was done well by most candidates.

(b)

(i) Some candidates did not label the graph axes. Point plotting was almost always accurate, but when asked for a smooth curve, some candidates drew straight lines and were not awarded credit.

(ii) To find the resistance of five wires candidates had to extend their graph and read off the value; although one or two candidates produced unlikely extrapolations, most did this correctly.

(c) Most candidates realised the need to repeat the experiment to make the result more reliable, but taking the average was also required.

Question 4

(a) As explained in the general comments above the value for 1/time for 55 °C should be recorded as 0.50 and not 0.5.

(b) A grid already labelled was supplied for candidates to plot a graph. The plotting of points was done accurately. This graph was unusual as some of the points were far from each other, Examiners therefore accepted curves that were far from ideal, but extra thick lines or graphs drawn with more than one line were rejected. There was a very obvious high point; the optimum temperature of 50 °C. When asked to explain why they could not be sure that this was the optimum temperature, the expected answer of not knowing the rate either side of 50 °C, was not always seen.

(c) Many candidates could not explain why the results between 35 and 45 °C were increasing and why they were decreasing between 55 and 60 °C. An answer relating to particle theory; particles gaining (kinetic) energy, moving faster or there being more collisions and enzymes being denatured at higher temperatures was expected.

(d) It was suggested that two further test-tubes should be set up. From the answers given candidates had not checked what was in the original test-tubes or did not appreciate what the experiment was trying to show. Test-tube **1** was to check if acid was required for the reaction to occur and test-tube **2** was to see if the pepsin was necessary.

Question 5

(a)

(i) Any suitable solvent received credit; water, ethanol, propanone etc., but not any acid.

(ii) The volume of liquid added should not cover the spots of ink on the start line; many lines were seen well above this at the very top of the paper.

(iii) Many candidates incorrectly wrote about 'things' entering the container, rather than the problem of the solvent evaporating.

(iv) Times suggested by candidates were often far too short, answers above 30 minutes were accepted.

(b) There were many acceptable conclusions that candidates could use when comparing the pairs of inks, and most candidates gained some credit.

(c) Many candidates did not answer this question in the way expected, but they were able to gain full credit for their answers. The expected answer was to cut the spot out of the paper and add hydrochloric acid to it, look for a colour change then add sodium hydroxide and look for a different colour change. Most candidates expected the spot to turn red in acid and blue in alkali even though many other indicators have different colour changes.

Question 6

(a) to (d)

Candidates had to construct lines on the diagram, measure them and calculate the refractive index of fresh water and salty water. Candidates that followed instructions and measured accurately received credit in these parts. Some candidates misread the instructions, and then drew incorrect lines. These candidates were able to gain some credit if their calculations were correct. Some candidates had difficulty in measuring both their lines and the pre-drawn one.

(e) Due to refraction, light is bent away from the normal as it leaves the surface of the water so the fish is deeper than the bird sees it and so it has to aim below where it appears. In salty water as the refractive index is greater than in fresh water and the bird has to aim even deeper. A large number of candidates incorrectly stated that the light was entering the water from the bird to the fish.