COMBINED SCIENCE

Paper 0653/11
Multiple Choice (Core)

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

General comments

When answering a question, candidates may write on the question paper if that helps them to formulate an answer: for example, crossing out an incorrect cell, column or row in a table.

Comments on specific questions

Question 1

Most candidates correctly identified that cars cannot reproduce a similar version of themselves. However, many then thought that cars could not release energy by breaking down energy-rich molecules. The energy-rich molecule here was the fuel (e.g. petrol or diesel). Candidates needed to look at a range of non-living items and identify why they are not living, using the characteristics of living organisms.

Question 2

This question was challenging for many candidates. Candidates need to carefully check what the end of the label line is touching. In this case it was the cell wall, which maintains the shape of the cell. The label line was not touching the cell membrane.

Question 5

Most candidates answered this question correctly. Some candidates chose option **B**. This indicated that they thought glucose was needed for photosynthesis, rather than a product of photosynthesis.

Question 6

Most candidates answered this question correctly. Options **A** and **B** were the most frequently chosen incorrect answers. Large molecules need to be broken down into small molecules for them to enter the cell. The breakdown of glucose to release energy occurs inside the cell.

Question 7

Candidates needed to read this question very carefully before committing to an answer. The pulmonary vein carries blood to the heart from the lungs. Candidates needed to carefully locate the “to” and “from” in the question.

Question 9

Most candidates found this question challenging. Only a few candidates correctly recognised that *both* roots and shoots respond to gravity. The Earth itself is the source of the gravitational field on Earth, so roots display positive gravitropism by growing downwards (i.e. ‘towards’ gravity, in the same direction as the gravitational field), and shoots display negative gravitropism by growing upwards (i.e. ‘away from’ gravity, in the opposite direction to the gravitational field).

Question 13

This question was challenging for many candidates. Many candidates chose the correct answer, but many others chose **C**, which was the death of the plant and not decay of the dead plants.

Question 14

Candidates chose the incorrect **A** and **B** more often than they chose the correct answer, **D**. Stronger candidates were able to use chemical symbols to distinguish different types of substances.

Question 15

Candidates chose the incorrect option **C** more often than they chose the correct answer, **D**. For chromatography, the ink spot must be placed above the level of the water, not below it.

Question 20

Candidates chose the incorrect option **B** more often than they chose the correct answer, **A**. They should be able to interpret experimental data, whether presented in a table or in graph form, to identify the reaction with the greatest rate. Many candidates chose the reaction which produces the greatest volume of gas instead.

Question 21

Candidates chose the incorrect options **A** and **B** more often than they chose the correct answer, **C**. Stronger candidates knew the effect of dilute sulfuric acid on metal carbonates and metal hydroxides, and that copper nitrate, a product of a neutralisation reaction, and copper do not react with dilute acids.

Question 22

Candidates chose the incorrect option **B** more often than they chose the correct answer, **A**. They clearly knew the test for chloride ions, but some candidates thought that zinc ions, not iron ions, form a green precipitate with aqueous sodium hydroxide.

Question 23

Only the strongest candidates answered this question correctly. Candidates need to know that vertical columns in the Periodic Table are called groups, and that horizontal rows are called periods.

Question 24

Only stronger candidates answered this well. These candidates knew that catalysts increase the rate of a reaction, and that transition elements, such as iron, often act as catalysts.

Question 25

Many candidates incorrectly chose options **A** or **C**. Stronger candidates understood the use of carbon in the extraction of copper from copper oxide.

Question 29

Here many candidates calculated density by dividing the mass by the length of one side of the cube rather than its volume.

Question 30

Few candidates recognised that a constant speed is related to zero resultant force, and all options were chosen by significant numbers of candidates.

Question 33

Many candidates thought that evaporation causes the temperature of the remaining liquid to increase. Candidates could use the example of human sweat as a way of correctly remembering this concept.

Question 34

The most common misconception here was that convection occurs in solids and liquids but not gases (option **D**).

Question 35

This question on waves required candidates to decide which of the given information was needed. This was in fact only the distance travelled in one second, but many candidates either divided this value by the wavelength, or divided the wavelength by the amplitude, to obtain option **A**.

Question 39

Only stronger candidates were able to identify from the circuit shown an ammeter and a voltmeter, the quantities they measure, and the units for these quantities. All incorrect options were popular.

Question 40

Candidates were required to use the equation for resistance to calculate the current in a simple circuit and then to choose the most suitable fuse to use. Very few could do this, with many candidates choosing option **C**, which is obtained by dividing the resistance of the resistor by the p.d. of the cell.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice (Core)

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

General comments

When answering a question, candidates may write on the question paper if that helps them to formulate an answer: for example, crossing out an incorrect cell, column or row in a table.

Comments on specific questions

Question 4

Most candidates answered this question correctly but some thought that the test for starch was Benedict's solution. Errors in food tests are common and should be revisited as part of candidates' preparations for their exams.

Question 5

This was often answered well. However, some candidates chose 70°C as the optimum temperature for enzymes in the human body. Candidates needed to read the question carefully and note that the question stated the enzyme works in the human body.

Question 8

Whilst many candidates answered this correctly, other options were chosen by a significant percentage of candidates. Large molecules need to be broken down into small molecules for them to enter the cell. The breakdown of glucose to release energy occurs within the cell.

Question 9

Many candidates answered this correctly, but many candidates chose the pulmonary vein. Care needed to be taken to locate the “to” and “from” in this question.

Question 10

This was usually answered well. However, some candidates identified that breathing rate or pulse rate had increased, but not both. Candidates need to be reminded that adrenaline prepares the body for fight or flight. Both of which require energy from respiration. Breathing and pulse increase to supply oxygen for respiration. This link was made by stronger candidates.

Question 11

Most candidates identified the correct response for asexual reproduction. However, some candidates thought that a zygote was produced by asexual reproduction and that the offspring were different from their single parent.

Question 12

This question was usually answered well. Where candidates did not chose the correct option, they had dismissed the style and chose either of the other two options (stamen and ovary).

Question 13

Candidates answered this question well. Most candidates who chose an incorrect option picked **C**, which was the death of the plant and not decay of the dead plants.

Question 14

Most candidates identified the diagram that represented a gaseous element.

Question 16

A significant number of candidates chose the incorrect option **B** rather than the correct answer **C**. Candidates need to be able to identify physical and chemical changes and understand the differences between them.

Question 17

Only stronger candidates knew the products of the complete combustion of hydrocarbons and were able to balance symbol equations.

Question 21

This was challenging for many candidates. Stronger candidates knew that dilute acids have pH values of less than 7 and that they react with metal carbonates to form carbon dioxide, a colourless gas.

Question 22

This question was challenging for almost all candidates. Many did not know the test for chloride ions or the test for iron ions.

Question 24

Candidates chose the incorrect option **D** more often than the correct answer, **C**. Only stronger candidates knew that although both transition metals and transition metal compounds can act as catalysts, only ionic compounds can be electrolysed.

Question 26

Most candidates knew that chlorination and filtration are used in water treatment. Some candidates did not know that cracking is used to make alkenes from fractions obtained from petroleum.

Question 28

This question involved understanding a speed−time graph. More candidates chose option **D** rather than the correct option, **A.** This was possibly because this showed a constant value of speed. Although this also represented a constant acceleration, the question specified that the acceleration must not be zero.

Question 29

Here very many candidates calculated density by dividing the mass by the length of one side of the cube rather than its volume.

Question 32

The most common misconception here was that convection occurs in solids and liquids but not gases (option **D**).

Question 33

This question on waves required candidates to decide which of the given information was needed. This was in fact only the distance travelled in one second, but a large proportion of candidates apparently either divided this value by the wavelength, or divided the wavelength by the amplitude, to obtain option **A**.

Question 34

This question was challenging for a large number of candidates, with many believing that the image of the object is formed at position **A**.

Question 37

Many candidates either thought that opposite charges repel (leading to option **B**) or believed that like charges do so (leading to the correct option **D**). Only the strongest candidates answered the question correctly.

Question 39

In this question on an electrical circuit many candidates did not recognise that the ammeter records the current in both lamps, leading them to think that the current stays the same when lamp Y is switched off (option **C**).

Question 40

The topic here was resistors in series and parallel. Slightly more candidates chose option **C** rather than the correct option **A**, not understanding that two resistors in parallel have a lower combined value of resistance than either on its own.

COMBINED SCIENCE

Paper 0653/13
Multiple Choice (Core)

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

General comments

When answering a question, candidates may write on the question paper if that helps them to formulate an answer: for example, crossing out an incorrect cell, column or row in a table.

Comments on specific questions

Question 3

This was often answered well. However, some candidates chose 70°C as the optimum temperature for enzymes in the human body. Candidates needed to read the question carefully and note that the question stated the enzyme works in the human body.

Question 4

More candidates chose the correct option than any of the others, but all options were chosen by a significant percentage of candidates. Some candidates chose the large intestine as the region of the digestive system associated with egestion. If the arrow had been pointing to the rectum or anus this would have been more likely.

Question 5

Most candidates answered this question correctly. Other candidates chose option **A** or **B**. Large molecules need to be broken down into small molecules for them to enter the cell. The breakdown of glucose to release energy occurs within the cell.

Question 7

Most candidates answered this question well. However, a significant number of candidates opted for answer **C** (the reverse of the correct answer). Candidates will benefit from experience of using this apparatus.

Question 9

Most candidates identified the correct response for asexual reproduction. Some candidates thought that a zygote was produced by asexual reproduction and that the offspring were different from their single parent.

Question 10

Most candidates answered this correctly and identified the anther as the place where pollen was produced. Where candidates chose the incorrect answer, they chose option **C**.

Question 11

Most candidates answered correctly but a significant number of weaker candidates thought that fertilization takes place in the ovaries.

Question 12

Most candidates answered correctly. Some weaker candidates chose decomposers.

Question 16

This question proved challenging for many candidates. Only stronger candidates knew know that metals, rather than non-metals, react with acids to form hydrogen gas, and that non-metallic elements combine to form covalent compounds.

Question 18

Candidates chose the incorrect option, **A** more often than the correct answer, **B**. Candidates should be able to describe the electrode products, using inert electrodes, in the electrolysis of concentrated aqueous sodium chloride.

Question 19

This question was challenging for many candidates. They were expected to know the meaning of exothermic and endothermic and describe the changes that occur in such reactions.

Question 20

Candidates chose the incorrect option **A** more often than the correct answer, **B**. Stronger candidates were able to describe practical methods for investigating the rate of a reaction which produces a gas.

Question 24

Many candidates found this question challenging. They needed to know that transition metals often act as catalysts, and that these elements have high melting points and high densities, and as they are metals, they all conduct electricity well.

Question 26

Candidates chose the incorrect **D** more often than the correct answer, **A**. Although they recognised that methane is a greenhouse gas, they were also expected to know that carbon dioxide, and not methane, is a product of the complete combustion of hydrocarbons.

Question 28

Few candidates could calculate the average speed of an object from its speed−time graph and choose the correct option **C**. Many candidates chose option **B** (the initial speed), or option **A** (half of the initial speed).

Question 29

There was confusion over the concept of mass, weight and gravitational field strength. Many candidates multiplied weight by *g* or divided *g* by weight to determine the mass.

Question 30

Here, many candidates calculated density by dividing the mass by the length of one side of the cube rather than its volume.

Question 34

The most common misconception here was that convection only occurs in gases.

Question 35

This question on waves required candidates to decide which of the given information was needed. This was in fact only the distance travelled in one second, but a large proportion of candidates either divided this value by the wavelength, or divided the wavelength by the amplitude, to obtain option **A**.

Question 40

A number of candidates believed that the purpose of a fuse is to maintain the correct voltage across an appliance.

COMBINED SCIENCE

Paper 0653/21
Multiple Choice (Extended)

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

General comments

When answering a question, candidates may write on the question paper if that helps them to formulate an answer: for example, crossing out an incorrect cell, column or row in a table.

Comments on specific comments

Question 1

Only stronger candidates answered this well. Candidates need to be reminded that the line touches the item being labelled. In this case it was the cell wall, and its function is to maintain the shape of the cell. The label was not touching the cell membrane.

Question 2

Most candidates answered this question correctly. Some candidates thought that the ciliated cells produce mucus.

Question 3

This was often answered well. However, some candidates chose 70°C as the optimum temperature for enzymes in the human body. Candidates needed to read the question carefully and note that the question stated the enzyme works in the human body.

Question 4

Most candidates answered this question well. Many weaker candidates chose option **B**. This indicated that they thought that glucose was needed for photosynthesis, rather than a product of photosynthesis.

Question 7

Candidates found this question challenging and all incorrect options were chosen by significant percentages of candidates. Stronger candidates worked out what caused the drop in water uptake by linking the uptake to transpiration at the leaves. Candidates typically did less well with questions involving plants. Candidates must ensure that they adequately prepare themselves for plant topics.

Question 9

Stronger candidates answered this question well. Weaker candidates often chose option **B**, that adrenaline is transported in the red blood cells. A review of blood components and their functions may better prepare candidates for this style of question.

Question 10

Stronger candidates correctly identified the position of the anther. Many weaker candidates chose option **C**. Candidates need to revise the position and description of the of the stigma.

Question 11

Most candidates identified the correct response for asexual reproduction. Some candidates thought that a zygote was produced by asexual reproduction and that the offspring were different from their single parent.

Question 12

Most candidates answered this question correctly. However, option **A** was chosen by some candidates. These candidates did not recognise the direction of the arrows going to and from the fetus. In this case the umbilical artery is coming from the fetus to the mother.

Question 17

Candidates chose the incorrect options **C** and **D** more often than the correct answer, **B**. Some did not know the formula for lead(II) nitrate, and that ionic equations do not include spectator ions.

Question 18

This question was challenging for almost all candidates and answers were spread across all four options. Candidates needed to understand electrolysis in terms of the ions present and the reactions at the electrodes.

Question 20

Candidates were expected to be able to identify an oxidising agent as a substance that oxidises another substance, but many candidates found this challenging. In this question, the iron(III) oxide, the oxidising agent, causes the aluminium to be oxidised.

Question 22

Candidates chose the incorrect option **B** more often than they chose the correct answer, **A**. They clearly knew the test for chloride ions, but some candidates thought that zinc ions, not iron ions, form a green precipitate with aqueous sodium hydroxide.

Question 23

Some candidates answered this correctly using knowledge of the group trends but option **C** was chosen by many candidates.

Question 24

Option **D** was a common incorrect choice for this question. Candidates were expected to know the effects of catalysts, and that transition elements, such as iron, often act as catalysts.

Question 29

Although a large majority of candidates could calculate weight from mass and gravitational field strength, many of these did not take into account that *g* was one quarter of its value at the Earth's surface, leading them to choose option **D**.

Question 30

Some candidates realised that the resultant force is zero, but others confused resultant force with the weight of the raindrop, and so chose **B**.

Question 32

This question involved candidates using the formulae for gravitational potential energy and kinetic energy to calculate speed. Few candidates could do this, and a large majority multiplied the height by *g* to produce option **C**. The mass was not given in the question as it is not needed, but this possibly caused confusion if candidates did not realise that it cancelled.

Question 34

The most common misconception here was that convection occurs in solids and liquids but not gases (option **D**).

Question 35

This question on waves required candidates to decide which of the given information was needed. This was in fact only the distance travelled in one second, but many candidates either divided this value by the wavelength, or divided the wavelength by the amplitude, to obtain option **A**.

Question 36

This question was challenging for many candidates. Although a majority knew that the image is virtual, few were aware on which side of the lens it is formed.

Question 37

Most candidates could identify a compression and a rarefaction, but others thought that the wave was transverse.

Question 39

Here most candidates carried out the correct calculation to determine the time taken, but a large majority of these did not convert the time to seconds, leading them to choose option **D**.

COMBINED SCIENCE

Paper 0653/22
Multiple Choice (Extended)

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

General comments

When answering a question, candidates may write on the question paper if that helps them to formulate an answer: for example, crossing out an incorrect cell, column or row in a table.

Comments on specific questions

Question 1

Most candidates answered this well. However, some candidates thought that the cell in the diagram differed from other animal cells as it contained cytoplasm. Candidates would benefit from looking at how cells are shown in exams by looking at diagrams from past papers.

Question 2

This was often answered well. However, some candidates chose 70°C as the optimum temperature for enzymes in the human body. Candidates needed to read the question carefully and note that the question stated the enzyme works in the human body.

Question 3

Most candidates answered this correctly. Some weaker candidates chose option **B**. This may be because the word digestion was in the stem of the question.

Question 5

Many candidates found this question challenging. Weaker candidates chose option **B**. This may be because they were thinking that the humidity was how moist the soil was rather than atmospheric humidity. A drop in atmospheric humidity would have increased water uptake. Stronger candidates worked out what caused the drop in water uptake by linking the uptake to transpiration at the leaves. Candidates typically did less well with questions involving plants. Candidates must ensure that they adequately prepare themselves for plant topics.

Question 8

Most candidates identified that human male gametes have flagella and are produced in large numbers. However, some chose the option suggesting that they also had energy stores. This is a feature of the human female gamete.

Question 9

Most candidates answered this question well and correctly identified the response for asexual reproduction. Some weaker candidates thought that a zygote was produced by asexual reproduction and that the offspring were different from their two parents.

Question 10

This question was often answered well. Some candidates thought that the pollen was deposited on the ovary.

Question 12

Most candidates answered this question correctly. Weaker candidates often discounted option **A** and chose either option **C** or **D**.

Question 16

This was a challenging question for many candidates. They were required to know that metal atoms form cations and that non-metal atoms form anions.

Question 18

Candidates chose the incorrect option **B** more often than the correct answer, **C**. They are required to understand electrolysis in terms of the ions present and the reactions at the electrodes.

Question 20

Although stronger candidates often answered correctly, many candidates found this question challenging. They are required to know the effect of changing temperature in terms of the frequency of collisions between reacting particles and the number of colliding particles possessing the minimum energy (activation energy) to react.

Question 23

Only the strongest candidates answered this question correctly. They are required to know that while both transition metals and transition metal compounds can act as catalysts, only ionic compounds can be electrolysed.

Question 30

Very many candidates knew the basic shape of the graph, but many of these did not identify the correct direction of the curve and so chose option **C**.

Question 31

Few candidates could calculate power, with many simply multiplying the two values given, to produce option **B**.

Question 34

This question on waves required candidates to decide which of the given information was needed. This was in fact only the distance travelled in one second, but a significant number of candidates either divided this value by the wavelength, or divided the wavelength by the amplitude, to obtain option **A**.

Question 35

This question was challenging for a large number of candidates, with many believing that the image of the object is formed at position **A**.

Question 37

A very large proportion of candidates could identify a compression and a rarefaction, but many thought the wave to be transverse.

Question 40

Many responses to this question were correct, but a common error was to divide the power by time rather than multiplying, leading to option **C**.

COMBINED SCIENCE

Paper 0653/23
Multiple Choice (Extended)

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

General comments

When answering a question, candidates may write on the question paper if that helps them to formulate an answer: for example, crossing out an incorrect cell, column or row in a table.

Comments on specific questions

Question 2

This was often answered well. However, some candidates chose 70°C as the optimum temperature for enzymes in the human body. Candidates needed to read the question carefully and note that the question stated the enzyme works in the human body.

Question 4

Most candidates answered correctly. Weaker candidates incorrectly discounted fatty acids then chose one of the remaining options.

Question 5

This question was challenging for some candidates. Most stronger candidates chose the correct option, but weaker candidates chose other options. Candidates should have worked out what caused the drop in water uptake by linking the uptake to transpiration at the leaves. Candidates typically did less well with questions involving plants. Candidates must ensure that they adequately prepare themselves for plant topics.

Question 6

Most candidates found this question straightforward. However, some weaker candidates chose option **B**, that mucus prevents friction between the air and the trachea.

Question 7

This was often answered correctly. Some weaker candidates chose option **B**, which was the balanced chemical equation for photosynthesis.

Question 10

Most candidates identified the correct response for asexual reproduction. However, a significant number of candidates thought that a zygote was produced by asexual reproduction and that the offspring were different from their single parent.

Question 12

Most candidates chose the correct response. Most weaker candidates chose option **A** as the correct answer (central vacuole). These candidates may have confused the jelly coat on the diagram with a plant cell wall. This may have caused a misconception where they applied the labels for a plant cell to the female gamete.

Question 15

There was a mixed response to this question which required candidates to understand that the R_f value of a dye is calculated as the distance moved by the dye divided by the distance moved by the solvent from the original position of the dye.

Question 16

Candidates understood very clearly what is meant by the term mixture, and how a mixture differs from an element and from a compound.

Question 25

Many candidates answered this correctly. Weaker candidates did not know that transition metals often act as catalysts, and that these elements have high melting points and high densities, and as they are metals, they all conduct electricity well.

Question 27

Candidates knew the definition of a hydrocarbon very well.

Question 28

A common mistake in calculating the average speed of the object was to halve the initial speed (option **A**).

Question 29

Here, as many candidates chose the inverse of the correct expression for spring constant as chose the correct one.

Question 30

A common error was to divide the pressure by the area to determine the force, rather than multiplying, leading to option **A**.

Question 31

Most candidates answered this question correctly, but others did not include the value of *g*, so chose **C**.

Question 33

Only stronger candidates knew that the source of the energy in natural gas is the Sun, with many others choosing geothermal.

Question 36

This question on waves required candidates to decide which of the given information was needed. This was in fact only the distance travelled in one second, but a significant number of candidates either divided this value by the wavelength, or divided the wavelength by the amplitude, to obtain option **A**.

Question 37

A very large proportion of candidates could identify a compression and a rarefaction, but many thought the wave to be transverse.

Question 39

The most popular incorrect response here was **C**, which is produced by dividing the current by the time.

COMBINED SCIENCE

Paper 0653/31
Core Theory

Key messages

Candidates should be encouraged to read each question very carefully to ensure that they answer exactly the question that is being asked.

Recall of syllabus terms is an important part of this subject and candidates need to be able to explain a syllabus term and also be able to recall the syllabus term when a description is given.

General comments

Some good responses were seen in this paper, with a number of candidates showing a sound understanding of the Core syllabus. Candidates were generally good at the recall and use of equations.

Candidates should be guided by the number of marks available for the question. **Questions 6(b)(iii)** and **7(b)(ii)** both required fuller answers than those given by most candidates.

Candidates had difficulty in interpreting graphical questions on this paper. In **Question 1(b)** and **Question 6(c)(i)** a wide variety of incorrect responses were seen.

Comments on specific questions

Question 1

(a) (i) A common mistake was to label the larynx, **A**, as the trachea or oesophagus. **B** is the intercostal muscles. A number of candidates incorrectly identified **B** as the ribs themselves.

(ii) The majority of candidates recognised that this was the heart and that its function is to pump blood around the body. A few candidates gave a function more appropriate to part of the digestive system, perhaps misidentifying **X** as the stomach.

(b) (i) Many candidates correctly extracted the correct answer, 4 breaths, from **Fig. 1.2**. There were many different incorrect answers seen suggesting that some candidates had difficulty in interpreting the figure.

(ii) Many candidates recognised that the breathing rate increased during exercise. These candidates also realised that the depth of breathing increased, but some candidates found it difficult to express this clearly. Saying that the person breathed more heavily does not clearly indicate deeper breaths.

(c) Only stronger candidates were able to fully complete the correct word equation for respiration. A number were confused between photosynthesis and respiration, putting glucose as a product.

Question 2

(a) (i) Most candidates recognised that carbon was the reactant here and gained at least partial credit. A common error was to include either water or oxygen as a product, often omitting copper.

(ii) Almost all candidates gained at least partial credit and stronger candidates generally answered well.

(iii) Candidates who correctly identified reduction here often provided a creditworthy explanation, such as “oxygen is removed”. Simply adding that “oxygen is reduced” was not a sufficient explanation. A number of candidates did not realise that this was reduction.

(b) (i) Very few candidates correctly identified electrolysis as the method of extracting aluminium from bauxite. A wide range of incorrect answers was seen.

(ii) Many candidates gained full credit here, recognising that aluminium atoms have 13 electrons and 14 neutrons.

Question 3

(a) (i) The majority of candidates correctly identified that between 5s and 15s the man was not moving.

(ii) Many candidates placed an **X** between 0 and 5s gaining credit here. The most common error was to place the **X** between 15 – 25s not realising that the slope of the graph is less steep in this latter section, indicating a slower speed than between 0 – 5s.

(iii) The majority of candidates gained credit here. Those who did not get the correct final answer often gained partial credit for showing working which included either the total distance travelled or recall of the formula for calculating speed.

(b) The majority of candidates correctly calculated the mass of the man as 80 kg. A common error was to multiply weight by gravitational field strength.

(c) (i) Many candidates gained full credit here.

(ii) Many candidates were not able to apply the principle of conservation of energy to this example and recognise that if less useful work is done then some energy has been wasted or lost to the surroundings as, for example, thermal energy.

Question 4

(a) (i) The majority of candidates correctly identified **Z** as the cell wall.

(ii) Many candidates described the change in shape/size of the cell and gained partial credit here. A few stronger candidates recognised that water was leaving the cell.

(b) (i) Some candidates correctly identified the xylem at the centre of **Fig. 4.2**. A number of candidates identified phloem instead. A few candidates made no attempt to answer the question.

(ii) Many candidates correctly identified the function of root hair cells as the absorption of water and/or mineral ions. Candidates sometimes incorrectly suggested that root hair cells transport water through the plant.

(iii) This question asked candidates to identify the processes by which water vapour is lost from plant leaves by evaporation from the surfaces of the mesophyll cells and then diffusion through the stomata. Only the strongest candidates correctly identified both processes. A common incorrect answer was to repeat transpiration from the stem of the question.

(c) (i) Many candidates correctly identified the chloroplasts as the structures inside plant cells in which photosynthesis takes place. A few candidates gave the answer “leaf”, which is part of a plant but not a structure inside the plant cells.

(ii) Many candidates recalled that oxygen is produced in photosynthesis. The common mistake was to confuse photosynthesis with respiration and to incorrectly suggest carbon dioxide is the gas produced.

Question 5

(a) (i) There were some correct answers, but many candidates incorrectly thought that oxygen makes up 78 per cent of the air. Other incorrect answers included carbon dioxide and hydrogen.

(ii) There were many correct answers to this part, and these candidates knew that oxygen must be present for rusting to occur.

(iii) The most common creditworthy responses here mentioned carbon monoxide and a link to breathing difficulties. Very few candidates mentioned oxides of nitrogen or sulfur dioxide. Carbon dioxide and a reference to global warming was a common incorrect response.

(iv) Only the strongest candidates gained full credit here. CO_2 was the most common correct answer and was often the only correct response included. A number of candidates wrote names and not formulae as required by the question.

(b) Most candidates gaining credit here were able to produce a fully correct dot-and-cross diagram. Partial credit was sometimes gained with correct hydrogen-oxygen bonds.

(c) Few candidates correctly recalled that water turns blue cobalt(II) chloride pink. An insufficient response seen several times was “there will be a colour change”. Candidates needed to be precise in describing the effect to gain credit.

Question 6

(a) (i) Stronger candidates realised that the separation of molecules decreased as more air is pumped into the tyre.

(ii) This question asked candidates to make the connection between an increase in temperature and an increase in the speed of the molecules. Many candidates correctly responded that speed increases. A few candidates gave the answer that there is “more movement” which was not enough to imply an increase in speed.

(b) (i) Only the strongest candidates gave the correct answer of radiation here. Thermal/heat energy was a common incorrect answer with other candidates suggesting conduction, convection or light energy.

(ii) Candidates were expected to consider how the hat prevents heat transfer, through the reflection of radiation or because the hat is a poor conductor.

(iii) To gain full credit here, candidates needed to mention that the sunscreen is blocking or filtering out ultraviolet radiation, which causes sunburn.

(c) (i) Candidates had great difficulty in using the figure to determine the wavelength; the distance between the same point on successive waves.

(ii) Some candidates correctly identified that a louder ring means a bigger amplitude of the wave. Other candidates incorrectly thought that the wavelength or frequency would change too.

Question 7

(a) This was correctly answered by most candidates.

(b) (i) Stronger candidates correctly identified an oviduct on the diagram as the place where fertilisation takes place. Many candidates incorrectly labelled the uterus.

(ii) To gain full credit here, candidates needed to realise that structure **P** is an ovary. A lot of candidates answered this question as though it were about the uterus and specifically about the uterus during menstruation. The most common answer to gain partial credit was for the idea that an egg is released.

(iii) This question was answered well by the majority of candidates. A common incorrect response for zygote was fetus, and the most common incorrect response for ovum was nucleus. Many candidates correctly identified sperm.

(c) Candidates showed good knowledge of ways of preventing the transmission of HIV. They needed to be very careful about language here though. Some answered in terms of using contraception which is not necessarily a way of preventing HIV transmission unless it is a barrier contraceptive such as a condom.

Question 8

(a) Many correct answers were seen here, but a few candidates talked about colour changes rather than the change in pH.

(b) (i) Here an answer in terms of elements being more metallic towards the left and more non-metallic towards the right of a period was expected. A number of candidates tried to answer in terms of reactivity, or the number of electrons in the outer shell of an atom.

(ii) For this question, as with the previous one, candidates were being asked to describe a trend. Many found this challenging. A few candidates also incorrectly described the reverse trend, i.e. reactivity decreasing as you go down the group.

(iii) Again, an answer in terms of a trend was expected here. Some correct answers were given describing the trend in melting or boiling point, but other candidates answered in terms of the change in state (at room temperature) from gas to solid. A number of candidates gave the insufficient answer of stating that state changes from gas to liquid. A few candidates attempted to give answers based on colour changes down the group.

(c) (i) Few candidates correctly described the colour change from brown to colourless. Many candidates simply stated one colour as an answer.

(ii) Stronger candidates gained credit here, correctly recalling the term cracking.

Question 9

(a) Most candidates were able to gain at least partial credit for this question. Many candidates included both a fuse and switch in the main circuit. Incorrect symbols were seen, and the fuse was often shown as a fixed or variable resistor. Some candidates only included one additional component in their circuit.

(b) (i) Candidates found it difficult to express a correct explanation here as to why the other heater continues to work when the wire in one heater breaks. Mention of the heaters being in parallel was not enough on its own since this was stated in the question.

(ii) This question was answered well. Most candidates were able to manipulate equations well and gained credit, with many correctly recalling the unit for resistance, the ohm, Ω.

(c) Candidates needed to recognise that a fuse must have a higher rating than the working current in the circuit. Given the information that the current was 5.0 A, the only choice for a fuse from the list was 13A. Some candidates selected the correct fuse but were unable to give a clear reason why.

COMBINED SCIENCE

Paper 0653/32
Core Theory

Key messages

Candidates should be encouraged to read each question very carefully to ensure that they answer exactly the question that is being asked.

Recall of syllabus terms is an important part of this subject and candidates need to be able to explain a syllabus term and also be able to recall the syllabus term when a description is given.

General comments

Candidates demonstrated a good spread of knowledge across the Combined Science syllabus. Sometimes candidates gained only partial marks for a question by not providing sufficient detail in their answer. Candidates were generally good at the recall and use of equations.

Candidates should be guided by the number of marks available for the question; a two-mark answer needs more than one statement. **Question 4(d)(i)** was frequently answered with insufficient detail.

Comments on specific questions

Question 1

(a) (i) This was answered well by almost all candidates who could identify algae as the producer in the food web shown.

(ii) Many candidates correctly stated the process of photosynthesis. A few candidates gave the word equation for photosynthesis. When a word equation is required it will be asked for in the question.

(iii) This was answered well with the most common correct answer being kingfisher. Frog and fish occurred several times as answers too. The most common incorrect answer was water beetle. When candidates are asked for one example, they should be careful not to write a long list.

(iv) Almost all candidates were able to construct an accurate food chain including the frog.

(b) This question proved challenging. A number of candidates incorrectly stated that the decomposer was the dead organism rather than an organism that gets its energy from dead organisms.

(c) Candidates were asked to identify processes marked on a diagram of the carbon cycle. Many correctly identified respiration. Stronger candidates also identified feeding, but few recalled that fossilisation is the process by which fossil fuels are made from dead plants and animals.

Question 2

(a) (i) Stronger candidates recalled that an alloy contains a metal mixed with other elements.

(ii) Many candidates recognised that being unreactive makes brass suitable for a tap. Credit was given if this was expressed as the brass not rusting or corroding. A few candidates also mentioned other relevant properties of brass such as brass being strong or hard.

(b) (i) Many candidates calculated that the number of neutrons was 35; the nucleon number, 65 – the proton number, 30. Common incorrect responses were either nucleon or atomic number on its own.

(ii) Some candidates were able to correctly state that an atom of zinc has 30 electrons.

(iii) Strong candidates realised that Zn^{2+} is a positive zinc ion which has lost two electrons and so the ion has 28 electrons. Two, the number of electrons lost in the formation of the ion, was a common incorrect response.

(c) (i) In this question, there was partial credit for taking the reaction information in the question and correctly completing the boxes for the word equation. It was important for candidates to read the question carefully as some candidates tried to write a symbol equation unsuccessfully where a word equation was specifically requested.

(ii) Stronger candidates correctly deduced the formula of $ZnCl_2$.

Question 3

(a) Many candidates correctly identified force **Q** in **(i)** and force **S** in **(ii)**. For **(iii)**, information was provided to indicate that these forces must be balanced because the question stated that the wheelbarrow was moving at a constant speed. Few candidates used this information correctly.

(b) (i) Many candidates correctly identified one of the two points where speed is changing. Some candidates confused the graph with a speed-time graph and labelled **X** on a sloping section of the graph.

(ii) A large number of candidates placed **Y** on the right-hand section of the graph, which is not as steep as the first section. The speed of the wheelbarrow is determined by the gradient of the distance-time graph and so the maximum speed occurs where the gradient is steepest.

(c) (i) Most candidates gained credit here, with many completing the full sequence correctly.

(ii) This question asked candidates to think about the less useful energy transformations that take place when the wheelbarrow is pushed. The insufficient answer “heat energy” without any further detail was seen often.

(d) Candidates found it difficult to answer this question clearly. They needed to state both that the wheelbarrow had less mass or exerted less force and then relate this to the fact that work done depends on the force applied. Many candidates simply stated that the wheelbarrow was now lighter or was empty without explaining how this leads to less work done.

Question 4

(a) (i) Many candidates correctly identified the xylem vessels labelled **C** in the figure.

(ii) This was answered well by the majority of candidates.

(b) Many candidates gained full credit here. Candidates sometimes incorrectly thought that water was being absorbed through the stomata, rather than diffusion as the mechanism of water leaving the surface of the mesophyll cells.

(c) (i) Stronger candidates identified phototropism as the tropic response. The answer photosynthesis was seen from a few candidates.

(ii) The majority of candidates knew that petals are there to attract insects.

(d)(i) For full credit, this question needed a fuller answer than simply “in the blood” which many candidates managed to recall. Full credit was gained by stronger candidates who referenced blood vessels/capillaries or the involvement of the plasma in the transport of hormones.

(ii) Many candidates gained full credit here. The most common correct responses seen mentioned the pulse/heart rate increasing and an increase in blood/sugar level. The question asked candidates to describe the effects and so answers such as “fight/flight” were insufficient to gain credit.

Question 5

(a) (i) The majority of candidates correctly recalled that the process shown is electrolysis.

(ii) Stronger candidates identified water as the solvent in aqueous sodium chloride.

(iii) A few candidates correctly identified chlorine as the product at the positive electrode. Since it is the gas that is collected, candidates needed to realise that "chloride" was not a creditworthy response. Even fewer candidates identified hydrogen as the product at the negative electrode with a number suggesting that it would be sodium.

(iv) Many candidates correctly named the cathode (negative) and anode (positive).

(b) (i) Few candidates correctly recalled that copper is extracted from its ore by heating with carbon.

(ii) Only the strongest candidates correctly identified that the type of chemical reaction that involves the loss of oxygen is reduction.

Question 6

(a) (i) Many candidates stated that evaporation happens at the surface of the sea water.

(ii) The strongest candidates were able to explain that it is the molecules with most energy that escape from the surface of the water.

(iii) The process of evaporation leaves the remaining sea water at a lower temperature. A few candidates were able to state this clearly.

(b) Many candidates correctly explained that the maximum temperature of the water is below boiling point and so the water does not boil.

(c) (i) The strongest candidates correctly stated that infrared radiation is responsible for heating the sea water.

(ii) Strong candidates were able to place infrared in its correct position in the electromagnetic spectrum.

(iii) The strongest candidates were able to give a clear definition of frequency as the number of waves produced per second. Other candidates often mentioned only the number of waves produced without relating this to a period of time.

(d) Candidates were expected to be able to interpret an experimental demonstration of the refraction of light. In this question, they needed to recognise that angles of incidence and refraction as the ray enters the glass tank are measured from the normal to the tank.

Question 7

(a) Many candidates correctly identified **P** as the trachea. Some did not gain full credit for the question as they identified **Q** as the bronchus, rather than correctly identifying a bronchiole.

(b) Many candidates identified the process of excretion. A common mistake was to name the characteristic as egestion. This question asked for one characteristic, so candidates should not give a list of answers.

(c) (i) Stronger candidates correctly identified the pulmonary vein.

(ii) Many candidates were able to state that white blood cells produce antibodies.

(d) (i) The majority of candidates who attempted this question correctly identified the ovary on the diagram.

(ii) Stronger candidates were able to identify structure **Y** as the oviduct.

(iii) To gain full credit here, answers had to be in terms of what happens to the uterus lining during just the first five days of the menstrual cycle. Many candidates wrote about what happens to an egg and, in particular, what happens to a fertilised egg, which was not relevant to the question asked.

Question 8

(a) (i) The strongest candidates were able to identify natural gas as the fossil fuel whose main constituent is methane. Common incorrect responses included coal and petroleum.

(ii) Many candidates correctly identified that methane molecules contain covalent bonds.

(iii) Many candidates were able to successfully complete the dot-and-cross diagram of a methane molecule.

(b)(i) Most candidates correctly identified the process used to obtain refinery gas as fractional distillation. A few candidates gave the insufficient answer “distillation”.

(ii) To answer this question, candidates needed confidence that “no change” was the correct response. Many candidates suggested colour changes of one kind or another.

(c) (i) Candidates often demonstrated a good knowledge of what an exothermic reaction is. However, some candidates struggled to correctly recall the term and heating was a common incorrect response.

(ii) This question asked specifically about the effect on the number of molecules of two different gases in a limited supply of air of the combustion of methane. A very careful reading of the question was required to realise that there would be no change to the number of nitrogen molecules and a decrease in the number of oxygen molecules in the sample.

(iii) Strong responses correctly stated that the gas is tested with limewater which turns milky in the presence of carbon dioxide.

Question 9

(a) (i) Most candidates were able to complete the circuit diagram with a correct lamp symbol connected in parallel. Candidates sometimes did not recall the correct circuit symbol for the lamp.

(ii) Since the question stated that the bell and lamp are connected in parallel, candidates needed to explain why that means that the bell could ring even if the lamp was broken. It was not sufficient to simply restate that they were in a parallel circuit.

(b) The stronger candidates were able to place a correct voltmeter symbol in parallel with the bell.

(c) The majority of candidates did well with numerical questions and gained at least some credit here. Many candidates recalled the correct symbol for the unit ohm (Ω).

COMBINED SCIENCE

Paper 0653/33
Core Theory

Key messages

Candidates should be encouraged to read each question very carefully to ensure that they answer exactly the question that is being asked.

Recall of syllabus terms is an important part of this subject and candidates need to be able to explain a syllabus term and also be able to recall the syllabus term when a description is given.

General comments

Candidates demonstrated a good spread of knowledge across the Combined Science syllabus. Sometimes candidates gained only partial marks for a question by not providing sufficient detail in their answer. Candidates were generally good at the recall and use of equations.

Candidates should be guided by the number of marks available for the question. **Questions 1(b)** and **4(b)(ii)** both required fuller answers than those given by most candidates.

Comments on specific questions

Question 1

(a) (i) Many candidates correctly identified the cell membrane (**A**) and nucleus (**C**). Fewer candidates were able to describe the function of the cytoplasm (**B**); the place where metabolic reactions take place.

(ii) Most candidates were able to recall that muscles are needed for movement.

(iii) Many candidates correctly stated that respiration releases energy. Two common incorrect answers were the characteristics excretion and nutrition.

(b) To gain full credit in this question, candidates needed to link red blood cells to the transport of oxygen and then go on to state a consequence of the lack of red blood cells; either less oxygen transported or less respiration. Some candidates simply stated that red blood cells carry energy around the body.

(c) (i) Few candidates correctly identified the septum in the diagram of the heart.

(ii) More candidates were able to identify a valve in the diagram.

Question 2

(a) (i) A majority of candidates placed both magnesium and hydrochloric acid in the correct place in this word equation. Fewer candidates correctly identified the other product as magnesium chloride. A few candidates gave “salt” as an answer, which was insufficient. Some candidates wrote a symbol equation though the question asked for a word equation.

(ii) Many candidates correctly identified that the test for hydrogen involves a lighted splint, which gives a squeaky pop in the presence of hydrogen. A common incorrect answer suggested using a glowing splint.

(b) Most candidates were able to state the meaning of the term exothermic.

(c) (i) (ii) Some candidates correctly stated that an increase in concentration of acid leads to an increase in the rate of reaction. More candidates were able to state that a decrease in temperature causes a decrease in the rate of reaction.

(d) Stronger candidates stated correctly that the rate of reaction will be slower because zinc is less reactive than magnesium. A few candidates incorrectly suggested that the reaction rate would be unaffected because the surface area of the two metals was the same.

Question 3

(a) (i) Stronger candidates correctly calculated the weight of the climber as 640N. A number of candidates used the formula $W = mg$ incorrectly.

(ii) Few candidates correctly stated that the source of the gravitational field was Earth. A common incorrect answer here was “the rock face”.

(b) (i) (ii) Candidates were asked to identify the types of energy associated with the climber’s motion and their change in position above the ground. Many candidates identified kinetic energy due to motion. Fewer candidates identified the gravitational potential energy due to the change in position above the ground.

(c) (i) Many candidates gained full credit here. To do this, they first had to calculate the total time and then use it in the equation speed = distance ÷ time. Candidates who showed their working and stated the equation were able to gain some credit even if an error led to the wrong final answer.

(ii) Work done depends on force and distance. Stronger candidates recognised that the same climber climbed the same distance in each section, and this explained why the work done was the same.

(iii) This question expected candidates to realise that the climber does the same work in a shorter time moving from **B** to **C** and this explains why the useful power is higher in this section.

Question 4

(a) (i) The majority of candidates identified chloroplasts as the structures that contain chlorophyll.

(ii) Most candidates gained credit here with many giving a fully correct word equation for photosynthesis.

(iii) There were a large number of correct responses here. A common incorrect answer included nitrogen, rather than oxygen, as an element in glucose.

(b) (i) Some candidates correctly stated that iodine is used to test for starch.

(ii) Here, candidates were asked to interpret and explain the results shown in the figure. Stronger candidates gained credit by stating that there was no starch in the white area and went on to link this to the fact that there is no photosynthesis in the white area.

(c) Stronger candidates correctly identified the anther as the part of the plant which produces pollen. Stigma was the most common incorrect answer.

Question 5

(a) (i) The majority of candidates stated that solid copper is heated to make it into molten copper.

(ii) Stronger candidates were able to compare the regular arrangement of atoms in a solid with the random arrangement in a liquid.

(iii) Many candidates struggled to explain why this is a physical change. The strongest answers stated that no new substance is made. Candidates sometimes incorrectly cited a chemical change.

(b) (i) Candidates were asked to recall differences in properties between transition and Group I metals. Some candidates wrote about colour differences, rather than the acceptable answer that copper forms coloured compounds.

(ii) Stronger candidates could identify a property shared by copper and sodium. All of the mark scheme answers were seen, with "good conductor" being the most common correct response.

(c) Stronger candidates correctly recalled that elements become less metallic as you move from left to right across a period. Common incorrect responses suggested a change in reactivity or a change in electron number.

Question 6

(a) Many candidates correctly placed gamma radiation in the electromagnetic spectrum.

(b) (i) Candidates needed to apply their knowledge of a thin converging lens here and show the rays converging on the screen. Some correctly drew converging rays, but these did not meet on the screen. Candidates did not always use a ruler to draw thin, neat rays.

(ii) Stronger candidates correctly identified the distance as the focal length.

(iii) Many candidates correctly stated the effect as refraction.

(c) (i) The majority of candidates were able to give a useful example of microwave radiation. A few candidates gave the one-word answer "microwave". Without the word "oven" or some reference to heating food, this was not accepted since it is another scientific term with its own meaning.

(ii) Here, candidates needed to state that there is no matter in space as the reason for no conduction or convection.

Question 7

(a) (i) Many candidates constructed a food chain with correct arrows from the information in the table.

(ii) There were many correct answers to this question.

(b) (i) Most candidates extracted the correct year, 1995, from the figure.

(ii) This question was well answered by many candidates.

(c) (i) Very few candidates recognised the root cortex cell. "Hair" was a common incorrect response though a root hair was labelled on the figure.

(ii) Most candidates drew an arrow from the soil into the root hair. Some candidates drew a line but omitted the arrow.

(iii) The strongest candidates gained credit here for mentioning diffusion or osmosis. Very few mentioned the partially permeable membrane.

Question 8

(a) (i) Many candidates recognised that covalent bonds are present in methane molecules.

(ii) A few candidates were able to explain that in a covalent bond, electrons are shared.

(iii) Many candidates correctly recalled the formula for methane.

(b) (i) Stronger candidates correctly identified oxygen as the gas necessary for combustion of methane. Incorrect answers seen frequently were nitrogen, hydrogen and carbon dioxide.

(ii) Candidates found it easier to identify carbon dioxide than water vapour.

(c) (i) A few candidates stated that refinery gas is separated from petroleum.

(ii) Some candidates recalled that the process of fractional distillation is used to separate refinery gas.

(iii) Heating and cooking were equally popular answers.

Question 9

(a) Many correct responses were seen for this question.

(b) (i) Many candidates correctly stated that evaporation is the process happening at the surface of the water in the bath. A common incorrect response was condensation.

(ii) To answer this question, candidates needed to realise that the more energetic particles escape leaving behind particles with less energy and therefore lowering the temperature of the water remaining in the bath.

(c) Most candidates gained some credit for the circuit diagram and the strongest candidates generally gained full credit. Common errors included drawing a fixed resistor symbol for the fuse.

(d) Many candidates were able to calculate the potential difference correctly. The incorrect symbol Ω was seen on a number of otherwise correct answers.

COMBINED SCIENCE

Paper 0653/41
Extended Theory

Key messages

- Candidates should be reminded to read the questions carefully and to use the number of marks available for each question as a guide to how much detail to include.
- Some questions tested the ability of candidates to apply their knowledge and understanding of science to describe and explain contexts that may be unfamiliar, for example **Question 6(c)(i)**. Candidates often found these questions challenging.

General comments

Some good answers were seen from candidates who had mastered most parts of the syllabus, who were well-prepared for examinations of this type and who presented answers in a well-organised manner. Some candidates who were less successful might have been better suited for entry to the core paper. Performance across the three science disciplines was well balanced. Most candidates showed their working in questions requiring calculation.

Comments on specific questions

Question 1

(a) (i) Generally, this was answered well by most candidates. Many candidates used the diagram to guide their answers as directed in the question. These candidates described oxygen and/or carbon dioxide moving into or out of the blood. The strongest answers also referred to these gases diffusing through the gas exchange surface. The most common error was that blood was not mentioned.

(ii) Alveoli was named by large numbers of candidates.

(iii) The most common correct answers were that the surface is thin and has a large area. Some answers referred to features of an individual cell rather than the structure of the surface. Credit was not given for answers such as “gases can get through” or any other suggestions involving permeability.

(b) (i) The function of the umbilical cord was familiar to most candidates. A large number of correctly identified substances passing either to or from the fetus was seen.

(ii) A significant number of candidates suggested the answer “to protect the baby”. This was not detailed enough, and candidates needed to have stated or implied protection from physical shock. Credit was not awarded for references to events occurring during birth.

(iii) Most candidates gained marks here.

Question 2

(a) Stronger candidates wrote clear, accurate descriptions of the boiling point trend, and explained the relationship between boiling point, molecular size and intermolecular forces. A number of candidates reversed the relationships. Some candidates answered in terms of position in the fractionating tower rather than position within the list of hydrocarbons. Some candidates confined

their answers to a discussion of just one of the hydrocarbons rather than describing trends across all of them.

(b) (i) Candidates needed to describe a homologous series as a family of compounds having a general formula and similar chemical properties. They needed to avoid suggesting that the chemical properties are the same. Many answers showed that candidates were familiar with the concept, but the wording of answers missed the key descriptors. Typical suggestions included "it is a family of compounds", "they all have the same formula", "they all contain the same elements" and "they are alkanes or alkenes".

(ii) A small number of candidates drew correct dot-and-cross diagrams of a carbon dioxide molecule. Carbon dioxide is listed in the covalent bonding section of the syllabus. Two double bonds were often drawn, but then either the lone pairs and/or the chemical symbols were missing, or additional electrons had been drawn on the carbon atom.

(iii) Strong candidates gained full credit for this question. More candidates correctly stated the chemical formulae.

(c) Most candidates correctly referred to global warming, avoiding simply stating the unqualified term greenhouse effect.

Question 3

(a) (i) The strongest answers showed clear working which included the relationship distance = speed x time, correct substitution of values into the relationship and the correct final answer. Some candidates used an incorrect relationship between distance, speed and time and/or misread values from the graph.

(ii) Most candidates correctly read 25(s) from the graph. The most common mistake was 35s.

(iii) Most candidates correctly placed an **X** on the curved section of the graph.

(b) (i) Most candidates answered this question well. The strongest answers showed clear working which included the relationship $\Delta PE = m \times g \times \Delta h$ (or $W \times \Delta h$), correct substitution of values into the relationship and the correct final answer. However, a number of candidates multiplied 600N by g. The other common mistake was to find the value of 600 ÷ 9.

(ii) Many candidates were familiar with this type of calculation. A frequent mistake was to find the value of 48 ÷ 20.

(iii) A small number of candidates gained credit for their suggestions by referring to the additional work required to lift the escalator itself or discussing the energy losses associated with the electric motor. Incorrect suggestions included the idea that extra people would normally use the escalator, and some restated the information in **(i)** and **(ii)**.

Question 4

(a) Some candidates correctly labelled the coronary artery. The aorta was the most often selected incorrect answer.

(b) Most candidates correctly identified haemoglobin. Incorrect answers included plasma and iron. Some candidates wrote red blood cells despite these being in the question, and others suggested blood vessels of all types.

(c) Candidates needed to discuss movement of oxygen and/or glucose and to identify muscles/cells as destinations where these substances are required. They should then have described what occurs in the muscles in terms of increased energy release via increased respiration. Inaccurate phrases which could not be awarded credit included: "we need more oxygen to produce energy", "the heart rate increases to get energy around the body quicker" and "the heart rate increases so blood flows more quickly".

(d) (i) Only a small number of candidates had learned the general definition of a hormone given in the syllabus. A large number of suggestions involved everyday effects of hormones such as mood

control or discussed the involvement of hormones in puberty. Some correct descriptions of the effect of a particular hormone were seen, mainly adrenaline, but a general answer was required in this case.

(ii) Adrenaline was identified by the majority of candidates.

Question 5

(a) (i) Care was needed in this energy diagram. Candidates should be encouraged to write the words *reactants* and *products* on the energy levels. A number of candidates drew a construction line from the energy peak across to the energy axis, labelling this as the activation energy, but this was not clear enough to be credited. Some candidates attempted to show the activation energy using a vertical arrow, but this was not always located with sufficient accuracy.

(ii) Some responses described phenomena other than what happens to energy or particle bonds. Many answers contained references to the chemical reaction between sodium and water, which were often correct but irrelevant. A significant number of answers revealed confusion about the relationship between energy and bond breaking, e.g. “the bonds break and energy is released increasing the temperature”.

(iii) The majority of candidates were unfamiliar with the pH of sodium hydroxide solution. Many did not recognise sodium hydroxide as a base and many suggested that it was an acid.

(iv) The majority of candidates were unfamiliar with the formulae of the ions in a solution of sodium hydroxide. Both symbols and both electrical charges were required for credit.

(b) The dangerous nature of the reaction between Group I metals and dilute acid was familiar to many candidates and credit was awarded for any implication of risk. One common incorrect suggestion was that there would be no reaction. The simple statement that sodium is reactive did not gain credit but the idea that sodium is too reactive was credited.

(c) This was answered correctly by many candidates. Candidates need to note that when the name of a substance is requested then they should write the name and not a formula.

(d) Only the strongest candidates answered this question correctly. Many thought that the question was just about electronic configuration of atoms in groups and periods. Other incorrect suggestions included the reverse of the required answer, and statements such as “Groups I to III are metals” with no mention of outer shell electrons.

Question 6

(a) The majority of candidates understood that the molecules inside the tyre are closer together than those outside. It was important that candidates compared the distances between molecules inside and outside the tyre.

(b) Candidates were familiar with the use of the relationship pressure = force ÷ area and large numbers gained full credit. The strongest answers showed clear working which included the rearranged relationship, correct substitution of values into the relationship and the correct final answer. However, there were also mistakes in the relationship used, usually suggesting force = pressure ÷ area, and arithmetic errors when using the pressure value in standard form.

(c) (i) This part proved to be challenging for most candidates and only a small number gained full credit. Answers needed to focus on the advantages of the holes in the structure which were to improve access of moving air to the cyclist’s head and to allow evaporated water an efficient way to escape into the air.

(ii) Candidates answered this question well. Most could describe how a white, silvered or light-coloured helmet would reflect radiation.

(d) Stronger candidates successfully used the relationship wavelength = wave speed ÷ frequency to work through to the correct answer. The most common mistakes were to calculate frequency ÷ speed or frequency x speed.

Question 7

(a) Some stronger candidates gained full credit. Many candidates were unfamiliar with fertilisation as part of sexual reproduction in plants. Some described either fertilisation of soil to promote growth or gave details of pollination, often in great detail. Candidates who were familiar with this topic frequently did not include the key fact that it is nuclei of the sex cells that have to fuse or combine. Since the question asked about plants, the location of the sex cells had to be identified as in pollen or ovule. It was not enough simply to refer to male and female gametes.

(b) (i) Many candidates had learned the features of anthers adapted for wind pollination or they were able to obtain the information from the diagram. It was important that candidates specified that the anthers hang outside the flower or petals. Candidates also needed to describe the anthers as long or elongated rather than use the words large or big.

(ii) The question required candidates to state evidence they could see in the diagram and so the answer coloured petals could not be credited. As in **(i)**, the location of the reproductive organs in relation to the flower or petals needed to be described. The suggestion that the reproductive organs are small or short was not credited.

(c) The idea that producers can make their own nutrients by using light energy during photosynthesis was familiar to stronger candidates. Significant numbers of candidates suggested that producers are so named because they produce food for other organisms or because they are first in food chains.

(d) Stronger candidates frequently gained at least partial credit for knowing that not all of the energy is passed on between trophic levels. Many were able to gain further credit for describing one cause of energy loss. The idea that not enough energy would be available to sustain higher levels was seen from a few candidates.

Question 8

(a) Stronger candidates often gave a correct response, with the most popular suggestion being copper oxide.

(b) (i) All of the allowed correct responses were seen, but this part was challenging for many candidates. Responses such as “they are both metals” and “they are in Period 4” were seen. These are not properties and so were not credited. Some candidates suggested a high melting point or being hard which are not properties of potassium.

(ii) Many candidates did not read the question carefully enough and missed that this question concerned compounds of copper and potassium and not the elements.

(c) Large numbers of candidates were familiar with oxidation and reduction and at least partial credit was very often awarded with significant numbers gaining full credit. Candidates needed to word their answers carefully when describing the reduction of copper oxide. They needed to state that copper oxide is reduced rather than copper is reduced. Similarly, they needed to make it clear that copper oxide loses oxygen.

(d) A small number of candidates correctly identified both alloy and mixture. Alloy alone was often circled.

Question 9

(a) The majority of candidates gained at least partial credit, but full credit was not often awarded. Candidates appeared to be familiar with the circuit symbol for a variable resistor. However, this symbol was a common source of error and many candidates drew the symbols for a fixed resistor or a thermistor. Some candidates did not include a switch in their circuit. Candidates should also note that a switch symbol should always be drawn in the open position as shown in the list of symbols in the syllabus.

(b) This test of Ohm's Law was very familiar to the majority of candidates. The strongest answers showed clear working which included the relationship resistance = potential difference ÷ current, correct substitution of values and the correct final answer. The most common mistake was to multiply 230V × 0.25A.

COMBINED SCIENCE

Paper 0653/42
Extended Theory

Key messages

- Candidates should be reminded to read the questions carefully and to use the number of marks available for each question as a guide to how much detail to include.
- Some questions tested the ability of candidates to apply their knowledge and understanding of science to describe and explain contexts that may be unfamiliar, for example **Question 9(a)(i)**. Candidates often found these questions challenging.

General comments

Some good answers were seen from candidates who had mastered most parts of the syllabus, who were well-prepared for examinations of this type and who presented answers in a well-organised manner. Some of the candidates who were less successful might have been better suited for entry to the core paper. Performance across the three science disciplines was well balanced. Most candidates showed their working in questions requiring calculation.

Comments on specific questions

Question 1

(a) The importance of vitamin C to prevent scurvy was familiar.

(b) Candidates found this question challenging. The idea that energy in excess of requirement would be laid down as fat was unfamiliar and rarely stated. The mistaken idea that fat in the diet is laid down directly as fat in the body was frequently suggested.

(c) Many candidates gained credit for this question. The most common incorrect suggestion was iron.

(d) The importance of fibre in preventing constipation was familiar and most candidates answered correctly. Candidates needed to use correct scientific terms and refer to the specific importance of fibre in the diet rather than general phrases such as “makes it easier to go to the toilet”.

(e) (i) Stronger candidates realised that this question referred to the roles of both red blood cells and haemoglobin. Other candidates described features of the circulatory system or suggested answers such as “when the blood flows around the body it takes oxygen with it”.

(ii) Many candidates understood that exercise would cause an increase of carbon dioxide in the blood and also that the depth and/or rate of breathing would increase. Stronger candidates also correctly described increased respiration and avoided confusing the idea with increased breathing rate. Some candidates used phrases like “the pattern of breathing is increased” which was not detailed enough.

Question 2

(a) (i) The meaning of saturated in the context of this question was familiar to many candidates, but they often found it difficult to explain it clearly enough. Candidates needed to state that only single bonds are found in these molecules. Frequently seen suggestions that did not gain credit included “they have single bonds”, “they have double bonds” as well as answers referring to solubility.

(ii) This was correctly answered by large numbers of candidates who were familiar with the process of balancing chemical equations.

(b) (i) Correctly drawn dot-and-cross bonding diagrams of an ethene molecule were often seen. One common mistake was the inclusion of additional electrons on carbon and/or hydrogen. Candidates should be advised that if a dot-and-cross diagram is requested then no credit can be awarded for a structural diagram even if fully correct.

(ii) The colour change in the bromine test for unsaturation was familiar to many candidates. Very few made the mistake of suggesting either clear or white instead of colourless.

(c) (i) Large numbers of candidates correctly identified carbon dioxide and water. Of those gaining only partial credit, carbon dioxide was given more often than water.

(ii) A small number of candidates were awarded full credit. Candidates often gave endothermic and exothermic on the correct answer lines. However, candidates frequently reversed endothermic and exothermic and few were able to explain why the combustion of ethene is exothermic. Some candidates came close to the correct explanation but, in wording their answers, made errors such as “less energy is needed to form a bond than to break a bond” or “more energy is released when a bond forms than when a bond breaks”.

Question 3

(a) (i) Almost every candidate correctly identified force **Q**.

(ii) Few candidates gave the complete answer that forces **Q** and **S** are equal and opposite. Most only stated that the forces were the same size.

(b) (i) Most candidates located **X** correctly. In questions like these, candidates should be encouraged to avoid the extremities of the section of graph they are labelling.

(ii) Most candidates located **Y** clearly on the curved line, avoiding the extremities of this section of the graph.

(iii) Candidates were familiar with this type of calculation and large numbers gained full credit. The strongest answers showed clear working which included the relationship acceleration = change in speed ÷ time, correct substitution of values into the relationship and the correct final answer. Common errors were omitting the negative sign and stating incorrect units, often m/s.

(c) (i) Significant numbers of candidates were familiar with the use of the relationship ΔG.P.E. = $mg\Delta h$ (or $W\Delta h$). Partial credit was awarded for stating an acceptable form of this relationship. A common incorrect answer was a value of 2.4.

(ii) Only the strongest candidates answered this question correctly and many candidates made no attempt to answer. The most common correct answer was a reference to frictional losses. A large number of incorrect ideas were suggested with one of the more common ones being that the distance moved up the slope is greater than simply lifting the sand vertically.

Question 4

(a) (i) Stronger candidates labelled the guard cell. Many candidates labelled cells that contained chloroplasts, but which were not located in the lower epidermis.

(ii) Significant numbers of candidates were awarded credit.

(b) This question proved to be very challenging for the majority of candidates. Stronger candidates often gained partial credit for showing they understood that increased transpiration rate was linked to increased evaporation. It was important that candidates avoided suggesting that evaporation occurred through stomata. References to stomata needed to make clear that water moves out of the leaf by diffusion. Some candidates described the process of diffusion in great detail, but additional credit was not available for this. Other candidates thought that increased temperature was related to more sunlight and so attempted an explanation in terms of increased photosynthesis.

(c) (i) Almost all candidates gained full credit for a correct food chain.

(ii) A significant majority of candidates gained full credit. Nearly every candidate correctly identified the primary consumer and most gave an acceptable reason. The most common mistake was to suggest that snails occupied the first trophic level.

(iii) A large number of candidates gained full credit and the majority of other candidates were able to give at least one reason why not all of the energy is transferred between trophic levels. Candidates should be advised that heat loss, muscle contraction and respiration are not counted as significantly different.

Question 5

(a) Only the strongest candidates answered this question correctly. In this case, candidates were required to state the name of the oxidising agent and so the formula alone did not gain credit.

(b) The particular properties of transition metals were familiar to large numbers of candidates and this mark was frequently awarded. The most common errors were suggesting a property common to all metals or stating that both metals occur in Period 4.

(c) (i) Stronger candidates usually answered this well. The answer needed to refer to mobile ions. Frequently suggested answers not gaining credit included “so that a current can flow”, “so the compound can be separated”, or “so that electrons are mobile”.

(ii) The formula of aluminium oxide was familiar. However, credit was not awarded if electrical charges were showing and/or if the stoichiometry was shown in any way other than subscripts.

(iii) At least partial credit was awarded to significant numbers of candidates. Many candidates gained partial credit for stating that aluminium oxide is ionic, and that methane is covalent. However, both types of bonding had to be identified. Other candidates did not make the connection between high attractive forces between particles and the increased energy needed to separate them.

(d) Stronger candidates understood what this question was testing and gained credit. Many candidates wrote correct statements referring to the changes in electronic structure of atoms across periods or within groups of the Periodic Table but did not relate these to the idea of whether an element was a metal or non-metal. Candidates who may not have understood the term metallic character often discussed chemical reactivity generally or the ionisation of aluminium atoms.

Question 6

(a) (i) Many candidates were familiar with the decrease in intermolecular forces as the distance between particles increases during evaporation. Credit for describing the change in motion of the water molecules during evaporation was awarded to only a small number of candidates.

(ii) This question was answered very well by large numbers of candidates who discussed the increased absorption of heat by black surfaces. Stronger candidates described the transfer of thermal energy into the water and/or the increase in water temperature. Candidates should be encouraged to avoid stating that the colour black traps heat.

(iii) Candidates generally found this question more challenging and correct ideas were seen mainly from stronger candidates**.** Significant numbers of candidates showed they understood that more energetic molecules escape taking thermal energy with them. Stronger candidates were awarded credit for the idea that this reduces the thermal energy content of the remaining water. One mistake made by some candidates was to discuss why the water in the underground tank would be cooler.

(b) Large numbers of candidates knew that energy arrives from the sun via radiation which was the only answer accepted.

Question 7

(a) Credit was awarded for stating a feature of an artery and explaining why this adaptation is important. This meant that the answer “it has thick muscular walls”, which was given by many

candidates, was not enough. Only a small number of candidates referred to the elasticity of the walls. Many suggested that the lumen was wide because it has to carry a lot of blood or that blood has to flow easily.

(b) The importance of thin capillary walls was generally familiar. Credit was not awarded if walls were not mentioned. This meant that answers such as “capillaries are thin” or “capillaries are one cell thick” could not be credited.

(c) (i) Blood vessel **A** was correctly identified as the vena cava by large numbers of candidates from across the mark range. A variety of unacceptable answers were given, a common one being the one-word answer, vein.

(ii) A significant number of stronger candidates correctly described the actions of the two heart valves. Both parts of the answer had to be correct for credit. Some candidates wrote lengthy descriptions of blood flow patterns through the heart which were often correct but were not required.

(d) The function of the valves in veins was very familiar to large numbers of candidates. Some candidates suggested that the valves push the blood towards the heart.

Question 8

(a) Full credit was frequently awarded for answers to this question. The most common error was that the sketched line did not meet the given line at the final mass.

(b) Most candidates correctly referred to global warming, avoiding the mistake of simply stating the unqualified term, greenhouse effect. Credit was awarded for answers that implied global warming, but none was given if candidates gave additional threats such as ozone loss.

(c) A small number of stronger candidates were familiar with the technique of paper chromatography. The question asked candidates to describe how to use a chromatogram rather than to attempt to describe how to perform the practical work. Many candidates made statements such as “do the experiment and see if the R_f is 0.4”. No credit was allowed for answers like this.

(d) Significant numbers of stronger candidates gained partial credit for knowing that the copper ions would gain electrons. A smaller number went on and gained further credit for specifying that each ion gains two electrons or that the ions are discharged. Full credit was awarded for the correct electrode equation. A common mistake was to describe how copper ions form from copper atoms or to suggest that copper ions lose electrons to the cathode. A few candidates thought that the ions are discharged but that this occurs by losing positive electrons. The question stated that copper forms at the cathode and so no credit was available in this case for descriptions of how ions are attracted and migrate.

Question 9

(a) (i) A small number of stronger candidates understood how to proceed through this question and gained full credit. Many more candidates gained partial credit for using the resistance equation.

(ii) A small number of candidates realised that the calculation of combined resistance of the lamps in parallel was required.

(b) Many candidates gained at least partial credit for this part. The most popular answers were that the lamps could be operated independently, and that one lamp will still work if the other breaks.

COMBINED SCIENCE

Paper 0653/43
Extended Theory

Key messages

- Candidates should be reminded to read the questions carefully and to use the number of marks available for each question as a guide to how much detail to include.
- Some questions tested the ability of candidates to apply their knowledge and understanding of science to describe and explain contexts that may be unfamiliar. Candidates often found these questions challenging.

General comments

Some good answers were seen from candidates who had mastered most parts of the syllabus, who were well-prepared for examinations of this type and who presented answers in a well-organised manner. Some of the candidates who were less successful might have been better suited for entry to the core paper. Performance across the three science disciplines was well balanced. Most candidates showed their working in questions requiring calculation.

Comments on specific questions

Question 1

(a) (i) For credit to be awarded here, an adaptation had to be described with a description of how this adaptation enables oxygen transport. An example of this is the biconcave disc shape of the red blood cell (the adaptation). This gives a large surface area for absorption of oxygen (explanation). Responses which just described a structural feature did not gain credit.

(ii) The functions of two different white blood cells as described in the syllabus were required here. Many candidates did not include enough detail in their answers. Typical weaker responses included “to fight infection” and “they are part of the immune system”.

(b) (i) Many candidates described the double circulation as one which sends blood to both the body and the lungs and they were awarded full credit.

(ii) Some candidates found this question challenging. The faster speed of delivery of blood to the body tissues was seen in many responses, but only stronger candidates described the advantage of blood exiting the heart with different pressures to the lungs and the body. There were many vague responses, for example “blood flow is more efficient” and “it keeps a continuous blood flow”.

(c) Most candidates answered this question correctly, explaining that more oxygen must enter the blood at the lungs and that this extra oxygenated blood has to be pumped by the heart faster to reach the exercising muscles. However, some candidates did not say that the oxygen enters the blood at the lungs. The speed of transport of the blood was also important for full credit to be awarded, not just “more oxygenated blood reaches the body”. There had to be some indication of an increase in the rate of blood flow.

(d) The three main diseases caused by smoking tobacco, as stated in the syllabus, are COPD, lung cancer and coronary heart disease. Many candidates quoted COPD (chronic obstructive pulmonary disease), and then stated either bronchitis or emphysema as their second disease. Candidates are reminded that the term COPD includes both bronchitis and emphysema. Lung cancer was not acceptable for credit because cancer had already been excluded in the question.

Question 2

(a) Many candidates gained credit in this question, correctly identifying ethene as compound **J**, and giving a correct reason. Some candidates who were unsuccessful stated that ethene had the formula C_2H_6, which is ethane. Others gave the correct letter for the compound, but with no reason, so these candidates did not gain credit.

(b) (i) The concept of cracking being the breaking of large hydrocarbon molecules into smaller ones was familiar to many candidates who gained full credit for their answer. However, other candidates described fractional distillation instead of cracking. There were many responses that were too vague, for example, "breaking up the oil", "breaking up a substance into smaller amounts". Several candidates referred to the process of fracking. Careful reading of the question should avoid this type of answer.

(ii) Most stronger candidates answered the question correctly, stating that heat or a catalyst was needed for the cracking procedure. Incorrect responses included the requirement for oxygen or air.

(c) Some candidates obtained full credit for their answer. In other weaker answers, candidates made one of the following errors:

- putting four electrons in the single carbon-carbon bond instead of two electrons
- missing out the symbols for the carbon and hydrogen atoms
- only having one electron in the single carbon-hydrogen bonds.

(d) Some stronger candidates gained full credit for this question. They had to give the correct formulae for the reactants and products, then balance the equation. Weaker candidates used oxygen as the reactant with methane, and not steam (H_2O). Other candidates wrote the formula for carbon dioxide instead of carbon monoxide. Some balanced equations were written with 6H as a product instead of $3H_2$. Candidates are reminded that hydrogen is produced as molecules, not as separate atoms.

(e) Some stronger candidates knew the products of complete combustion of a hydrocarbon, namely carbon dioxide and water. Incorrect responses included carbon monoxide and hydrogen.

Question 3

(a) (i) The majority of candidates successfully calculated the mass of the climber, 82 kg. Only a few candidates multiplied the weight by 10 instead of dividing by 10 to arrive at an incorrect answer.

(ii) Many candidates arrived at the correct answer using the formula $\Delta GPE = mg\Delta h$. Credit was not awarded when candidates used an incomplete equation, usually missing out the 10 N/kg for g, the gravitational field strength.

(b) (i) This question was generally answered well. Most candidates read the required information from the graph (increase in speed = 27 m/s and time taken = 3s). Fewer candidates knew the correct unit for acceleration. The most common incorrect answer was m/s. Other incorrect units given were m^2/s.

(ii) Most candidates placed **X** at time = 3s, indicating when the piece of rock lands on the slope.

(iii) Many stronger candidates answered this question correctly. Other responses described deceleration but did not explain that the deceleration is non-constant. Some candidates stated responses such as "it decelerates at a non-constant speed". This could not be credited because speed always changes during deceleration.

(c) (i) This question was answered well with most candidates calculating an extension of 0.84 m.

(ii) Few candidates scored full credit in this question. Some candidates stated that the extension of the rope was proportional to the load added if Hooke's Law is obeyed, but then did not follow this up with any calculation to prove their statement. Successful candidates used the equation $F = kx$ and applied it to each of the two tests, to show that k is the same in each case.

Question 4

(a) The role of vitamin D in the body was the important fact to include in the answers to this question. Therefore, specific facts about bone growth and health, and assistance in calcium absorption were needed to obtain credit. There were many vague statements made in responses which included "she needs vitamin D both for herself and the baby" and "to keep the mother and baby healthy". These responses were not awarded credit.

(b) (i) There were several acceptable answers and many candidates stated one of these for credit. Common errors included weak bones, nausea and scurvy.

(ii) Many candidates knew a good source of iron. The most common responses were red meat and spinach. Fruit and/or vegetables were stated by several candidates. These responses were considered to be too vague, so no credit was awarded to them.

(c) (i) Most responses contained a reference to the fact that obesity results from a person taking in more energy in food than their body needs. This could be phrased in a different way, for example "the person eats too much fat/carbohydrate". General statements such as "the person does not have a balance of all the nutrients" were not awarded credit because in the case of obesity, it is the excess of energy-producing nutrients that is important.

(ii) *Please note that due to an issue with this question, full marks have been awarded to all candidates for this question in order that no candidate is disadvantaged.*

(d) (i) This question was generally answered well. Candidates were aware of the acidic nature of the inside of the stomach.

(ii) The acidic conditions in the stomach aid digestion by providing an optimum pH for the digestive enzymes present. Some stronger candidates explained this fact and scored credit for their responses. The role of hydrochloric acid in killing bacteria was not awarded credit because the question asked how the process of digestion is aided by the acidic conditions in the stomach.

Question 5

(a) (i) The majority of candidates gained full credit in this question. The most common error was the number 24 written for either the number of protons or the number of neutrons.

(ii) The response to this question had to be expressed in terms of a trend. This was done successfully by stronger candidates. Unacceptable answers included descriptions of how the electrons of the outer shell of a period increase across a period without any reference to the changing metallic character of the elements.

(b) Many candidates successfully deduced the correct formula for magnesium chloride, $MgCl_2$. Candidates are reminded that although the Mg^{2+} and Cl^- ions are charged, the formula of magnesium chloride is neutral. Therefore, $Mg^{2+}2Cl^-$, $Mg^{2+}Cl_2$ and $Mg^{2+}+2Cl^-$ were not awarded credit.

(c) (i) Some stronger candidates gained full credit for this question. They described the importance of ions being able to move towards the electrodes in molten magnesium chloride. There were many answers where candidates referred to the ions as molecules, particles or atoms. Answers which used these terms could not gain full credit.

(ii) This question was answered well by stronger candidates who understood that the magnesium ion collects electrons at the cathode to become a neutral atom. Other candidates did not show an understanding that the cathode was negative, and that electrons are collected by the magnesium ion, rather than donated.

(d) Most candidates found this question challenging. Candidates had to show an understanding that the amount of energy required to break the bonds of the reactants was less than the amount of energy given out by bond formation of the products. The excess energy is then given out as thermal energy. Many candidates stated incorrectly that the breaking of bonds gives out energy.

Question 6

(a) The correct boxes were ticked or crossed by most candidates who identified radio waves as having the lowest frequency, and ultraviolet as causing sunburn. Other candidates placed a tick or a cross in every box, therefore obtaining no credit. Careful reading of the question was needed to avoid this.

(b) (i) Most candidates recognised the fact that the gamma radiation would take time from when it was emitted until it reached the Earth. To gain credit, candidates had to state that it would take a long time to reach the Earth. Therefore, answers stating "it will take a while/days/weeks" did not gain credit.

(ii) This question was answered successfully by stronger candidates. The remaining candidates found it challenging. Some either did not know the formula or rearranged the formula incorrectly. There were some candidates who had a problem with the scientific notation of the numbers of speed and wavelength. The calculation often gave the answer 1.5×10^{-6}. Candidates are reminded to include the formulae used in calculations so that credit may be awarded if the numerical answer is incorrect.

(c) (i) The heating effect of infrared radiation was correctly recalled by some candidates. Approximately the same number wrote ultraviolet and this answer was not awarded credit.

(ii) Most candidates knew that the black areas of the penguin absorb more radiation than the white areas because of their colour. Incorrect answers included "the head will absorb more radiation because it gets more sun", or "the front of the penguin will absorb more radiation because it is facing the sun". Several candidates stated that the black surfaces attract radiation. This term is incorrect because the radiation lands on surfaces of all colours. The black surface absorbs more of this radiation, becoming warmer. The white surface of the penguin will reflect more radiation and will not become as warm.

Question 7

(a) (i) Many candidates gained credit in this question, concluding that the part of the flowering plant responsible for the uptake of water and mineral ions is the root. Some candidates stated xylem. Although the xylem conducts water and mineral ions through the plant, it is not responsible for the uptake of these substances, so xylem was not awarded credit.

(ii) Most candidates answered this question correctly, stating that magnesium ions are needed for making chlorophyll. Answers which did not gain credit were nitrate, water and glucose.

(iii) The need for chlorophyll for photosynthesis was described reasonably well by most candidates. These candidates explained that the light energy has to be absorbed by chlorophyll so that it can be converted to chemical energy, and if the chlorophyll is absent, the plant is unable to carry out photosynthesis. Fewer candidates described the yellow leaves that result from a lack of chlorophyll, or the name of a product of photosynthesis, for example glucose.

(b) (i) Many candidates wrote a complete food chain using the information provided. Most chose the first food chain on the mark scheme. A correct example is shown below.

mistletoe → thrush → cat → hawk

This food chain was sufficient to gain full credit, but some candidates added another arrow directly from the thrush to the hawk. This answer ceased to be a food chain and became a food web. Another common error was seen when candidates drew the arrows pointing in the wrong direction. Candidates are reminded that the arrows show the direction of flow of energy, and this must flow from the producer. A few responses contained the following food chain.

mistletoe → berries → thrush → cat → hawk

Since the arrows in the food chain arrows are indicating movement through trophic levels, the first step of the food chain is invalid since the mistletoe and berries are at the same trophic level.

(ii) Many candidates gained full credit for this question, explaining that the hawk feeds on both a primary consumer (making it a secondary consumer) and a secondary consumer (making it a tertiary consumer). Weaker responses gave incomplete explanations of these points, and vague statements such as “the hawk is the top predator”.

Question 8

(a) This question was generally answered well by candidates who explained both points correctly. Weaker responses referred to the movement of the acid particles as vibrating, the term used to describe solids. Candidates should be aware that for the rate of reaction to increase, the rate of collisions should also increase. Therefore, the phrase more collisions did not obtain credit, but more collisions per second, or a higher rate/frequency of collisions did gain credit.

(b) There were several acceptable responses to this question. It was clear from many answers that candidates had not read the question properly, and they stated properties that are common to both transition elements and Group I metals. This was illustrated by answers such as “they both conduct electricity/heat” and “they are both ductile”.

(c) (i) Stronger candidates answered this correctly by stating that chlorine gas bleaches litmus paper. Common errors were candidates stating that the litmus turned blue or green.

(ii) The use of chlorine to kill bacteria in water supplies was known by the majority of candidates.

(d) Many candidates were unfamiliar with the calculation of R_f values from a chromatogram. The two measurements needed were the distance that the copper ions travelled, and the distance of the solvent front, both from the spotting line. Candidates gained credit for these two measurements, then further credit for a correct calculation of the R_f value. Credit was not given to candidates who only stated 4.5 cm on the answer line. This was the distance that the copper ions travelled, not the R_f value. Other unsuccessful responses subtracted 4.5 cm from the solvent front measurement of 8.0 cm to give an answer of 3.5 cm.

Question 9

(a) The question provided the structure which candidates could use to write their answers. Successful candidates took each of the points in turn to compare the molecules in a gas with a liquid, therefore gaining full credit. Several candidates were not specific enough in their explanations of the motion of gas molecules. Statements such as “they hit each other” and “they hit the walls of the container” were not given credit.

(b) Many candidates found this question challenging. The main point of the fan was to remove damp air from the bathroom, replacing it with drier air. Some candidates stated that the air from the fan would cool the air and therefore reduce the rate of evaporation. These answers did not gain credit because the question states that the fan is extracting air meaning that the air is moving out of the bathroom.

(c) (i) Many candidates successfully used the $P = IV$ equation to calculate the potential difference across the motor.

(ii) The majority of candidates found this question challenging. The current through the bathroom light had to be calculated using the $I = P \div V$ equation (0.12A) This current then had to be added to the current through the motor (0.08A). This gave the total current in the circuit of 0.20A and a 5A fuse gives a suitable margin. Some candidates successfully calculated the current through the light but did not add this value to the current through the motor.

COMBINED SCIENCE

Paper 0653/51
Practical Test

There were too few candidates for a meaningful report to be produced.

COMBINED SCIENCE

Paper 0653/52
Practical Test

There were too few candidates for a meaningful report to be produced.

COMBINED SCIENCE

Paper 0653/61
Alternative to Practical

Key messages

- Drawings should be 2D and should show structures clearly in cross section. When asked to make a drawing from a photograph, candidates should ensure that they use clear, unfeathered, continuous smooth lines. They should not shade their diagrams. Shading and attempts to represent a 3D shape usually obscure the lines which show structure and can be unclear. When using diagrams to represent apparatus, candidates should again use a 2D representation and take care that junctions between pieces of apparatus are clearly shown to be either sealed or open as appropriate.
- When candidates are asked to add values to a table, they need to judge the number of significant figures or decimal places based on the other entries in the table. Additionally, some candidates did not follow the instructions in questions which stated how many significant figures or decimal places needed to be used in the answer.
- In planning questions, candidates need to address all areas of the task to access the full mark range. They are guided in this by the bulleted list included in the task.
- Graphs appear on all practical papers. Candidates need to ensure that the axes are the right way around; choose scales to occupy more than half the grid; ensure that axes are labelled with units; plot carefully and draw appropriate lines of best fit. Candidates also need to follow instructions relating to labelling lines or adding lines to show how they have read values from the graph.
- Candidates should take care when discussing reasons for repeating readings so that they make clear scientific points. Repeating readings alone does not make results more accurate. When repeats are carried out, candidates need to be aware that this is in order to check for consistency by looking for similar results and identifying any anomalous values.

General comments

There were some strong answers to the questions on this paper. Most questions were fully answered. Most omissions were seen in **Question 2**.

Comments on specific questions

Question 1

(a) Most candidates drew the diagram enlarged from the original. Further credit was not always gained. Some drew a feathered outline with gaps rather than a continuous smooth line. The pith was usually shown, but many candidates did not look carefully to see that the segments do not go all the way into the centre. Many drew all segments meeting in the centre. Candidates should not shade diagrams because it obscures the detail of their drawings.

(b) (i) Most candidates read the syringe correctly. A common incorrect answer was 9.1.

(ii) Almost all candidates correctly calculated the volume of orange juice added.

(iii) Almost all candidates added up the three values, but some did not remember to then divide by 3 to calculate the average.

(iv) Repeating readings alone does not make them more accurate or correct. Candidates needed to explain that the student should look for similar readings and anomalous results.

Question 2

Stronger answers typically followed the bullet points in the question to ensure all points were covered. These candidates described separately how to test for sugar and fat. The answers described the procedures, stated clearly how they would control variables (the volumes of drinks and test reagents) and gave the observations they would expect for Drink A and Drink B.

Weaker responses sometimes listed apparatus which was not used. They sometimes stated incorrect reagents. Iodine, biuret, litmus, universal indicator and limewater tests were all seen as choices for sugar and fat. Other candidates showed an incorrect method. A relatively common error was to suggest evaporating each drink to dryness to find out what it contained. There was often a lack of fine detail in these plans. Many did not heat the Benedict's test. Others did not offer any suggestions for controlling the volumes of drinks or reagents between tests. In addition, on occasion, vague safety precautions such as "wear goggles and gloves" which are not related to specific safety issues for this practical were suggested. Safety procedures which were accepted included identifying that ethanol is flammable and should be kept away from naked flames or for identifying a specific precaution to avoid burns or scalds when heating the Benedict's test.

Question 3

(a) Many candidates did not know the test for hydrogen. Common incorrect tests included adding magnesium to acids or using limewater. Of those who did know that the test involved a pop, a common error was to state 'a splint' or 'a glowing splint' is used rather than a lighted splint.

(b) (i) Most candidates gave answers to whole seconds, although some incorrectly stated values to one decimal place.

(ii) Candidates need to read the instructions for a graph carefully. The question asked candidates to plot a graph of time (vertical axis) against concentration. Many candidates had the axes the wrong way around. It is also important that axis labels include units. These were frequently omitted.

Candidates need to consider two factors in their choice of scale: that the scale is linear and that it allows a graph of suitable size to be drawn.

The values for concentration provided in the table started at 1.0M, but the intervals in the values were 0.5M. Most candidates used the first major gridline on the horizontal concentration axis as '1.0' but then numbered the other major gridlines in intervals of 0.5M. This meant that the area between 0.0 and 1.0 was non-linear. The graph axis does not need to start at zero, but the origin needs to be clearly labelled with a value.

In choosing a scale, the points on the graph need to occupy at least half the grid. Many candidates chose scales which were not sufficiently large. In general, plotting of points was well attempted.

(iii) The line of best fit should be carefully considered to follow the main trend, touching points where possible. If values are not in a straight line, the position of the line should take this into account so that a similar spread of points is seen either side of the line.

(iv) The question asked candidates to describe the relationship between concentration and time for magnesium to fully react. Some candidates discussed rate. This was not asked for by the question.

(v) Most candidates correctly read the graph at concentration 1.8M.

(vi) This question proved challenging and many candidates suggested doing repeats which was not awarded credit. Some made suggestions for improvement to measuring apparatus, such as using a graduated pipette to measure the acid. The strongest candidates realised that it is difficult to judge when the magnesium has fully reacted, and therefore correctly stated that the volume of gas in a particular time or the time to collect a particular volume of gas could be measured.

(vii) Some stronger candidates answered this question. A common error seen in this question was line **C** incorrectly crossing line **B**.

(c) The strongest answers correctly represented a container (a test-tube or flask) connected by a delivery tube to a gas syringe or measuring cylinder over water, with no leaks and no inadvertent seals in the apparatus. Common errors included:

- showing the acid being heated by a Bunsen burner
- leaving the reactant container open so that no gas would be collected
- collecting the gas in a container which does not measure volume (e.g. a test-tube).

Question 4

(a) (i) Most candidates correctly calculated the volume of the block.

(ii) The question asked candidates to record the mass to the nearest 0.1 g. This instruction was not always followed, leading to incorrect answers to 2 decimal places.

(iii) Almost all candidates correctly calculated density. The most common reason for partial credit being awarded was that candidates did not follow the instruction to give their answer to 2 significant figures.

(b) (i) The strongest candidates answered this question. A common error was that the **X** added to the diagram was incorrectly placed either within the block or near point **F**.

(ii) Most candidates knew how to construct a normal. Some did not ensure that the angle made with the block was 90°. Some drew the normal downwards into the block rather than above it.

(iii) Only the strongest candidates answered this question correctly. Candidates needed to use a protractor to measure the angle. Many angles were stated to be 45°.

(c) Most candidates correctly constructed lines **EG** and **EJ**.

(d) (i) Most candidates measured their lines correctly. The most common error was to record the measurement to a whole number, for example 8, rather than following the instruction in the question to measure to 0.1 cm.

(ii) Candidates responded similarly to **(i)**.

(iii) Almost all candidates correctly calculated a refractive index, either using their own values or those provided.

(e) Stronger candidates realised that even a small difference can mean that the values disagree by over 10 per cent.

COMBINED SCIENCE

Paper 0653/62
Alternative to Practical

Key messages

- Drawings of apparatus or structures should always be 2D. When drawing from a photograph, candidates should ensure that they use clear, continuous smooth lines without any feathering. They should not shade or stipple their diagrams. Shading and attempts to represent a 3D shape generally obscure the lines which show structure and can be unclear. Candidates should take care that junctions between pieces of apparatus are clearly shown to be either sealed or open as appropriate.
- When adding values to a table, candidates need to judge the number of significant figures or decimal places based on the other entries in the table. This is most commonly missed when .0 is involved, as seen in **Question 3(a)(i)**.
- In planning questions, candidates need to include all areas of the task to access the full mark range. They are guided by the bulleted list included in the task.
- Candidates can expect graphs to appear on most practical papers. Axes need to be the right way around with sensible scales chosen to ensure that values can be determined easily and the plotted points (not just the scale) occupy more than half the grid. Axes must be labelled with units and points plotted clearly and carefully. Lines of best fit should be finely drawn and need to follow instructions relating to any labelling, or drawing lines to show how they have read values from the graph.
- Candidates should take care when discussing reasons for repeating readings that they make clear scientific points. Repeating readings alone does not make results more accurate. When repeats are carried out, candidates need to be aware that this is in order to check for consistency by looking for similar results and identifying any anomalous values.
- The appendices in section 7 of the syllabus contain important information relevant to the alternative to practical paper. For example, 7.8 states that the gradient of a straight line should be taken using a triangle whose hypotenuse extends over at least half of the length of the best-fit line, and this triangle should be marked on the graph. Many candidates did not seem to be aware of this. Section 7.7 contains the mathematical requirements and terms that candidates need to be familiar with such as diameter.

General comments

There were some strong answers to the questions on this paper. Most questions were fully answered with most omissions and gaps seen in **Question 2**.

Comments on specific questions

Question 1

(a) Nearly all candidates were able to draw a basic outline using more than half of the box. Many were able to give a clear and continuous outline with some correct indication of the inner detail. Those gaining full credit had paid attention to the detail of the numbers and orientation of the lines and circles on the photograph.

(b) Candidates were generally able to measure the diameter in the photograph in millimetres and then apply the equation to calculate the actual diameter of the original specimen. Some used centimetres instead of following the instructions, even though they were also guided with the unit provided on the answer line. These candidates were still able to gain partial credit for calculation. It was clear some candidates were not familiar with the term diameter or measured the diameter and then multiplied it by the magnification given, giving a popular incorrect value of 127 500 for **(i)**.

(c) Candidates demonstrated their observational skills by giving some good descriptions of similarity and difference. Shape and size were popular correct answers and many gave good detailed descriptions particularly of the different patterns seen to gain credit.

Question 2

Stronger candidates typically followed the bullet points in the question to ensure all points were covered. These candidates had a fully labelled diagram, described cutting pieces of potato and carrot of equal size, explained two variables and stated what needed to be kept the same, then went on to describe how they would perform calculations or comparisons. There was evidence that many candidates had carried out osmosis practical work as part of their course and were then able to coherently give a method for an unfamiliar scenario.

Weaker responses often listed apparatus which was not used, for example stating that a measuring cylinder was needed but then omitting any reference to measuring the same volumes. Some candidates gave an incorrect method. A fairly common error was to suggest completely drying out the potato and carrot or observing how crinkly they looked. Other candidates did not give a calculation or comparison of the plant tissues.

Question 3

(a) (i) The most common mistake recording the thermometer readings was to state 21 and 38 rather than 21.0 and 38.0 to match the rest of the table.

(ii) Many candidates started the vertical axis at 0 rather than 20 which meant their points and therefore lines of best fit were very close together.

(iii) Most candidates who had plotted points were able to follow the instructions for drawing and labelling two lines that intersected. Some candidates used a pen rather than a pencil, so could not make any changes easily. Lines needed to be drawn clearly with a ruler.

(b) Candidates who completed the graph for the first acid were generally able to plot the graph and draw the lines for the second acid.

(c) Most candidates were able to correctly read the values from their graphs.

(d) Candidates demonstrated that they were able to use the table to link the colour change to red, to when the mixture is near the maximum temperature.

(e) (i) Many candidates correctly identified sulfuric acid but a number then failed to provide data from the graph to confirm the smaller volume.

(ii) Stronger candidates were able to link a greater number of hydrogen ions in the sulphuric acid formula to the smaller volume needed.

(iii) Few candidates answered this question correctly. Many just restated apparatus that had either already been named in the procedure or would not provide greater confidence in the result.

Question 4

(a) Most candidates were familiar with the correct symbols for ammeter and voltmeter, but many connected both in series. Those that had the voltmeter in parallel often had it across the variable resistor, switch or ammeter, rather than the cell.

(b) (i) (ii) Many candidates were able to correctly read the voltmeter and draw the pointer in the correct place. Of those that had an incorrect reading, most were still able to gain partial credit for having the pointer drawn correctly.

(iii) Extrapolating the line was generally well done. Some candidates did not follow the instructions and stated the correct value but did not draw the line on the graph.

(iv) This question required candidates to calculate the gradient from the graph and to show their working on the graph. Many candidates did not show their working for the gradient as a clear triangle on the graph and others chose an area which was too small.

(c) Candidates were generally able to read the ammeter and voltmeter correctly.

(d) There were a number of answers gaining full credit. Some candidates did not quote values or state that higher currents were needed though this was cued in the question. A common incorrect answer was to add more cells. Stronger candidates realised the variable resistor could be used to reduce the resistance (in order to increase the current).

COMBINED SCIENCE

Paper 0653/63
Alternative to Practical

Key messages

- When candidates are asked to add values to a table, they need to judge the number of significant figures or decimal places based on the question or other entries in the table. Some candidates did not follow the instructions in questions which stated how many significant figures or decimal places needed to be used in the answer.
- In planning questions, candidates need to address all areas of the task to access the full mark range. They are guided in this by the bulleted list included in the task.
- Graphs appear on all practical papers. Candidates need to ensure that the axes are the right way around; choose linear scales such that plots occupy more than half the grid; ensure that axes are labelled with quantities and units; plot carefully and draw considered, smooth lines of best fit.

General comments

There were some strong answers to the questions on this paper. Most questions were fully answered. Most omissions and gaps were seen in **Question 2**.

Comments on specific questions

Question 1

(a) (i) Few candidates explained why the plants needed to be the same species with many suggesting it was to give a fair test. Stronger answers clearly explained that only one variable was then changed or that it would allow a comparison between the effects of the minerals.

(ii) Most candidates correctly measured the height of the plant and gave the unit as mm.

(iii) Almost all candidates correctly calculated the percentage difference.

(b) Almost all candidates gave detailed differences between plants **B** and **C**. Occasionally answers were suggested that were not visible differences, such as stronger stems or dead leaves and these were not credited.

(c) Most candidates were able to recall the information that magnesium is needed for chlorophyll production.

Question 2

Stronger candidates typically described how to vary the intensity of light, described a way of measuring the rate of gas produced (such as counting the number of bubbles in 3 minutes), stated clearly that they would control the temperature of the water and repeated their experiment to find an average.

Weaker responses sometimes gave an incorrect method. A common error was to carry out a starch test on the plant, or to measure its growth over several days. Some candidates did not specify how to obtain the **rate** of photosynthesis, e.g. by measuring the reaction for a set period of time or by collecting a fixed amount of gas and measuring how long it took to collect. Other candidates stated that the species of plant or volume of water should be kept the same but did not include any details of repeats in their plans. In other answers,

candidates did not use their results to check if the statement was correct, such as describing how to calculate the rate or stating that the experiment with double the light intensity would produce more gas in the same time.

Question 3

(a) (i) Most candidates were able to correctly record the temperature to 0.5°C. A common mistake was recording 50.5°C.

(ii) Most candidates recorded the times correctly. Some candidates did not follow the instruction on recording the times to the nearest second.

(b) (i) Candidates need to read the instructions for a graph carefully. The question asked candidates to plot a graph of time (vertical axis) against temperature. Some candidates had the axes the wrong way around. It is also important that axis labels include units. These were frequently omitted. Candidates need to consider two factors in their choice of scale: that the scale is linear and that it allows a graph of suitable size to be drawn.

The graph axis does not need to start at zero, but the origin needs to be clearly labelled with a value. In general, plotting of points was well attempted.

(ii) Almost all candidates identified the anomalous result.

(iii) Most candidates stated that the anomalous result was too high. Few went on to give a correct reason for this. Stronger answers stated that it was hard to tell when the cross had disappeared, or that the stopwatch was stopped too late. Common errors included:

- incorrect volumes of reagents being used
- temperature changes in the room
- stating that the time was too long or that the anomalous point does not follow the pattern rather than suggesting a reason why.

(iv) The line of best fit should be carefully considered to follow the main trend, touching points where possible and ensuring an even spread of points either side of the line. Many candidates included the anomalous point in their line of best fit. Others drew two lines, with one line not including the anomalous point but then did not label which was their line of best fit.

(v) Most candidates correctly stated that the rate increased as the temperature was increased. Some candidates referred to the time taken rather than rate and this was not credited. Some candidates did not include a detailed enough description of the non-linear relationship for full credit.

(vi) Many candidates correctly stated that the time would be too short to measure. A common error was to suggest that the time taken would be less than zero or there was no need to carry on the experiment as there were already sufficient results.

(c) Many candidates correctly suggested repeating the experiment and averaging the result. The most common error was suggesting whole values be used for the temperatures.

Question 4

(a) (i) Many candidates were able to explain that the control experiment allowed the wet and dry cotton wool to be compared, or that the purpose of the control was to show that the liquid alone affected the temperature.

(ii) Almost all candidates calculated the temperature change correctly. Many did not follow the pattern in the table to be awarded full credit.

(iii) Almost all candidates correctly listed the liquids in order.

(iv) Many candidates were able to give at least one improvement to the procedure, such as using the same volume of liquid or the same mass of cotton wool.

(b) (i) Many candidates correctly linked the largest temperature increase with the smallest energy needed.

(ii) Almost all candidates correctly calculated the energy required. However, most did not give their answer to 2 significant figures, as required by the question. It is recommended that candidates show how they have calculated their answer as, in this case, it allowed partial credit to be given.

(c) (i) Almost all candidates recorded the mass correctly.

(ii) Most candidates correctly calculated the mass of the liquid in the beaker.

(iii) Almost all candidates correctly calculated the mass of the evaporated liquid.

(iv) This question was generally well answered with most candidates suggesting heating the liquid to increase the rate of evaporation. Common errors included “adding more light”.