

COMBINED SCIENCE

Paper 0653/11
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Questions 2** and **14**. **Questions 15, 18, 19, 28, 29, 30, 35, 38** and **39** proved more challenging.

Comments on specific questions

Question 1

Whilst most candidates chose the correct option in this question, several candidates selected option **B**.

Question 2

This question was answered correctly by almost all the candidates.

Question 3

Most candidates answered this correctly. However, some candidates incorrectly thought that all enzymes had an optimum pH of 7.0.

Question 4

Many candidates chose the correct option. However, some candidates incorrectly thought that the product of photosynthesis was light and others thought that the product was chlorophyll.

Question 5

Candidates found this question challenging. Most candidates correctly discounted option **D** but then selected either option **B** or **C**.

Question 6

This question was challenging. Many candidates identified that the blood vessel was pulmonary, but many of those then chose the incorrect option.

Question 7

Most candidates were able to identify that lime water in the apparatus would turn cloudy in the presence of carbon dioxide. However, only a few candidates chose the correct tube.

Question 8

Most candidates found this question easy. When candidates did not answer correctly, they chose **B**.

Question 10

This question was challenging. Whilst most candidates chose the correct response, there were many that incorrectly chose the stamen.

Question 11

Most candidates answered this correctly. Some candidates incorrectly identified the functions of the uterus and vagina.

Question 12

Whilst most candidates answered correctly, a significant number chose an option containing T (a producer) as a consumer. Candidates need to know that the arrows indicate the flow of energy.

Question 13

Candidates found this question challenging. Options **B** and **C** were common incorrect answers. They need to know that photosynthesis is the only process in a typical depiction of the carbon cycle that can remove carbon dioxide from the atmosphere (process 1 in the diagram in the question).

Question 14

Candidates understood the term evaporation and were able to identify different the physical states of matter from the diagrammatic representations.

Question 15

Candidates did not recognise the limitations of each piece of apparatus in measuring a specific volume of a liquid. Many candidates chose the incorrect option, **D**.

Question 18

More candidates chose one of the incorrect options, **A**, **C** and **D** than the correct answer, **B**. Candidates are expected to be able to interpret simple symbol equations and understand how to determine the total number of product molecules. Some candidates did this, but did not recognise that this number was for two molecules of ethane, rather than per molecule of ethane.

Question 19

Many candidates chose the incorrect options, **A** and **D** rather than the correct answer, **B**. Candidates need to know the products of the electrolysis of dilute sulfuric acid using inert electrodes.

Question 21

Many candidates chose the incorrect option, **C** rather than the correct answer, **B**. Candidates need to know how the temperature and the concentration of reactants affect the rate of a reaction.

Question 22

There was evidence that many candidates had guessed at the answer. Candidates need to be able to describe the effect of dilute sulfuric acid on metals, bases (including oxides and hydroxides), and carbonates.

Question 27

Some candidates chose the incorrect option, **B** rather than the correct answer, **A**. Candidates need to know that methane is the main constituent of natural gas and that it is unreactive, and that it does not decolourise aqueous bromine or contain any double bonds.

Question 28

In this question on accurate measurement of the period of a pendulum, many candidates incorrectly selected option **A**. They chose the most frequently occurring result rather than calculating the average value.

Question 29

Although nearly all candidates were familiar with the newton as the unit of force, many candidates believed the kilogramme to be the unit for weight, rather than mass. This led them to opt for the incorrect option, **C**.

Question 30

This question proved challenging for many candidates and the most common error was to divide the mass by the density, then take the calculated volume of 8.0 cm^3 as the length (option **C**). Other candidates multiplied the density and the mass and so chose option **D**.

Question 32

This question on non-renewable energy sources was generally well answered.

Question 34

The topic here was transfer of thermal energy. A significant number of candidates thought that transfer from the outside of the potato to the inside was mainly caused by radiation, leading them to choose the incorrect option **D**.

Question 35

Many candidates incorrectly believed that the ray of light would pass straight through the glass without being deflected (option **B**) while others chose the wrong direction for refraction (option **A**).

Question 37

There seemed to be fairly widespread confusion over the charge on electrons as more candidates thought that the negatively charged rod had lost electrons to the cloth than the other way round.

Question 38

Candidates were required to use Ohm's law in this question to identify the smallest current, but only a few did this. The popularity of the incorrect option **A** suggested that possibly many of them failed to read the question carefully and instead found the largest current.

Question 39

This question on circuits proved to be very challenging. Although only one option showed the ammeter connected correctly, fewer candidates chose this circuit than any of the others.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice (Core)

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

General comments

Questions 19, 29, 30, 32, 33, 38 and 39 proved the most challenging for candidates.

Comments on specific questions

Question 1

Whilst most candidates chose the correct option for this question, all other options were chosen by significant numbers of candidates.

Question 2

Candidates found this question challenging. Whilst the correct answer was the most chosen response, many candidates chose option A. Candidates need to be clear about the difference between diffusion and osmosis.

Question 3

Only stronger candidates answered this correctly. Most weaker candidates incorrectly thought that the molecule containing carbon, oxygen, hydrogen and nitrogen was glucose.

Question 4

This question was only answered well by stronger candidates. Most other candidates chose option B.

Question 5

Most candidates answered this question well, but a small number incorrectly chose option **B**. Candidates need to be clear about the difference between photosynthesis and respiration.

Question 6

Most candidates answered this question correctly. Other candidates incorrectly selected option **B**. Dairy products are not in fact good sources of iron.

Question 7

Candidates found this question challenging. Most correctly discounted option **D**. However, many then incorrectly selected either **B** or **C**.

Question 8

This question was challenging. Many candidates identified that the blood vessel was pulmonary, but not all correctly decided whether it was an artery or a vein.

Question 9

Most candidates answered correctly. Candidates needed to realise that breaths become both deeper and more frequent after physical activity.

Question 10

Most candidates found this question easy. When candidates had chosen the incorrect response there was a very slight preference for option **B** (growing away from the light).

Question 11

It was clear from the answers that most candidates had identified that gametes are formed during sexual reproduction. Unfortunately, candidates were then unsure of whether the offspring of the result of sexual reproduction were identical to the parents or not.

Question 12

Whilst most candidates opted for the correct answer, others chose an option containing T as a consumer. Candidates need to know that the arrows indicate the flow of energy.

Question 13

Candidates found this question challenging. Whilst most candidates chose the correct option, option **C** was the most common incorrect option. Candidates need to know that photosynthesis is the only process in a typical depiction of the carbon cycle that can produce oxygen (process **B** in the diagram in the question).

Question 14

More candidates chose the incorrect option **B** than the correct answer, **C**. Candidates need to understand what a molecule is, and how molecules, atoms, elements and compounds are represented diagrammatically.

Question 15

More candidates chose the incorrect option **C** than the correct answer, **A**. Candidates need to understand the limitations of different pieces of apparatus when measuring a specific volume of a liquid.

Question 18

More candidates chose the incorrect option **A** than the correct answer, **C**. They are expected to be able to balance simple symbol equations.

Question 19

There was evidence that many candidates had guessed at the answer. Candidates need to be able to describe the products of the electrolysis of dilute sulfuric acid using inert electrodes, including the electrode at which each product forms and the nature of the inert electrodes.

Question 22

Some candidates chose the incorrect option **B** rather than the correct answer, **D**. Candidates need to know that litmus paper shows whether the pH of a substance is greater or less than 7, and that universal indicator is used to identify the pH number of a substance.

Question 25

More candidates chose the incorrect option **A** than the correct answer, **C**. Candidates need to describe alloys, such as brass, as mixtures of a metal with other elements, which may be either metallic or non-metallic.

Question 29

Although nearly all candidates were familiar with the newton as the unit of force, a very large majority of these believed the kilogramme to be the unit for weight, rather than mass. This led them to choose the incorrect response, **C**.

Question 30

By far the most common mistake here was to fail to subtract the mass of the empty measuring cylinder from the combined mass of 120 g, leading to the incorrect option **D**. Candidates needed to look carefully for all the information given in the question.

Question 32

Only a few candidates could identify the energy source for a geothermal power station, with many others opting for **C**.

Question 33

This question on states of matter and molecular arrangement was challenging for many candidates. It was often thought that statement 3 was incorrect.

Question 35

Here, a significant number of candidates chose the wrong direction for refraction (option **A**) while others believed that the ray of light would pass straight through the glass without being deflected (option **B**).

Question 38

Candidates were required to use Ohm's law in this question to identify the smallest current, and only a few candidates did this. The popularity of the incorrect option **A** suggested that many of them instead found the largest current.

Question 39

This question on circuits was challenging for many candidates. Although only one option showed the ammeter connected correctly, fewer chose this circuit than any of the others.

Question 40

More candidates incorrectly chose the variable resistor as the correct component here, rather than the fuse.

COMBINED SCIENCE

Paper 0653/13
Multiple Choice (Core)

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

General comments

Questions 19, 29, 30, 32, 33, 38 and 39 proved the most challenging for candidates.

Comments on specific questions

Question 1

Whilst most candidates chose the correct option for this question, all other options were chosen by significant numbers of candidates.

Question 2

Candidates found this question challenging. Whilst the correct answer was the most chosen response, many candidates chose option **A**. Candidates need to be clear about the difference between diffusion and osmosis.

Question 3

Only stronger candidates answered this correctly. Most weaker candidates incorrectly thought that the molecule containing carbon, oxygen, hydrogen and nitrogen was glucose.

Question 4

This question was only answered well by stronger candidates. Most other candidates chose option **B**.

Question 5

Most candidates answered this question well, but a small number incorrectly chose option **B**. Candidates need to be clear about the difference between photosynthesis and respiration.

Question 6

Most candidates answered this question correctly. Other candidates incorrectly selected option **B**. Dairy products are not in fact good sources of iron.

Question 7

Candidates found this question challenging. Most correctly discounted option **D**. However, many then incorrectly selected either **B** or **C**.

Question 8

This question was challenging. Many candidates identified that the blood vessel was pulmonary, but not all correctly decided whether it was an artery or a vein.

Question 9

Most candidates answered correctly. Candidates needed to realise that breaths become both deeper and more frequent after physical activity.

Question 10

Most candidates found this question easy. When candidates had chosen the incorrect response there was a very slight preference for option **B** (growing away from the light).

Question 11

It was clear from the answers that most candidates had identified that gametes are formed during sexual reproduction. Unfortunately, candidates were then unsure of whether the offspring of the result of sexual reproduction were identical to the parents or not.

Question 12

Whilst most candidates opted for the correct answer, others chose an option containing T as a consumer. Candidates need to know that the arrows indicate the flow of energy.

Question 13

Candidates found this question challenging. Whilst most candidates chose the correct option, option **C** was the most common incorrect option. Candidates need to know that photosynthesis is the only process in a typical depiction of the carbon cycle that can produce oxygen (process **B** in the diagram in the question).

Question 14

More candidates chose the incorrect option **B** than the correct answer, **C**. Candidates need to understand what a molecule is, and how molecules, atoms, elements and compounds are represented diagrammatically.

Question 15

More candidates chose the incorrect option **C** than the correct answer, **A**. Candidates need to understand the limitations of different pieces of apparatus when measuring a specific volume of a liquid.

Question 18

More candidates chose the incorrect option **A** than the correct answer, **C**. They are expected to be able to balance simple symbol equations.

Question 19

There was evidence that many candidates had guessed at the answer. Candidates need to be able to describe the products of the electrolysis of dilute sulfuric acid using inert electrodes, including the electrode at which each product forms and the nature of the inert electrodes.

Question 22

Some candidates chose the incorrect option **B** rather than the correct answer, **D**. Candidates need to know that litmus paper shows whether the pH of a substance is greater or less than 7, and that universal indicator is used to identify the pH number of a substance.

Question 25

More candidates chose the incorrect option **A** than the correct answer, **C**. Candidates need to describe alloys, such as brass, as mixtures of a metal with other elements, which may be either metallic or non-metallic.

Question 29

Although nearly all candidates were familiar with the newton as the unit of force, a very large majority of these believed the kilogramme to be the unit for weight, rather than mass. This led them to choose the incorrect response, **C**.

Question 30

By far the most common mistake here was to fail to subtract the mass of the empty measuring cylinder from the combined mass of 120 g, leading to the incorrect option **D**. Candidates needed to look carefully for all the information given in the question.

Question 32

Only a few candidates could identify the energy source for a geothermal power station, with many others opting for **C**.

Question 33

This question on states of matter and molecular arrangement was challenging for many candidates. It was often thought that statement 3 was incorrect.

Question 35

Here, a significant number of candidates chose the wrong direction for refraction (option **A**) while others believed that the ray of light would pass straight through the glass without being deflected (option **B**).

Question 38

Candidates were required to use Ohm's law in this question to identify the smallest current, and only a few candidates did this. The popularity of the incorrect option **A** suggested that many of them instead found the largest current.

Question 39

This question on circuits was challenging for many candidates. Although only one option showed the ammeter connected correctly, fewer chose this circuit than any of the others.

Question 40

More candidates incorrectly chose the variable resistor as the correct component here, rather than the fuse.

COMBINED SCIENCE

Paper 0653/21
Multiple Choice (Extended)

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

General comments

In general candidates did not appear to find any questions particularly straightforward or particularly challenging.

Comments on specific questions

Question 1

Most candidates answered this correctly. When candidates chose one of the incorrect options it appeared that they were guessing.

Question 2

Most candidates answered this well. A few candidates incorrectly thought that all living organisms were made of organs.

Question 3

When answering this question most candidates chose the correct option. A small number of candidates incorrectly thought that all enzymes had an optimum pH of 7.0 and some candidates incorrectly thought that enzymes were made of carbohydrates.

Question 4

Most candidates identified **D** as the correct answer. The most chosen incorrect answer was the option where the chemicals were correct but only one side was correctly balanced.

Question 5

Most candidates found this question easy. However, a significant minority chose the incorrect deficiency disease, scurvy.

Question 6

Most candidates answered this correctly. Incorrect responses confused mechanical and chemical digestion.

Question 7

Many candidates answered this correctly. When candidates chose the incorrect option, they selected **A**, oxygenated blood being pumped at high pressure to the lungs.

Question 8

Some candidates found this question challenging. Whilst there would be decreased oxygen in the blood following aerobic respiration, it is not the cause for the increased rate and depth of breathing. The cause is an increase in carbon dioxide in the blood.

Question 9

Most candidates found this question easy. When candidates chose an incorrect answer, it appears that they were guessing between the remaining options.

Question 10

This question was usually answered well. When candidates made mistakes, they incorrectly chose stamen. The stamen holds the stigma in the optimum position for pollination.

Question 11

Although most candidates answered this correctly, a few thought that oxygen was transported from the fetus to the mother and that carbon dioxide left the mother and went to the baby.

Question 12

Whilst most candidates opted for the correct answer, a small number selected an option containing T as a consumer. Candidates need to know that the arrows indicate the flow of energy.

Question 13

This question was usually answered well. When candidates chose an incorrect option, most had included the extinction of species as a cause for an increase in atmospheric carbon dioxide levels.

Question 14

More candidates chose the incorrect option **C** than the correct answer, **D**. Candidates need to know that the process of melting ice requires heat energy to be taken in, and so is endothermic, and so the opposite, the freezing of water to become ice, releases heat energy and so is an exothermic change.

Question 16

Some candidates chose the incorrect option **B** rather than the correct answer, **D**. Candidates need to know that rust is iron oxide, and that it has a greater mass than the iron alone.

Question 28

In this question on speed–time graphs, some candidates chose the incorrect option, **D**. Candidates needed to realise that the line did not start at the origin.

Question 29

Many candidates were familiar with the correct expressions for kinetic and gravitational potential energies. However, some of these did not recognise that gravitational potential energy is reduced as the ball rises and, as a result chose the incorrect option, **C**.

Question 33

The most common incorrect responses were that the ray of light would pass straight through the glass without being deflected (option **B**) or that it would be refracted in the wrong direction (option **A**).

Question 37

Candidates were required to use Ohm's law in this question to identify the smallest current, and many candidates did this successfully. Some candidates possibly did not read the question well enough and instead found the largest current.

Question 38

Although it was quite widely known that shorter wires have a smaller resistance, a few candidates did not use the inverse relationship between resistance and diameter, resulting in them choosing the incorrect option, **A**.

Question 39

This question on circuits was challenging for many. Although only one option showed the ammeter connected correctly, a significant number of candidates opted for one of the incorrect circuits, **B** or **C**.

COMBINED SCIENCE

Paper 0653/22
Multiple Choice (Extended)

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

General comments

In general, candidates did not appear to find any questions particularly straightforward but found **Questions 3, 30 and 39** more challenging.

Comments on specific questions

Question 1

Most candidates chose the correct option for this question and the most common incorrect option contained the word 'growth'.

Question 2

Most candidates chose the correct option. The incorrect options were seen as often as each other.

Question 3

Whilst the correct answer was the most chosen option, it appears that many candidates found this question challenging. Many incorrectly thought that the molecule containing carbon, oxygen, hydrogen and nitrogen was glucose.

Question 4

Most candidates answered this correctly. However, some candidates thought that the most effective collisions were at point **B** on the graph, even though this point was not at the peak of enzyme activity.

Question 5

Whilst most candidates chose the correct option, many selected one of the incorrect options. When candidates chose incorrectly there was a slight preference for option **C** (the correct equation with only one side correctly balanced).

Question 6

This question was usually answered well. Some candidates incorrectly chose fruit or milk as a good source of iron.

Question 7

Most candidates identified the correct structure. Of those a small number incorrectly thought that the enzyme that converted starch to simple sugars was protease.

Question 8

Most candidates answered this correctly. However, some incorrectly thought that exercise caused an increase in the rate of breathing, without an increase in depth.

Question 10

Most candidates realised that asexual reproduction involves the formation of gametes. There was a relatively even split between whether the offspring of the result of sexual reproduction were identical to the parents or not. Most weaker candidates decided that the offspring were identical to their parents.

Question 11

Most candidates correctly chose an option that had a feature of a sperm. However, only some of these candidates correctly identified a correct feature of an egg. Many of those that correctly identified a feature of a sperm thought that an egg had a flagellum. This was most evident in weaker candidates.

Question 12

Whilst most candidates answered this question well, others chose an option containing **T** as a consumer. Candidates need to know that the arrows indicate the flow of energy.

Question 13

Some candidates found this question challenging. The correct answer was the most chosen, but a significant number of candidates incorrectly thought that the main reason for the increased growth of producers was caused by increased availability of carbon dioxide. Weaker candidates incorrectly thought that the increase in producers was caused by an increase in oxygen.

Question 16

More candidates chose the incorrect **C** than the correct answer, **B**. Candidates need to be able to describe bond breaking as an endothermic process and bond forming as an exothermic process.

Question 29

A large majority of candidates performed well in this question on gravitational field strength.

Question 30

The topic here was the source of energy released from the Sun, and the most popular choice was the incorrect option **B**.

Question 31

This question on states of matter and molecular arrangement was challenging for some candidates. It was often thought that statement 3 was incorrect.

Question 32

Very many candidates knew that the water at P expands, but a few candidates incorrectly concluded that the expansion causes its density to increase (option **B**).

Question 33

The most common chosen incorrect option was **C**. This involved correctly recalling the speed of light, then multiplying this by the frequency instead of dividing by it.

Question 34

Here, a significant number of candidates chose the wrong direction for refraction (option **A**) while others believed that the ray of light would pass straight through the glass without being deflected (option **B**).

Question 36

Although many candidates answered correctly, a significant number either divided the time by the charge (option **A**) or multiplied the time by the charge (option **B**).

Question 37

Candidates were required to use Ohm's law in this question to identify the smallest current, and many candidates could do this. Some candidates possibly did not read the question clearly and instead found the largest current.

Question 38

Although it was quite widely known that shorter wires have a smaller resistance, some candidates did not use the inverse relationship between resistance and diameter, resulting in them choosing the incorrect option **A**.

Question 39

This question on circuits was challenging for some candidates. Although only one option showed the ammeter connected correctly, a significant number of candidates opted for the incorrect circuit **B**, and a large number opted for **C**.

COMBINED SCIENCE

Paper 0653/23
Multiple Choice (Extended)

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

General comments

Candidates performed very well on **Questions 19, 21 and 24**. **Questions 32, 36 and 40** were more challenging.

Comments on specific questions

Question 1

Most candidates answered this correctly. When weaker candidates chose an incorrect option, they selected an answer with respiration but not nutrition.

Question 2

Stronger candidates answered this correctly but weaker candidates often chose option **B**.

Question 4

Most candidates answered this correctly. However, many weaker candidates incorrectly selected option **A**.

Question 5

Whilst most candidates chose the correct option. When candidates chose incorrectly there was a preference for option **C** (the correct equation with only one side correctly balanced).

Question 6

Stronger candidates chose the correct option. Weaker candidates often incorrectly thought that the answer was mechanical digestion.

Question 7

Stronger candidates answered this correctly. Most weaker candidates incorrectly chose option **A**.

Question 8

This question was usually answered well but some weaker candidates incorrectly identified the bronchi and a bronchiole.

Question 9

Some weaker candidates incorrectly thought that starch collects on the shaded side of the plant.

Question 10

Most candidates correctly identified the characteristics of insect-pollinated plants. Most identified option **D** as incorrect and if they did not know the correct answer candidates seemed to be guessing.

Question 11

Most candidates answered this correctly. However, some weaker candidates thought that the egg had a flagellum, rather than the sperm.

Question 12

Some weaker candidates selected option **A**. Candidates need to know that the arrows indicate the flow of energy.

Question 13

Most stronger candidates chose the correct option (**C**). Weaker ability candidates opted for answer **D**.

Question 16

More candidates chose the incorrect **A** than the correct answer, **B**. Candidates need to be able to interpret energy level diagrams and to know that bond making is an exothermic process and releases energy.

Question 21

Candidates were able to predict the properties of neon very well by using the information in the table to identify the trends in the properties of the noble gases.

Question 23

More candidates chose the incorrect option **A** than the correct answer, **C**. Candidates need to be able to describe alloys, such as brass, as mixtures of a metal with other elements, which may be either metallic or non-metallic.

Question 24

Candidates had little difficulty in placing the unknown metal in the reactivity series using the given set of experimental results.

Question 30

Most candidates could identify the correct equation for the spring constant of a spring. Some divided the force by the total length rather than by the extension, leading to the incorrect option **B**.

Question 32

This question on states of matter and molecular arrangement was challenging for some candidates. It was often thought that statement 1 was incorrect.

Question 34

The most common error here was to choose option **A**. This involved correctly recalling the speed of light, but then multiplying this by the frequency instead of dividing by it.

Question 35

Here a significant number of candidates chose the wrong direction for refraction option **A**. Candidates need to know that the angle of refraction is taken in relation to the 'normal'.

Question 36

Stronger candidates chose the correct option in this question on a converging lens. Most candidates knew that the image would move to the right, but a majority of these also believed that it would become larger.

Question 39

Although it was quite widely known that shorter wires have a smaller resistance, some candidates did not use the inverse relationship between resistance and diameter, resulting in them choosing the incorrect option **A**.

Question 40

This question on circuits was challenging for some candidates. Although only option **A** showed the ammeter connected correctly, several candidates chose circuit **C**.

COMBINED SCIENCE

Paper 0653/31
Core Theory

Key messages

- Candidates should ensure they read the questions carefully and answer exactly the question that is being asked.
- Many candidates found it difficult to provide a clear explanation of terms given in the syllabus. Being able to provide a clear statement of the meaning of scientific terms is an important part of this course.

General comments

Some good responses were seen in this paper, with some candidates showing a strong understanding of the Core syllabus.

Comments on specific questions

Question 1

- (a) (i) Candidates were asked to identify the aorta (**X**) and vena cava (**Y**) on a diagram of the circulatory system. There were few fully correct answers but some candidates gained partial credit for recognising **X** as an artery and **Y** as a vein. A common error was to identify the vessels as the pulmonary artery and pulmonary vein.
- (ii) Most candidates correctly stated that the function of the heart is to pump blood.
- (iii) Many candidates correctly identified the trachea.
- (b) This was answered well by many candidates.
- (c) (i) There were many correct answers to this question. A few candidates ticked multiple boxes despite the clear instruction to tick just one box.
- (ii) Most candidates were able to calculate the difference in pulse rate (90 bpm) and gained partial credit even if sitting (60 bpm) or running fast (150 bpm) pulse rates had been incorrectly read from the graph. A common mistake was to misread the pulse rate for running fast.
- (iii) This question specifically asked about how breathing when walking is different compared to jumping. Stronger candidates referenced a slower breathing rate and shallower breathing when walking. Many candidates answered the question in terms of the effect on heart rate which did not gain credit.

Question 2

- (a) (i) Few candidates identified both Potassium (**A**) and either Magnesium or Aluminium (**B**). A common error was to identify **A** as Lithium.
- (ii) Most candidates recalled that fizzing/bubbles is an observation of this reaction. Other answers were seen less frequently and a common error was for candidates to state, for example, that a solution is formed which is not an observation.

- (b) This question asked candidates to identify physical properties that differed between iron, a transition metal, and sodium, a group I metal. Common errors included giving a generic property that applied to both, such as 'iron is a metal' or identifying a chemical rather than a physical difference, such as a difference in reactivity.
- (c) Stronger candidates correctly identified copper as the other metal in brass.
- (d) Since the question stated that recycling uses less energy and costs less money, candidates needed to identify a different reason for recycling, not simply restate part of the question. Stronger candidates recognised that metals are a finite resource.
- (e) (i) Many candidates stated clearly that exothermic means that energy is given out.
(ii) In this question, candidates were given the electronic structure of sodium and chlorine ions and asked to complete a figure to show the electronic structure of sodium and chlorine atoms. Many correct diagrams were drawn but a common mistake was to simply repeat the sodium and chlorine ion structure.

Question 3

- (a) Stronger candidates correctly identified both the wavelength (**X**) and amplitude (**Y**). Those gaining partial credit were more likely to recall the wavelength with a number of candidates incorrectly stating that **Y** is the height of the wave.
- (b) Candidates needed to look for the whale with a lowest frequency above 20 Hz and its highest frequency sound below 20 000 Hz using their knowledge of the frequency range of the healthy human ear, 20–20 000 Hz. Very few correctly identified the dwarf minke whale.
- (c) (i) To answer this question correctly, candidates needed to read the question carefully and realise that if the whale is swimming at a constant speed, then there will be no resultant force on it as it is not accelerating.
(ii) Full credit was gained by many candidates who correctly calculated the distance of 5500 m. Candidates who did not convert time into seconds still gained partial credit if they correctly used the formula distance = speed × time.
(iii) Most candidates identified that the moving whale has kinetic energy. Fewer candidates were also able to state that this is transferred into thermal energy in the sea.

Question 4

- (a) This question was answered well with almost all candidates getting at least partial credit and many gaining full credit.
- (b) (i) Some candidates correctly recalled that Benedict's solution is used to test for the presence of reducing sugar. Common incorrect responses were to recall other food testing reagents.
(ii) Most candidates correctly identified glycogen. Glycerol was a frequent incorrect response.
- (c) (i) Many candidates correctly calculated that two burgers contain 1.2 g salt.
(ii) Many candidates showed some confusion about the importance of eating fibre in keeping food moving through the alimentary canal. Incorrect answers suggesting that fibre gives energy or helps digestion were quite often seen.

Question 5

- (a) This question was answered well by many candidates.
- (b) (i) Very few candidates expressed clearly that evaporation is a physical change because there are no new substances made, only a state change. Many described evaporation and a few repeated the

question stating that it is a physical change because there are no chemical changes, which did not gain credit.

- (ii) Many candidates were able to describe how the structure of a gas and liquid differ and gained at least partial credit.
- (c) Here candidates were asked to deduce that a sulfate is made by reacting with sulfuric acid. Candidates needed to be careful when writing chemical terms that they were accurate. Sulfuric was the correct answer here, and any misspellings needed to be sufficiently close to the correct spelling that they could not be confused with incorrect responses such as sulfate or sulfur.
- (d) This question tested candidates' ability to recall a correct use of naphtha. The syllabus provides a list of uses of the different fractions and naphtha is used in the manufacture of other chemicals. Candidates who provided alternative examples needed to be careful that their answer was clearly a use of naphtha and not a use of another fraction. A common incorrect example given was as fuel in cars, which is the use ascribed to gasoline in the syllabus.

Question 6

- (a) (i) This question was answered well by most candidates but there were a few weaker candidates unable to recall the boiling point of water.
- (ii) This question tested candidates' ability to recall the main method of thermal energy transfer through solids and liquids. Stronger candidates gained full credit but weaker candidates often gave answers that were unrelated to thermal energy, suggesting that they did not understand the question. A small but significant number offered no answer at all.
- (b) Candidates were generally able to recall renewable energy sources and many gained full credit here. Common incorrect answers included water and hydro both of which were too vague to be credited.
- (c) (i) Answers here suggested that many candidates did not understand the term 'lateral inversion'. The strongest candidates, who did understand the term, were generally able to gain full credit for realising that left and right are reversed in the mirror image.
- (ii) Only stronger candidates answered this correctly. A number of candidates seemed to be trying to answer the previous question again by describing lateral inversion. Another common incorrect answer seen was reflection, suggesting that candidates did not understand all the characteristics of an image.

Question 7

- (a) (i) Only stronger candidates correctly identified process X as fertilisation. There were a variety of incorrect responses, including reproduction, germination and planting.
- (ii) To gain credit in this question, candidates needed to state that amino acids are used to make proteins, which are needed for growth. Very few candidates made any reference to proteins in their answer.
- (b) (i) Many candidates correctly identified the site of the stigma on the figure as the place where pollination takes place.
- (ii) Anther was the most common correct answer here. A common incorrect response was stigma.
- (c) Many candidates recognised that the identical offspring came from one parent. Fewer were able to qualify the identical offspring as being genetically identical and gain full credit.
- (d) There were many correct answers here. A common incorrect response was gravitational force and a number of candidates made no attempt at this question.

Question 8

- (a) To gain full credit here, candidates needed to state that a hydrocarbon contains only carbon and hydrogen atoms. Common errors mentioned a mixture of hydrogen and carbon and weaker candidates were not explicit that only hydrogen and carbon are present.
- (b) Many candidates recognised that covalent bonding involves the sharing of electrons, but few were clear that a single bond involved one pair of electrons in each C–H bond.
- (c) (i) A significant number of candidates made no attempt at this question and it was common to see chemical symbols and formulae written in the spaces where numbers were expected. Those who understood the question generally gained full credit.
- (ii) A correct response here required both the identification of carbon being oxidised and an explanation that the carbon has gained oxygen. While many candidates correctly identified the process of oxidation, only the strongest candidates were able to explain this process.
- (iii) The question asked candidates to explain why argon does not react with oxygen in terms of electronic structure. Stronger candidates recognised that argon has a full outer shell of electrons. A significant number of candidates made no attempt at this question.
- (d) There were many correct responses stating that alkenes have a double bond. Some candidates did not gain credit as they only mentioned alkanes having a single bond, which was information already given earlier in this question.

Question 9

- (a) (i) This question was answered well. A few weaker candidates attempted to use the formula for resistors in parallel.
- (ii) There were few fully correct responses here. A correct numerical value of 3.6 was often combined with an incorrect unit, while the correct unit of V was often accompanied with an incorrect calculation.
- (b) Only stronger candidates correctly identified the variable resistor symbol. Some other candidates made no attempt at the question. A wide variety of incorrect responses were seen.
- (c) (i) Many candidates correctly identified this as having resistors **F** and **G** in parallel.
- (ii) Many candidates identified A₁ as having the highest reading but did not give a valid reason. The answer 'it is next to the battery' was a very frequent incorrect response.
- (iii) This question proved challenging to many candidates. They were being asked to notice that if switch **S** is opened then all that remains is a series circuit and so both ammeter readings will be the same, since the current is the same at all points in a series circuit.

COMBINED SCIENCE

Paper 0653/32
Core Theory

Key messages

- Candidates should ensure they read the questions carefully and answer exactly the question that is being asked.
- Many candidates found it difficult to provide a clear explanation of terms given in the syllabus. Being able to provide a clear statement of the meaning of scientific terms is an important part of this course.

General comments

Some good responses were seen in this paper, with some candidates showing a strong understanding of the Core syllabus.

Comments on specific questions

Question 1

- (a) (i) Almost all candidates gained some credit here with most stronger candidates gaining full credit.
- (ii) The majority of candidates correctly identified **D** (the xylem) as the vessels that transport the blue liquid.
- (b) (i) This was answered well by most candidates.
- (ii) Very few candidates correctly stated that the ethanol emulsion test is used to test for the presence of oil in seeds. Some candidates gave the insufficient answer, emulsion test.
- (c) (i) Most candidates correctly read the data from the graph to state the mass of palm oil used worldwide in 2011 was 48×10^9 kg.
- (ii) Candidates showed excellent understanding of the effects of deforestation on rainforest animals. Answers often referred to the destruction of habitat or loss of shelter and disruption to food supply. A common insufficient response was the idea that animals would die, which did not describe how deforestation affects the animal.

Question 2

- (a) (i) Stronger candidates correctly identified filtration as the separation technique required to separate insoluble solid from the mixture of solid and aqueous sodium chloride. A significant number of candidates made no attempt at this question. Common incorrect answers included evaporation and crystallisation suggesting that candidates had misunderstood the question and thought they were trying to obtain sodium chloride from the solution.
- (ii) Very few candidates identified sodium chloride as the solute and water as the solvent. A common incorrect answer was sodium as solute and chloride as solvent, suggesting candidates did not understand the terms used in the question.
- (iii) Candidates were often unable to explain clearly the term 'concentrated' as a larger number of solute particles in a given volume of solution. The statement, 'a lot of particles present' was

insufficient since it is necessary to distinguish between solute particles (a concentrated solution has more of these) and solvent particles (a concentrated solution has relatively few of these).

- (b) (i)** A majority of candidates recognised the process of electrolysis. Some weaker candidates made no attempt at this question.
- (ii)** Many candidates correctly identified the anode.
- (iii)** Only the very strongest candidates were able to state that hydrogen is formed at the negative electrode. There was a wide range of incorrect responses and significant number of candidates made no attempt at this question.
- (c) (i)** While many candidates realised that diatomic must involve two atoms, only a few gave the correct response that made it clear that these atoms are joined or form a molecule.
- (ii)** Ionic bonding was correctly identified by some candidates, with the common incorrect response of covalent bonding seen frequently too. There were also answers unrelated to chemical bonding suggesting that the question had not been well understood by some candidates.
- (iii)** Very few candidates gave a fully correct response to this question. Candidates had to state clearly that the test involved adding nitric acid as well as aqueous silver nitrate, with the positive result being the formation of a white precipitate. Many candidates made no attempt at this question.

Question 3

- (a) (i)** This question was answered well by most candidates.
- (ii)** Most candidates answered this correctly.
- (b) (i)** To gain credit here, candidates needed to clearly indicate that the wavelength is the distance between two equivalent points on consecutive waves. The strongest candidates marked the two points (e.g., two consecutive crests) and joined these points carefully with a straight line. A number of weaker candidates identified the amplitude or left the question unanswered.
- (ii)** Many candidates were able to correctly calculate the frequency of the wave as 2.5 Hz.
- (c)** To gain full credit here, candidates needed to recall and use the formula $\text{speed} = \text{distance} / \text{time}$. Additionally, they had to realise that when the echo is heard, the sound has travelled twice the distance from student to cliff. Many candidates recalled and used the equation but only the strongest correctly calculated the correct distance from student to cliff.

Question 4

- (a) (i)** This question was answered well by most candidates.
- (ii)** Most candidates answered this correctly.
- (b) (i)** Stronger candidates identified the smaller internal area for blood flow in the artery and the thicker wall of muscle in the artery (or reverse arguments about the vein). A common error was for candidates to write about the different functions of arteries and veins, which did not answer the question. Candidates should note that saying 'artery walls are thicker and walls of veins are thinner' is only one difference expressed in two ways and not two differences as asked for in the question.
- (ii)** Haemoglobin transports oxygen. A common incorrect response was that haemoglobin makes blood red, which is true of haemoglobin but it is not its role.
- (c) (i)** Only a few candidates were able to identify the septum clearly.
- (ii)** The strongest candidates correctly identified the pulmonary artery. As the question asked for the specific artery that takes blood from the heart to the lungs, the term artery on its own was insufficient.

- (d)(i) Many candidates were able to state that the hormone adrenaline is released in response to a 'fight or flight' situation.
- (ii) A wide variety of different effects of adrenaline were given here. However, candidates needed to read the question carefully as answers about an effect on heart rate added nothing to the information given in the question about increasing pulse rate and these did not gain credit.

Question 5

- (a) Many candidates gained credit here for identifying chlorine as the element used to kill bacteria in water supplies.
- (b) Few candidates correctly recalled that a mixture of a metal with other elements is an alloy.
- (c) Most candidates were able to gain some credit here. Only the strongest candidates correctly identified all four elements.
- (d) Candidates were instructed to use ideas about types of atom to explain the difference between an element and a compound. Where candidates simply talked about numbers of atoms, rather than being clear about one type or more than one type, they did not gain credit.

Question 6

- (a) Most candidates correctly stated that the meteorite has kinetic energy due to its motion.
- (b) Fewer candidates recognised that air resistance slows the meteorite down. A common incorrect answer was gravitational force.
- (c) Many candidates correctly calculated the mass of the meteorite.
- (d)(i) Many candidates identified where the meteorite hits the earth and were able to explain this by stating that there is a sudden decrease in speed.
- (ii) Candidates found this question more challenging. Some were able to state that there was smaller deceleration in the first 5.5 s but only the strongest candidates linked this to the less steep gradient on the graph.
- (e) Very few candidates knew that **ray 2** continues without deviation through the lens and beyond, and even fewer were able to draw the image inverted, between the intersection of the rays and the principal axis. A number of candidates made no attempt at this question.

Question 7

- (a)(i) Many candidates were able to construct an accurate food chain from the data in the figure. It is important that animals are linked by arrows which indicate the direction of energy flow in the food chain.
- (ii) Many candidates correctly identified the lion as the secondary consumer.
- (iii) This question was answered well by most candidates.
- (iv) Many candidates identified photosynthesis as the part of the carbon cycle that removes carbon from the atmosphere. A common incorrect response was respiration. Although acid rain does involve taking carbon from the atmosphere, precipitation is part of the water cycle and not the carbon cycle and so was not given credit.
- (b) To gain credit here, candidates needed to state a clear function of the cell membrane and a clear function of the cell wall. Some candidates correctly stated that the membrane controls movement of substances in and out of the cells. Fewer candidates identified that the cell wall provides support to the cell with a number incorrectly stating its function as to give the cell its shape.

Question 8

- (a) This was answered well by many candidates. A number of weaker candidates made no attempt at this question.
- (b) To know the rate of a reaction it is necessary to time it and so a stopwatch or other timing device is needed. A common incorrect response was to suggest the need for a thermometer.
- (c) Very few candidates were able to complete the word equation accurately. However, many gained some credit, either for recognising that calcium chloride is made or for knowing that the other two products are carbon dioxide and water.
- (d) (i) Candidates gained credit here when they suggested a means of increasing the surface area of the calcium carbonate, either by crushing or using a powder or smaller piece. A number of candidates suggested using more calcium carbonate suggesting that they had not read the question carefully, since it stated that the same mass of calcium carbonate is used.
- (ii) More candidates were able to state that warmer or more concentrated hydrochloric acid would increase the rate of the reaction.
- (e) (i) Many candidates correctly deduced the number of neutrons in the calcium atom.
- (ii) Few candidates correctly deduced the number of electrons in a calcium ion. A wide variety of incorrect responses were seen.

Question 9

- (a) (i) Many candidates correctly identified the series circuit arrangement shown in the figure.
- (ii) A fully correct answer here required candidates to first calculate the total resistance of the two resistors, then to recall and rearrange the equation $V = IR$, and finally to add the unit, A, for current. Many candidates gained some credit. The most frequent error was to calculate the current based on the resistance of one lamp only. A significant number of candidates who performed a fully correct calculation then failed to provide the correct unit of current.
- (iii) To gain credit here, candidates needed to state that the other lamp goes out because there is no longer a complete circuit. Stating that the other lamp goes out because they are in series was an insufficient description of the reason.
- (b) Many candidates answered this correctly.
- (c) (i) Few candidates correctly identified the variable resistor. A number of different incorrect responses were seen. Resistor on its own was an insufficient response since **X** is specific type of resistor.
- (ii) Almost all candidates who attempted this question gained at least partial credit for drawing a complete circuit. Fewer included the correct symbol for an ammeter. A significant number made no attempt at this question.

COMBINED SCIENCE

Paper 0653/33
Core Theory

Key messages

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- (b) Many candidates answered this correctly.
- (c) (i) Few candidates correctly identified the variable resistor. A number of different incorrect responses were seen. Resistor on its own was an insufficient response since **X** is specific type of resistor.
- (ii) Almost all candidates who attempted this question gained at least partial credit for drawing a complete circuit. Fewer included the correct symbol for an ammeter. A significant number made no attempt at this question.

COMBINED SCIENCE

Paper 0653/41
Extended Theory

Key messages

Candidates who did well on this paper:

- read the questions carefully and wrote answers that were appropriate for the command words given, e.g., describe, explain and suggest.
- drew electric circuit symbols as they are shown in the syllabus
- were able to use particle theory in explanations
- were familiar with definitions as they appear in the syllabus.

General comments

Many candidates had excellent understanding of most of the syllabus and gave clear, well-organised answers. Knowledge of the three science disciplines was usually well-balanced. Candidates usually showed their working in questions requiring calculation, whether instructed to do so or not, and this is good practice.

The time allowed for the examination was sufficient for the great majority of candidates.

Comments on specific questions

Question 1

- (a) Almost all candidates gained full credit.
- (b)(i) Cell wall was the most popular answer. Common incorrect answers were chloroplast and cytoplasm.
- (ii) Most candidates recognised the root hair cell.
- (iii) Some candidates wrote correct and concise answers, gaining full credit. Many candidates gained credit for the use of the term osmosis and understood the concept of water potential and how this controls the flow of water. A common reason why only partial credit was awarded was that candidates omitted any reference to a partially permeable membrane. Candidates are advised to avoid using the term concentration. This is only accepted as an alternative to water potential if candidates make it clear that they are referring to the concentration of water.
- (c) Many candidates gained partial credit for describing how water vapour diffuses out of the leaf through the stomata. Both terms, 'diffusion' and 'stomata' were required. Only stronger candidates gained full credit for stating that the water being lost arises by evaporation from the surface of mesophyll cells.
- (d) Many candidates were familiar with the yellowing of leaves due to magnesium deficiency. Not as many explained the colour change in terms of the role of magnesium in chlorophyll production. Purple or brown were not accepted as alternatives for yellow.

Question 2

- (a) The terms melting, condensation and freezing were familiar to most candidates.

- (b) Many candidates wrote well-expressed answers to each part of the question and gained full credit. Most candidates gained credit for their comparison of the energy difference at the two temperatures. One mistake was to include the idea of free movement when attempting to describe the arrangement. When describing movement, many candidates were familiar with the vibration of particles in a solid like ice, but often could not find words to describe freely moving particles at 120°C. Many suggested that the particles moved faster, which was not quite enough. A minority of candidates did not clearly match their descriptions to either of the two temperatures in the question.
- (c) Several candidates gained full or partial credit. Most candidates gained credit for recognising that sodium chloride contains ionic bonds. Candidates needed to avoid phrases like 'ionic bonds in sodium chloride are stronger than covalent bonds in water'. They also needed to make it clear that stronger bonds require greater energy, rather than temperature, to break. The idea that the strength of ionic bonds arises from the high attractive force between opposite electrical charges on particles was stated by some of the stronger candidates.

Question 3

- (a) Full credit was frequently awarded. Some candidates gained partial credit for identifying 'thermal' or 'heat'. Elastic was accepted as an alternative for chemical, but the unqualified term potential was not credited.
- (b)(i) The relationship, $\text{acceleration} = \text{change in speed} \div \text{time}$, was familiar to many candidates and most of these worked through to the correct final answer, 4.9 m/s². This answer showed two significant figures and any answer given by candidates that rounded to 4.9. was acceptable. The answer 5 was not accepted. A common mistake was the misreading of the maximum value of speed.
- (ii) The calculation of the area under the graph to give distance was familiar to many candidates, and many worked through to the correct answer, 30 m. The two most common mistakes were to calculate the area under the whole graph and to use the simpler relationship, $\text{distance} = \text{speed} \div \text{time}$.
- (iii) The use of the formula for kinetic energy was very familiar and many candidates gained full credit. Most candidates gave the final answer as 4624 J which rounds to 4600 J and so was accepted. One common mistake seen from candidates who correctly stated the formula, was that they did not calculate the square of the speed.
- (iv) The relationship between power, energy change and time was familiar to stronger candidates who often gained full credit. Many candidates gained at least partial credit for recalling the correct unit. The most common incorrect unit was joules (J).

Question 4

- (a) Candidates should be encouraged to learn the definitions of ecological terms given in the syllabus. In this question the term 'abiotic factors' was accepted as an alternative to 'environment'. A variety of words that conveyed the idea of area were accepted as alternatives. Many candidates had learned ecological vocabulary but used it incorrectly.
- (b)(i) Many candidates answered this question correctly. The most common mistake arose from not realising that phytoplankton occupy the first trophic level which led to bird or leopard seal being suggested.
- (ii) The majority of candidates understood how energy is passed on in this feeding relationship. Candidates needed to refer to feeding at least once. Therefore, answers such as 'energy goes to bird from zooplankton via fish' did not gain full credit.
- (c) Eutrophication had been learned very well by large numbers of candidates, many of whom gained full credit for their answers. Any sensible named producer was accepted and many candidates referred to algal blooms. Respiration by decomposers was the least familiar stage in the process, and respiration in a variety of plants and animals was suggested. The lack of oxygen causing the death of fish was the most common correct answer. Candidates suggesting suffocation without mentioning oxygen were not awarded credit.

Question 5

- (a) The majority of candidates were awarded full or partial credit. When writing the formula CuO , candidates needed to make sure that the letter u was obviously lower case. Formulae that had the appearance CUO were not credited.
- (b) Many candidates correctly identified carbon as the reducing agent. For the explanation, it was important that candidates stated the idea that carbon reduces lead oxide or that lead oxide has oxygen removed by carbon. It was not enough simply to suggest that carbon is oxidised and so is the reducing agent. Explanations in terms of electron transfer were occasionally attempted and gained credit if they were perfectly correct e.g., 'reaction with carbon causes lead ions to gain electrons'.
- (c) (i) It was essential that candidates wrote the names of the three metals, iron, lead and copper into the table, and not the names of oxides. In their explanations of the reactivity order, candidates needed to show they had used the information about competition for oxygen. Credit was not awarded for answers such as 'this is the order of these metals in the reactivity series'.
- (ii) Some candidates answered this correctly. Others suggested that there would not be a reaction because iron is more reactive than zinc and some candidates suggested that there would not be a reaction because zinc was more reactive.
- (d) A minority of candidates were familiar with the observations when lead reacts with aqueous copper nitrate. Many seemed to be guessing and suggested effervescence, temperature increase and production of odours. Candidates should avoid suggesting that the blue solution turns 'white' when they are attempting to describe decolouration. A variety of alternatives to the brown/orange coating were allowed.

Question 6

- (a) (i) Some candidates made a successful attempt at showing a wavelength, and the allowed margin of error allowed many to gain credit. One error that was often seen was a double headed arrow that spanned the whole diagram.
- (ii) Most candidates could interpret the diagram correctly and so gained credit here. Some candidates reversed the meanings of the terms compression and rarefaction, and others made unqualified statements such as 'some of the particles are close and others are far away'. Stronger answers avoided phrases such as 'loosely packed' when trying to describe greater separation.
- (b) (i) Most candidates correctly selected two from bat, dog and horse.
- (ii) Many candidates identified the bat but only a small number also identified the canary. Both were needed for credit.
- (c) Stronger candidates identified both of the steps required in this question, and usually gained full credit. Many who gained partial credit successfully used the relationship, $\text{wavelength} = \text{wave speed} \div \text{frequency}$, and got as far as finding the value of wavelength, 2 m.
- (d) A small number of candidates realised that the large surface area and being thin made the elephant's ears good radiators of thermal energy. An acceptable alternative was that the ears are able to flap and so could transfer thermal energy by convection. Some candidates suggested an energy transfer process without linking it to an adaptation of the ears. Answers like this could not be credited.

Question 7

- (a) (i) Many candidates were able to label a bronchus. Trachea, bronchiole and alveolus were common incorrect answers. A small number of fairly strong candidates appeared to have overlooked this question.
- (ii) Many candidates were able to state two relevant features of alveoli. The most popular answers were large surface area and thin walls. Candidates usually avoided wording such as 'alveoli are

one cell thick' without reference to the walls of the alveoli. Some candidates seemed unsure of the word 'features' and made suggestions such as 'gaseous exchange happens in them'.

- (b) (i) The significance of the key word 'increase' was overlooked by some candidates who gave answers such as 'person 1's breathing rate is higher after exercise'. Credit was awarded if candidates answered by quoting correct data from the bar graph. Some candidates attempted to answer using the pulse rate data.
- (ii) Many candidates were able to read the bar graph correctly and calculated the increase in pulse rate. They were less secure in calculating the percentage increase. A value of 85.7(per cent) was accepted but 85 per cent was not. A mark was awarded for a correct calculation of percentage increase from incorrect data.
- (c) Even stronger candidates did not always answer this question in terms of changes that occur during exercise. They discussed respiration rather than increased respiration and they described the production of carbon dioxide rather than the increased production of carbon dioxide. The reasons for the increase in breathing rate were therefore not explained. Many other candidates made no reference to carbon dioxide and repeated the information given in the question about the need for increased oxygen.

Question 8

- (a) Most candidates were very familiar with the process of filtration. The reason large numbers could not be awarded full credit was because they missed the significance of the command word 'explain' and wrote answers that were limited to a description. Therefore, answers such as 'sea water is the filtrate and plastic is the residue' did not answer the question.
- (b) Many stronger candidates gained full credit for clear explanations of the processes occurring in distillation. A minority named and discussed crystallisation possibly because they missed the significance of the phrase 'to obtain pure water' in the question. When referring to cooling or condensation, candidates needed to be careful with wording and make it clear that water vapour rather than water was being condensed.
- (c) Full credit was very frequently awarded. Ozone was allowed as an alternative for chlorine, but chloride, chlorination and names of various commercial sterilizers were not. Candidates should avoid using the term 'germs' which is not accepted as an alternative for bacteria, microorganisms or pathogens.

Question 9

- (a) Many candidates knew that the sum of the currents in each branch of the circuit adds to give the total current. The most common mistake was to think that the current in each of the branches containing the lamps was $1.5\text{A} + 1.5\text{A} = 3\text{A}$. This produces a final answer of 14.5A which gained partial credit.
- (b) The majority of candidates correctly stated ammeter. Misspelling that was not credited included 'ampmeter' and 'amperimeter'. Voltmeter was the most common incorrect answer.
- (c) Most candidates connected the components correctly and many were awarded full or partial credit. Candidates should be encouraged to draw circuit symbols as they appear in the syllabus. The symbol for a fuse was less familiar than for a switch. Switches should be shown in the open position.

COMBINED SCIENCE

Paper 0653/42
Extended Theory

Key messages

Candidates who did well on this paper:

- read the questions carefully and wrote their answers legibly
- drew electric circuit symbols as they are shown in the syllabus
- were able to use particle theory in explanations in all three sciences
- understood the concept of activation energy.

General comments

Many candidates had excellent understanding of most of the syllabus and gave clear, well-organised answers. Knowledge of the three science disciplines was usually well-balanced. Candidates usually showed their working in questions requiring calculation, whether instructed to do so or not, and this is good practice. Some questions required candidates to label a diagram and a small number of fairly strong candidates omitted to do this. Candidates should note that some questions may not have an answer line.

The time allowed for the examination was sufficient for the great majority of candidates.

Comments on specific questions

Question 1

- (a) The location of the cervix was familiar to many candidates. The placenta was the most common incorrect response. A small number of fairly strong candidates appeared to have overlooked this question.
- (b) (i) Many candidates gained credit here. There was a wide variety of incorrect suggestions.
- (ii) Candidates needed to state that the mother's blood is the source of amino acids for the fetus for full credit to be awarded. Only a minority of candidates did this. Many candidates gained partial credit for referring to the placenta, the umbilical cord and diffusion. A mistake was to suggest or imply that the mother's blood flows across the placenta to the fetus.
- (c) Stronger candidates made it clear that iron taken in by the mother has to be shared with the fetus. A variety of ways to express this idea were given and most gained credit. Some candidates went on to gain full credit with a correct reference to the role of iron in the formation of haemoglobin or red blood cells or by stating a specific symptom of iron deficiency in the mother. It was not enough simply to state that the tablets are taken for iron deficiency.
- (d) Most candidates gained at least partial credit for recognising 'mouth'. Many also gained credit for 'anus'. Rectum was often seen instead of anus but this was not accepted. The function of the large intestine was less familiar and many candidates described digestion. Candidates needed to state that water is absorbed by the large intestine. Other correct suggestions such as mineral salts, vitamins and even unqualified nutrients were not accepted on their own.

Question 2

- (a) (i) Many candidates gained credit for any clear reference to a lack of reactivity. Stronger candidates used the context of the question and explained that the electrode does not change chemically as the result of electrolysis. Candidates who relied on their knowledge of the term 'inert' in the context of noble gases did not gain credit for answers such as 'the electrode has a full outer shell'.
- (ii) Most candidates had learned these gas tests and gained full credit. Chloride was not accepted for chlorine. Several candidates incorrectly suggested sodium as the product at the positive electrode.
- (iii) Large numbers of candidates gained credit here. The main errors were reversing the names of the electrodes or suggesting substances that candidates thought might be formed during electrolysis.
- (b) Candidates were familiar with the general process of electrolysis but not with the depth of detail required to answer this question. Some stronger candidates gained full credit, sometimes by stating a correct electrode equation. Many others found the question challenging but partial credit was often awarded for stating that sodium ions move to the cathode. Some of the more common mistakes included suggesting that sodium ions lose electrons at the electrode or that sodium atoms gain electrons.
- (c) Candidates found this question very challenging and only a minority of the strongest candidates gained full credit. Other candidates did not know that the electrolysis of aqueous sodium chloride produced hydrogen at the cathode. Many tried to answer in terms of the flow of free electrons through the molten electrolyte. Some stated that an aqueous solution contains water but then did not go on to make the link to hydrogen.

Question 3

- (a) (i) Most candidates gained credit here. The most common mistakes were 2, 4, 5 and 7.
- (ii) Stronger candidates were able to label the amplitude correctly and positioned their arrows carefully. However, some arrows were carelessly drawn. The most common mistake was to show the double amplitude between minimum and maximum on the diagram.
- (b) (i) Many stronger candidates understood that frequency refers to waves per second and so knew that they needed to calculate the value of 6 waves divided by 40 seconds. Calculation of 6×40 was a common mistake. Candidates who did not make progress with the calculation often gained partial credit for stating the correct unit. Acceptable alternatives to Hz were Hertz and hertz but not hz.
- (ii) The use of the relationship, wave speed = frequency \times wavelength, was familiar to many candidates who gained full credit. The most common mistake was the incorrect recall of the relationship.
- (c) Stronger candidates understood that sound waves travel faster through water than through air and that this means that the time taken for the sound to travel would be shorter. Unless candidates had circled 0.055s no credit could be awarded whatever was suggested for the reason. Significant numbers of candidates stated that sound travels faster in water but then circled the greatest time delay. Others circled 0.055s but then stated that sound travels more slowly in water. Relevant references to the greater density of water were accepted as an alternative reason.

Question 4

- (a) (i) Most candidates recognised the diaphragm. The most common error was rib.
- (ii) Many candidates correctly labelled the larynx. Common errors included trachea, alveoli and ribs.
- (b) Most candidates gained credit here for stating that exhaled air contains the greater proportion of carbon dioxide. Stronger candidates usually gained further credit for referring to respiration. A common mistake was to suggest that oxygen is turned into carbon dioxide in the lungs.
- (c) Many candidates were familiar with the effect of cigarette smoke on the cells in airways, and many stronger candidates were awarded full credit. Common errors included the ideas that cilia trap particles, that cilia produce mucus and that goblet cells absorb mucus.

Question 5

- (a) The use of colour change indicators to test pH was very familiar to most candidates. The data table included a range of numerical pH values and so credit was not given for suggesting a two-colour indicator such as litmus. Any suggestions involving a digital pH meter were accepted as an alternative.
- (b) (i) Many candidates identified iron chloride solution as most acidic because it has the lowest pH. Candidates needed to identify the 'lowest' pH and so answers such as 'it has an acid pH' or 'its pH is very low' were not enough.
- (ii) Only stronger candidates put together their knowledge of the reactivity series and metal displacement reactions to gain credit here. Every combination of pairs of solutions was seen from those who guessed.
- (c) Most candidates gained at least partial credit even if they did not identify experiment 4 as having the highest rate. Credit was awarded for correct statements about the effect on rate of increased surface area, for stating that particle energy is increased at higher temperature and for referring to collision frequency. Few candidates related their answers to the concept of activation energy. Many candidates, attempting to include activation energy, suggested that it was a variable that increased or decreased with temperature. The idea of 'successful collisions' was accepted as an alternative for the idea of collisions exceeding the activation energy. A common mistake was that larger pieces of copper carbonate would have a greater total surface area.

Question 6

- (a) (i) Many candidates realised that the meteorite would increase in speed due to the gravitational pull of the Earth. A variety of ways of expressing this idea were accepted.
- (ii) The use of the formula for kinetic energy was familiar to many candidates who gained full credit. Correct numerical answers not in standard form were accepted. A significant number of candidates stated the correct form of the equation but then omitted to square the velocity when they came to the calculation.
- (b) (i) Stronger candidates understood that opposing forces emerge to slow the meteorite down when it enters the earth's atmosphere. The idea of drag was accepted as an alternative to air resistance and friction. A common misconception was that gravitational force decreases in the atmosphere or when the meteorite approaches the ground. Some candidates suggested that changes in gravitational potential energy influenced the speed. Others did not mention the atmosphere and gave answers such as 'the meteorite is not in the vacuum of space anymore'.
- (ii) Some candidates understood that air resistance and friction increase as the meteorite gets closer to the ground. The idea that the density of the atmosphere increases at lower altitudes was stated by only a few candidates. As seen in (i), some candidates attempted to explain the increase in deceleration in terms of misconceptions such as reduced gravitational pull nearer to the ground.
- (c) (i) The great majority of candidates gained credit here.
- (ii) Many stronger candidates worked through this calculation and gained full credit. Final numerical answers of 4600 and 4612 were accepted in addition to 4610 kg/m^3 . Partial credit was awarded for recall of the relationship, $\text{density} = \text{mass} \div \text{volume}$. Many did not convert 980 cm^3 to m^3 and so ended up with a final answer that did not match any of the density ranges given to identify the composition of the meteorite. Credit was also available for identifying the composition of the meteorite using the density values shown in the data table. Candidates that guessed the composition of the meteorite to be stony-iron but showed no working did not gain credit.

Question 7

- (a) (i) Many candidates gained full credit. Candidates who stated an incorrect final answer often did not show any working. This meant that partial credit could not be awarded for any correct steps such as calculation of the number of seconds in three minutes. A common incorrect answer was 0.002 cm/s and there was sometimes evidence that candidates had arrived at this value by looking for patterns in the supplied data.
- (ii) Full credit was awarded to only a small minority of stronger candidates. Credit, for recognising that below 20 cm the rate of photosynthesis reaches a constant value, was rarely awarded. Many candidates did not refer to light intensity and/or rate of photosynthesis in their answers, preferring instead to answer in terms of the column headers in the data table and this was not credited.
- (b) Some stronger candidates gained at least partial credit for referring to denaturation of enzymes above the optimum temperature and for giving a description of how this prevents the engagement of the active site and the substrate. Candidates were asked to explain the shape of the graph which included the section at temperatures below the optimum. Only a small number of stronger candidates did this.
- (c) Most candidates gained full credit.
- (d) (i) Most candidates gained credit here. A small number incorrectly suggested photosynthesis.
- (ii) Many candidates gained credit for this question. There were many incorrect suggestions from those candidates who were unfamiliar with the role of auxin.

Question 8

- (a) (i) This was answered very well by many candidates who gave the most common answer, respiration. Breathing was not an acceptable alternative. The most common acceptable alternative was combustion provided fossil fuels were not mentioned.
- (ii) In this question combustion of fossil fuels was the expected answer and this was given by most candidates. The most popular alternative was deforestation and increased human population was another acceptable alternative. Candidates wanting to suggest emissions from motor vehicles or industries needed to specify that emissions from these sources have increased. For example, the simple answer 'cars' did not gain credit but the answer 'increased numbers of cars' was credited. Stronger candidates referred to increased emissions from car engines.
- (b) Candidates usually answered this question very well and large numbers gained full or partial credit. Some candidates correctly specified 'enhanced', 'increased' or 'run-away' greenhouse effect rather than simply referring to the greenhouse effect but most opted for global warming. Credit for stating a consequence of global warming was usually awarded for reference to climate change.
- (c) (i) This was answered very well by most candidates. Carbon dioxide was allowed as an alternative for the solute.
- (ii) Only a small number of candidates gained credit here. They needed to say that as more carbon dioxide dissolves, sea water becomes increasingly acidic and not just acidic. Some candidates attempted a consequence of increased acidity but this had to be specific and very few correct suggestions were seen. References to the 'harming' of marine life were not enough. Many candidates incorrectly suggested that increased carbon dioxide in sea water would reduce oxygen levels and so fish would suffocate.

Question 9

- (a) The boiling point of water was correctly stated by almost all candidates.
- (b) Some candidates realised that this question required an explanation of the functioning of the bi-metallic strip in terms of the difference in thermal expansion of brass and steel. Only the strongest candidates seemed familiar with the context and could explain that brass expands more than steel. Some suggested that steel showed the greater expansion and others gained partial

credit for an unqualified reference to expansion. Many candidates made no reference to the physics and wrote answers based on health and safety or power saving.

- (c) (i)** Many stronger candidates produced perfect answers to this calculation. Partial credit was awarded to candidates whose only mistake was to omit the conversion of kW to W. Many candidates either did not recall the correct form of the relationship, $P = IV$ or thought that they had to use frequency in the calculation.
- (ii)** Many stronger candidates were awarded full credit for their circuits. These candidates realised that since the heater and the lamp both had the same voltage across them as the power source, then they had to be in parallel. They also drew correct circuit symbols as shown in the syllabus, although a limited number of alternative symbols for a lamp were allowed. The switch needed to be drawn in the open position. Many candidates drew a series circuit for which partial credit could be awarded.

COMBINED SCIENCE

Paper 0653/43
Extended Theory

Key messages

Candidates who did well on this paper:

- read the questions carefully
- used the number of marks available for each question as a guide to how much detail to include
- showed all working
- were familiar with the contents of the syllabus.

General comments

There were some excellent answers from candidates who demonstrated a thorough knowledge of the syllabus and were able to answer questions in both familiar and unfamiliar contexts. Candidates should ensure that their handwriting is legible.

Comments on specific questions

Question 1

- (a) (i) Some candidates identified the cervix successfully. Incorrect answers included uterus, vagina and placenta.
- (ii) There was some confusion between the functions of the amniotic sac and the amniotic fluid. Many responses described the physical protection given to the fetus by the amniotic fluid. These answers did not gain credit because the main function of the amniotic sac is to contain the amniotic fluid.
- (iii) The role of the placenta in the exchange of substances between the mother and the fetus was key to the answer to this question. Therefore, the route of blood through the umbilical cord to the placenta, followed by diffusion of the carbon dioxide was the correct sequence of events. Most candidates scored credit by covering some of these points correctly. Credit could not be awarded if the sequence was not in the correct order. Any indication that the blood of the fetus in the placenta mixes with the blood of the mother was not awarded credit.
- (b) Careful reading of the question was needed here. The question asked how the heart works to pump blood around the body. Therefore, responses needed to describe how the heart causes blood to get round the body. This is clearly the function of the muscular wall of the left ventricle contracting to send blood out of the aorta. There were many responses which did not address the question specifically enough. Many candidates described the whole heart cycle, including the oxygenation of the blood at the lungs. Though these descriptions were correct, they did not answer the question.
- (c) This question was generally well answered, with many candidates scoring full credit. A few candidates quoted 'spermatozoid' as the male gamete. This was not awarded credit because spermatozoid refers to a male gamete in plants.

Question 2

- (a) There were many correct answers here, with candidates describing the higher energy in products compared with the reactants. Some candidates confused the terms endothermic and exothermic.
- (b) (i) Most candidates scored full credit in this section. Incorrect responses included 'beaker'. Although this was probably used in the experiment, it was not essential to the collection of data.
- (ii) There were many correct responses to this question. However, some candidates did not refer to both an increase and a decrease in temperature. Weaker candidates limited their answers to the last part of the 60 s, describing how the temperature decreases. This did not prevent candidates from gaining credit for explaining that the temperature decreased because the reaction finished. Candidates of all abilities omitted to mention that the reaction was exothermic, which would have enabled them to score more credit.
- (iii) Several candidates answered this correctly. A common error was 6.5 °C. However, this was not the maximum temperature change shown by the data. The difference between 34.5 °C and 22 °C gave the correct answer of 12.5 °C.

Question 3

- (a) (i) This question was generally answered well. Candidates who did not gain credit either put the two types of radiation in incorrect boxes, or wrote them in every empty box, thus negating any correct answers.
- (ii) Some candidates gave the correct answer and explanation. Responses from others gave a range of incorrect answers, for example, 3×10^6 or 6×10^8 . Their explanations showed that they had varied the speed of the radiation in much the same way as the frequency and wavelength differ for different parts of the spectrum, instead of keeping the speed constant.
- (b) This question required use of the equation, $v = f\lambda$. Many candidates scored full credit. The most common errors included incorrect recall of the equation, and the unit, Hz. Candidates are reminded to show their working because credit can be gained from this even if the final answer is wrong.
- (c) (i) This question was generally answered correctly.
- (ii) The majority of candidates successfully described the greater absorbing qualities of a dull, black surface. The most common error was stating that black surfaces attract radiation.
- (d) Most candidates found this question challenging. Metals can conduct thermal energy by increased vibration of the particles being passed through the metal solid, and by the greater kinetic energy of the free electrons. The most common error was given by candidates who gave examples of metals conducting heat instead of the process, for example the base of a frying pan during cooking.

Question 4

- (a) (i) Most candidates drew the arrow connecting the grasshopper and eagle successfully. Some candidates did not give any answer to this question.
- (ii) This question was generally answered correctly.
- (iii) The loss of energy at each trophic level as the food chain progresses was key to answering this question. Incorrect responses included the top predator as not having a predator, and that any further levels would make it a food web.
- (b) Most candidates identified the term osmosis as the method of entry of water into the root hair cells. Using the question as guidance, the explanations should have used the term 'water potential'. Those candidates who successfully applied this term gained credit. Other candidates wrote their answers in terms of a concentration gradient, and it was often not clear whether the concentration gradient was a water or solute concentration gradient. When describing osmosis, many candidates did not include the partially permeable membrane in their responses.

Question 5

- (a) Many candidates answered the first part of this question successfully. The explanation was not as clearly expressed. A common error was to refer to the aluminium oxide product as just aluminium. Another common error was the omission of the state of one of the products. For example, just referring to the aluminium oxide as a solid, with no reference to the state of the iron.
- (b) Many candidates recognised that this question was based on the comparison of reactivity between iron and aluminium, with the more reactive element taking the oxygen from the less reactive element. Weaker candidates either reversed the reactivity of the iron and the aluminium or did not refer to reactivity at all.
- (c) Generally, candidates found this question challenging. Many candidates incorrectly stated that iron instead of iron oxide is the oxidising agent. Other incorrect answers included oxygen and aluminium as the oxidising agent. Candidates need to know that the oxidising agent oxidises the aluminium during a redox reaction.
- (d) The different charges of iron(II) and iron(III) in their oxides were described well by some candidates. The need to balance these two different charges by different numbers of oxygen ions was often missed or poorly explained. Some candidates stated that unbalanced charges remain in the iron(III) compound, and these responses did not score credit.

Question 6

- (a) Many candidates answered this question successfully. However, some candidates omitted to double the area of each foot to get the total area in contact with the ground. Other candidates did not change the mass of the dinosaur into newtons. Candidates are reminded to show their working because credit can be gained from this even if the final answer is wrong.
- (b) (i) This was generally well answered.
- (ii) Most candidates interpreted the graph correctly, stating that the dinosaur is decelerating. Fewer candidates described the deceleration as non-constant. Candidates should be aware that the phrase 'decelerating at a non-constant speed' does not score full credit because during deceleration the speed varies. 'Deceleration at a non-constant rate' is a preferable wording to gain full credit.
- (iii) Most candidates used the correct equation to calculate the kinetic energy of the dinosaur.

Question 7

- (a) (i) Many candidates answered this question successfully. However, some candidates did not describe the increase of the rate of photosynthesis with increasing temperature in the initial stages of the experiment. There was no credit awarded for explanations of the results in this part of the question.
- (ii) The majority of candidates scored credit by stating that the enzyme denatures at higher temperature. Fewer responses further explained that the substrate no longer fits the active site of the denatured enzyme. Candidates are reminded that enzymes do not 'die' since they are not living organisms.
- (b) (i) There were many correct answers to this question. Some candidates labelled a spongy mesophyll cell or a guard cell. Some candidates did not give an answer to this question. Candidates are reminded to read the question carefully because responses that do not have an answer line can easily be missed.
- (ii) Most candidates described a correct function of the stoma in gas exchange. Answers which did not gain credit included stomata and guard cells.
- (iii) Only the strongest candidates gained credit in this question. Several candidates knew that magnesium ions are needed to make chlorophyll. A few candidates then described the role of chlorophyll in transferring light energy to chemical energy in the form of carbohydrates. Many answers were just a repeat of the question, saying 'because magnesium ions are needed to make carbohydrates'.

Question 8

- (a) (i) Many candidates gained full credit for this question. Others did not know the missing state or colour. Common errors were to enter liquid as the state for iodine, and yellow or blue for the colour of bromine.
- (ii) This question was generally answered well.
- (b) (i) Most candidates did the dot-and-cross diagram successfully. However, some candidates either had one electron in the single bond instead of two, or just included the pair of shared electrons and no lone pairs. It was also clear that some candidates were unfamiliar with dot-and-cross diagrams.
- (ii) The explanations of diatomic elements had to include some indication that the two atoms are bonded together. Therefore, explanations such as 'there are two atoms' did not gain credit, whereas 'it's a molecule of two atoms of the same element' was an example of an answer gaining full credit.
- (c) (i) Most responses identified rubidium as the correct answer and provided an acceptable explanation. The most common error was naming potassium as the most reactive element. These explanations may have been based on candidates' own experience, having seen the top three metals reacting. However, the question was about trends down Group 1, where reactivity increases down the group, so the correct answer was rubidium.
- (ii) The majority of candidates stated the correct formula for potassium hydroxide. Incorrect responses included K^+Cl^- , or any charged ions, because the compound is neutral. Answers which used the incorrect case in the formula, for example kCl and KCL , were not awarded credit.

Question 9

- (a) Most candidates scored full credit for this question.
- (b) Some candidates completed this calculation correctly. Many other candidates did not do the conversion of time correctly. To work out the charge in coulombs, the quantities should be amperes and seconds. Some candidates did not do the time conversion at all or converted the time to minutes instead of seconds. In these answers some credit could be given, but candidates who did not show their working could not score.
- (c) This question was generally answered well. However, some candidates put the **S1** in the main circuit instead of the branch leading to the starter motor. Other candidates did not know the electrical symbol for a switch or used the symbol for a closed switch instead of an open switch as is shown in the syllabus.

COMBINED SCIENCE

<p>Paper 0653/51 Practical Test</p>

Key messages

- Candidates should read the instructions carefully and should follow them closely so that the recorded results demonstrate good practical skills.
- 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. It is also important that they think about their method to make sure that it is workable and will generate meaningful results. In a method which involves timing, it should be clear when timing starts and how to judge that timing should stop.
- When drawing graphs, candidates are expected to:
 - choose scales so that the plotted results occupy more than half the grid
 - plot points neatly and carefully
 - draw appropriate lines of best fit using a sharp pencil and a thin, smooth continuous line.
- An instruction in the question that candidates need not start the scale at zero is there to guide candidates towards choosing an appropriate scale.

General comments

Candidates were able to carry out all the practical tasks in this paper and demonstrated good practical skills. Most candidates attempted every question, with some good answers seen across all the questions.

When questions ask for answers to be recorded to a specific degree of accuracy, such as in **Question 3(a)** 'to the nearest 0.1 g' and **Question 3(c)** 'to two significant figures' candidates will only gain full credit if a correct answer is given to the required precision. Candidates should therefore read questions very carefully and be sure to follow instructions fully.

Comments on specific questions

Question 1

- (a) Most candidates gave at least one difference between the two animals, usually noting the animal from the cold climate has more fur or a shorter tail. To gain credit, answers had to be about the animals, not just referencing differences in the two climates, such as that there is snow in the cold climate.
- (b) (i) Almost all candidates recorded a full set of temperature values for the large beaker. If the instructions were followed carefully, candidates recorded the highest temperature at $t = 0$ and the temperature gradually decreased over 300 s.
- (ii) Most candidates also recorded a full set of temperature values for the small beaker, with the values showing a greater decrease in temperature over 300 s.
- (c) Almost all candidates correctly calculated the temperature change in the two beakers.
- (d) All candidates who plotted points on a graph correctly chose one scale suitable for both sets of temperature on the same axes. Candidates need to choose a scale that allows the plotted points to cover more than half the grid. When it states in the question 'You do not need to start the scale at zero' that is usually because if the experiment yields expected results a good scale will start at a number above zero.

Candidates need to plot points with neat small dots or crosses and to draw a best-fit curve that is a single, thin, smooth line close to all points and giving a spread of points either side of the line. Common errors were thick lines or lines that attempted to join each point to the next one.

- (e) Most candidates identified the smaller animal as the one which loses heat more quickly but not all candidates fully justified this with reference to the data. Stronger candidates commented either on the gradient of the line on the graph being steeper for the small beaker, or on the greater overall temperature change. Some answered in terms of 'faster heat loss' which was a restatement of the question so was not awarded credit.
- (f) Stronger candidates suggested ensuring that the initial water temperature is the same in both beakers. Many candidates misunderstood that the variable being investigated here was rate of temperature drop in different sized beakers. Some suggested the use of a lid, which would make the experiment less valid by insulating the beaker.

Question 2

- (a) Almost all candidates observed the presence of bubbles (fizzing) when reacting solid copper(II) carbonate with dilute sulfuric acid. Often, only partial credit was gained here because while many candidates observed the blue colour, they neglected to state that blue is the colour of the solution.
- (b) (i) When asked to describe the appearance of a chemical substance it is important that a colour and a state is given. The possible states to choose from are solid, liquid, gas and (aqueous) solution. In this case, the filtrate is a 'blue solution'.
- (ii) Very few candidates were able to give a clear description of crystallisation. Some correctly stated that the filtrate should be heated, and a few candidates knew that the filtrate should be left somewhere warm for a long time to allow crystals to form. Weaker candidates suggested filtering before any heating, implying that filtering would produce the crystals.
- (iii) As in (i) both a colour and state were required for a full description of the residue. It was common for candidates to give only a partial description by omitting the state or by using inappropriate terms such as precipitate, (not relevant in this case) or residue, (which was given in the question). Candidates should be taught to describe appearances in terms of colour and state.
- (c) (i) Many candidates correctly reported observing a brown mixture.
- (ii) This observation question was generally answered well with many candidates noting the formation of a white precipitate. Again, full credit required both the colour and state of the substances observed.
- (d) (i) Stronger candidates recognised that the wire is cleaned to avoid cross contamination from substances used in previous tests. Since the question stated that the wire is cleaned, an answer that stated only 'to remove dirt' was not specific enough.
- (ii) Candidates gained credit here either by noting that there are two different flame colours or by stating that the presence of yellow in the flame colour indicates an impure sample. Some candidates stated 'observes a blue-green and yellow flame' which was a restatement of information in the question and not an explanation.
- (iii) Some candidates gained credit here by noting that the blue flame is hotter. Those who discussed the colour of the flame were less able to clearly express that a yellow flame makes it more difficult to see results.

Question 3

- (a) Stronger candidates followed the instruction in the question and gave the mass of the cork to the nearest 0.1 g. Answers given to greater or less precision did not gain credit.
- (b) (i) Almost all candidates recorded the volume of water and bob. Answers with a value less than 70 cm³ were not given credit since the instructions in the question told candidates to add 70 cm³ of water to the measuring cylinder before lowering the bob into the water.

- (ii) Almost all candidates recorded a sensible value greater than the value in (i).
- (iii) Almost all candidates were able to calculate the volume of the cork.
- (c) This question was answered well by many candidates who gained full credit by calculating density and giving their answer to two significant figures.
- (d) Candidates found it difficult to give a clear answer to this question. Since the question stated that the cork floats simply saying 'so the cork does not float' did not add enough information to gain credit. Stronger candidates recognised that to measure the volume it was necessary for the cork to be fully submerged in the water.

Question 4

Stronger candidates typically thought about how they could carry out a method which would lead to meaningful and repeatable measurements. Weaker methods which relied on seeing how long it would take for the cloth to dry, without clearly stating how this could be judged usually gained less credit. Stronger answers suggested weighing wet pieces of cloth, timing for a fixed amount of time and then reweighing. Other points covered in stronger answers included a clear statement of the variables that would be kept constant, for example using the same size of cloth pieces, the same temperature, the same drying environment. Only the strongest answers included clear strategies for meaningful measurements and processing of results.

It is recommended that in planning questions:

- A labelled diagram is included. Credit for apparatus (such as the stop watch and balance) may be awarded directly from labels on diagrams. Diagrams without labels are not awarded any credit.
- Every bullet point in the question should be addressed. Candidates who tick off or cross out the aspects of the question as they answer are more likely to address all parts of the question. Weaker candidates often only addressed one or two areas of the question, allowing themselves access to only some of the available credit.
- Candidates should ensure they clearly state which factors will be kept the same, what measurements will be made and how the results will be compared. These are the bullets which are most often omitted.

In this question candidates who did not give full answers, often made the following errors or omissions.

- Putting pieces of cloth into water, but not stating that these would be removed. Some candidates described heating beakers full of water with the cloths submerged inside them. These methods would not give any meaningful results.
- Discussing timing of how long until the cloth dried, with no method of stating how the time would be made repeatable.
- Stating an intention to 'repeat and take averages' when the measurements suggested were not repeatable. In order to gain credit for describing repeats and averages, it is essential that the method is robust enough to generate meaningful and repeatable measurements.

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

- 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 size of the scale on the instrument. Where possible, for example in **Question 3**, instruments should be read to at least one decimal place.
- 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. It is also important that they think about their method to make sure that it is workable and will generate meaningful results. In a method which involves timing, it should be clear when timing starts and how it will be judged that timing should stop.
- Graphs appear on most practical papers. Candidates need to ensure that the axes are the right way around, that they choose scales so that the plotted results occupy more than half the grid, plot carefully and draw considered, finely drawn lines of best fit. Where they choose a scale which does not start at 0, they should take care to label the origin with the value at which they are starting that axis.
- Candidates should take care not to repeat questions in answers. There are rarely any marks given for repeating what has been said or stating its direct opposite. For example, when asked why a flame test wire is cleaned in **Question 2 (c) (i)**, there was no credit for stating 'to remove dirt'. Similarly, in **Question 3 (c)** when the question states the cork floats, there was no credit for stating that the metal object is used 'so it does not float'.

General comments

Candidates generally showed a positive approach to the Alternative to Practical Paper. Most questions were fully answered.

Comments on specific questions

Question 1

- (a) Most candidates gave at least one relevant difference, usually commenting on the fact that the animal from the cold climate has more fur or a shorter tail. Some candidates gained only partial credit as they made comments which were unrelated to the animals, for example by saying that there is snow in cold climates.
- (b)(i) Almost all candidates correctly read the temperatures from the two thermometers.
- (ii) Almost all candidates correctly calculated the temperature change in the two beakers.
- (c) Candidates generally chose scales which were appropriate. However, some did not follow the instruction to choose an appropriate scale for both beakers on the same axis. Some gave two scales, one on each axis, and plotted the two beakers on different scales. Scales chosen should occupy at least half the grid. Some chosen scales were too small. When a candidate chooses (often correctly) not to start a scale at zero, the origin should be labelled. Many candidates started their scale at 50 but did not label this on the origin.

Plotting was generally completed correctly and almost all candidates gained credit for plotting.

The curve of best fit was close to a straight line for both beakers and this was usually correct. Errors included using a dot-to-dot approach and joining each pair of points by a straight line. Some candidates drew feathered, double, broken or overly thick lines. Some drew a line or curve which was either above or below the majority of points.

- (d) The command word 'compare' meant that candidates needed to state both similarities and differences where appropriate. The main similarity was that both beakers showed a decrease in temperature. Not all candidates stated this clearly. Differences were usually stated. Many commented on the relative size or rate of the temperature change being greater for the smaller beaker. Some commented that the large beaker started and ended at a higher temperature.
- (e) Most candidates identified the smaller animal as the one which loses heat more quickly but not all fully justified this with reference to the data. Stronger candidates commented either on the gradient of the line on the graph being steeper for the small beaker or commented on the greater overall temperature change. Some answered in terms of 'faster heat loss' which was a restatement of the question so was not awarded credit.
- (f) Many candidates appeared to misunderstand the variables being investigated. Many suggested limiting heat loss, which would have made the experiment less valid, by insulating the beaker. Others suggested using the same size beaker or the same volume of water. Stronger candidates suggested that the start temperature should be the same in both.

Question 2

- (a) (i) Most candidates correctly stated that a measuring cylinder could be used. Other apparatus which can be used to measure volume such as a graduated pipette, a syringe or a burette were also accepted. Pipette alone was incorrect as many pipettes are not graduated and small dropping pipettes would not be able to be used to measure 20 cm³ of acid.
 - (ii) Almost all candidates know that the gas that turns lime water milky is carbon dioxide.
 - (iii) When asked to describe the appearance of a chemical substance it is important that a colour and a state is given. The possible states to choose from are solid, liquid, gas and (aqueous) solution. In this case, the residue is a green solid and the filtrate is a blue solution. It was common for candidates to give only a partial description by omitting the state or by using inappropriate terms such as precipitate (not relevant in this case) or residue (which was given in the question). Candidates should take care to ensure that appearance is always described in terms of colour and state.
 - (iv) This question was well answered. Candidates generally knew how to carry out a crystallisation. Many answers correctly described heating to evaporate the water to crystallisation point and leaving to cool. Very few made the error of stating that the mixture should be heated to dryness. A relatively common error was to discuss filtering to remove crystals before any heating had taken place, implying that filtering would produce the crystals.
- (b) (i) Candidates who had learned the anion tests from the syllabus data sheet gave excellent answers, describing the blue precipitate which redissolves to form a dark blue solution. Some only gave the final observation, others only gave the precipitate. As with (a)(iii), the colour and the state are important for full credit. In this case the word 'precipitate' was appropriate to describe the state of the substance formed.
 - (ii) Only stronger candidates knew that dilute nitric acid and aqueous barium nitrate are used to test for sulfate ions.
- (c) (i) This question stated that the student cleans the flame test wire. Answers which commented that this was to remove dirt were not given credit. Stronger candidates discussed cross contamination from substances used in previous tests.
 - (ii) This question was well answered, with most candidates stating that the mixture of flame colours or the presence of yellow in the flame colour, indicate that the sample is impure.

- (iii) Many candidates correctly stated that the blue flame is hotter. Those who discussed the colour of the yellow flame often found it difficult to clearly express the problem that the flame colours would not be seen. Answers such as 'you would see yellow' or 'the flame is yellow' were repeats of the question so did not answer the question.

Question 3

- (a) (i) Many candidates stated that it was important to avoid parallax error but did not clearly state how this could be achieved.
- (ii) The scale on the measuring cylinder was large enough to be judged to 0.5 cm³. Most candidates correctly gave the second measuring cylinder reading as 78.5, but most incorrectly stated that the reading for the first cylinder was 74 rather than 74.0. It is important that all values in a table are given to the same number of decimal places.
- (iii) Almost all candidates used the expression provided and correctly calculated the volume of the cork.
- (b) Most candidates correctly substituted into the equation, but a minority confused the numerator and denominator values. However, a common error was to quote the calculated value to too many decimal places. The question asked for two significant figures. Some candidates gave answers such as 0.4, implying that they did not understand significant figures if the value is smaller than 1.0.
- (c) The main issue with this question arose from answers being stated unclearly. The question stated that the cork floats. Answers such as 'so the cork does not float' does not add enough to this to earn credit. Stronger candidates discussed that to measure the volume, the cork needs to be completely below the level of the water.

Question 4

Stronger candidates typically thought about how they could carry out a method which would lead to meaningful and repeatable measurements. Weaker methods which relied on seeing how long it would take for the cloth to dry, without clearly stating how this could be judged usually gained less credit. Stronger answers suggested weighing wet pieces of cloth, timing for a fixed amount of time and then reweighing. Other points covered in stronger answers included a clear statement of the variables that would be kept constant, for example using the same size of cloth pieces, the same temperature, the same drying environment. Only the strongest answers included clear strategies for meaningful measurements and processing of results.

It is recommended that in planning questions:

- A labelled diagram is included. Credit for apparatus (such as the stop watch and balance) may be awarded directly from labels on diagrams.
- Every bullet point in the question should be addressed. Candidates who tick off or cross out the aspects of the question as they answer are more likely to address all aspects of the question. Weaker candidates often only address one or two areas of the questions, allowing themselves access to only some of the available credit.
- Candidates should ensure they clearly state which factors will be kept the same, what measurements will be made and how the results will be compared. These are the bullets which are most often omitted.

In this question candidates who did not give full answers, often made these errors or omissions:

- Putting pieces of cloth into water, but not stating that these would be removed. Some candidates described heating beakers full of water with the cloths submerged inside them. These methods would not give any meaningful results.
- Discussing timing of how long until the cloth dried, with no method of stating how the time would be made repeatable.
- Stating an intention to 'repeat and take averages' when the measurements suggested were not repeatable. In order to gain credit for describing repeats and averages, it is essential that the method is robust enough to generate meaningful and repeatable measurements.

COMBINED SCIENCE

Paper 0653/62
Alternative to Practical

Key messages

- It is recommended that candidates read through the whole question first so that they can check what they are being asked before starting.
- When marking a graph to show how a reading is obtained, it is important that these markings are visible. Clear ways to mark the graph include adding a line to the axis for the value requested, adding bold dotted lines from both axes to show the intersection with the best-fit line or marking with a clear X at the intersection.

General comments

Candidates showed they were able to follow instructions to complete the tasks within the time set with few gaps or unanswered questions seen. The importance of covering all practical opportunities during the course must be emphasised. This could be by teacher demonstration or video clips for instance, when candidates are not able to carry out the practical work themselves.

Graphs appear on most practical papers. Candidates need to ensure that the axes are the right way around and that they choose scales to ensure the plotted points occupy more than half the grid. They should plot carefully and draw considered, finely drawn lines of best fit. In choosing a scale, candidates need to take note of the highest and lowest values required to work out a sensible scale for the size of grid provided. Where candidates use a scale which does not start at 0, they should label the origin with the value at which they are starting that axis or include a zig-zag to show that part is non-linear and therefore not being used to plot points.

Drawings of structures (or apparatus) 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 ensure that they make clear scientific points when discussing reasons for repeating readings. 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 concordance by looking for similar results and identifying any anomalous values.

In planning questions, candidates need to address all areas of the task to fully answer the question. They are guided in this by the bulleted list included in the task. It is also important that they think about their method to make sure that it is workable and will generate meaningful results. In a method which involves timing, it should be clear when timing starts and how it will be judged that timing should stop. Candidates need to make sure they name any apparatus being used, for example a thermometer to measure the temperature.

Comments on specific questions

Question 1

- (a) (i) Most candidates were able to measure the distances correctly.
- (ii) Candidates were generally able to do the calculation correctly with their data from (i). The expected answer was 17 496, which is 17 000 to 2 significant figures. The most common mistake was not providing a final answer to 2 significant figures, usually by stating the original calculation or giving 3 significant figures.
- (iii) Many candidates demonstrated good skills in choosing the vertical scale and plotting a graph. Stronger candidates made use of more than half the grid for the plotting area with a linear scale that allowed easy plotting. Candidates were instructed they could use a scale which does not start at 0. In this situation, they should take care to label the origin with the value at which they are starting that axis, otherwise it is not linear. It was clear that some candidates had not taken into account the highest and lowest values required and had non-linear values above 12 000 because they needed to squeeze values in. Others had scales that did not have a sensible value for 1 division to enable correct plotting and so did not gain credit for this.
- (iv) Candidates were instructed to draw a curve. Judgement for the line was generally good but some candidates connected their points with ruled lines which was not creditworthy. Candidates with incorrect plots could still gain partial credit as the correct best-fit line was based on the plots they had made.
- (v) Many candidates were able to give a figure that was correct from their graph, but many did not show how they did it. Clear ways to mark this graph included adding a label line at 3.5 to the horizontal axis, adding bold dotted lines from both axes to show the intersection or a clear X at the intersection. Stronger candidates used at least two of these methods.
- (b) 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 concordance by looking for similar results and identifying any anomalous values.
- (c) Candidates generally performed well with the drawing. Those that did not gain full credit either did not include all the leaflets in the picture, had feathery edges to the outline or shaded the stem.

Question 2

- (a) (i) When answering a question about safety equipment, it needs to be relevant to the scenario provided. In order to gain credit, candidates needed to identify the eyes as the part of the body that the goggles would protect and link that to the liquids used. References to general scenarios or an explosion were not creditworthy.
- (ii) Many candidates were able to identify a measuring cylinder as a suitable piece of apparatus. A number of candidates used containers that would not have enough graduations on the scale to be suitable, e.g., a beaker or pipette. Alternative graduated apparatus such as a graduated pipette, syringe or burette did gain credit.
- (iii) Candidates were asked to read the burette to the nearest 0.1 cm^3 . Many candidates stated 10 instead of 10.0 and so did not gain credit. Some candidates then did not study the graduations carefully enough to work out either the value of each graduation or to take into account where 27 and 28 were labelled. This was a common error in reading the burette.
- (iv) Most candidates were able to calculate the correct volume added from their data in (iii).
- (v) Some candidates were clearly familiar with performing titrations and were able to identify that it is easy to over-shoot the end-point and to add too much acid. By slowly adding the acid, you could accurately identify the end-point where the indicator changes colour. Many candidates wrote about vigorous reactions and splashing of chemicals, which were not creditworthy.

- (b)(i)** When asked to describe the appearance of a chemical substance, it is important that a colour and a state is given. The possible states to choose from are solid, liquid, gas and (aqueous) solution. In this question candidates were given the fact that the residue is on the filter paper. The correct answer was black solid. It was common for candidates to give only a partial description by omitting the state or by using inappropriate terms such as precipitate (not relevant in this case). Many candidates identified that the residue would be wet, so paste was an acceptable alternative to solid. Candidates should take care to ensure that appearance is always described in terms of colour and state.
- (ii)** It was clear that some candidates had carried out this practical themselves and were able to identify that the indicator in the solution would lead to coloured crystals. The addition of the carbon would remove the colour and therefore allow colourless crystals to form.
- (c)** Most candidates gained credit for this question. Those scoring full credit wrote about heating to the point of crystallisation, removing from the heat source and then leaving the remainder of the water to evaporate.
- (d)(i)** In answers to this question a range of metal and non-metals were named. Candidates needed to read the question carefully, as any incorrect ion named meant that the answer was not creditworthy, so those stating sodium sulfate here did not gain credit.
- (ii)** This was only answered well by stronger candidates. Some candidates ticked more than one box which did not gain any credit.

Question 3

- (a)(i)(ii)** These questions were generally answered well. However, candidates often did not give the answer to 2 significant figures and so only gained partial credit here.
- (iii)** Many candidates answered correctly but others referred to reading below the meniscus or parallel rather than perpendicular to the scale.
- (iv)** Only stronger candidates identified a way of ensuring that the ruler was horizontal, for example, by checking the height above the bench at both ends. Many talked about fixing it in position rather than getting the position correct in the first place.
- (b)** The values calculated in **(a)** were correctly used here to obtain 117.
- (c)** Many candidates recognised the limits of error but failed to answer the question stating 'yes' or 'it agrees'. Stronger candidates were able to identify that the answer is actually the same when both values are quoted to 2 significant figures.

Question 4

Candidates generally answered this question well. Common omissions were taking readings for time, temperature or volume without naming the apparatus used.

Some candidates had carefully considered the question and used two separate glasses to cover the fact that if the sleeve did not cool the water as expected, they needed to start with water at 10 °C to test claim 2. This approach was not specifically needed to gain credit for method as candidates were allowed to assume that the sleeve cooled the water to 10 °C in 5 minutes as part of the method.

Candidates often used the temperature at 5 and 30 minutes to test the theories, but methods monitoring the temperature change rather than using a set time were also creditworthy.

Only the strongest candidates specifically stated the claims and linked how they would use their results or measurements to draw a conclusion about whether each claim was met to gain full credit.

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 size of the scale on the instrument. Where possible, for example in **Question 3**, instruments should be read to at least one decimal place.
- 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. It is also important that they think about their method to make sure that it is workable and will generate meaningful results. In a method which involves timing, it should be clear when timing starts and how it will be judged that timing should stop.
- Graphs appear on most practical papers. Candidates need to ensure that the axes are the right way around, that they choose scales to occupy more than half the grid, plot carefully and draw considered, finely drawn lines of best fit. Where they choose a scale which does not start at 0, they should take care to label the origin with the value at which they are starting that axis.

General comments

Candidates generally showed a positive approach to the Alternative to Practical Paper. Most questions were fully answered.

Comments on specific questions

Question 1

- (a) (i) Most candidates correctly read the start and end position of the centre of the bubble.
- (ii) Few candidates were able to describe how they had determined the centre of the bubble, with many repeating the question to say that they found the middle of the bubble. Stronger answers stated that they had measured the diameter and divided it by two.
- (iii) Almost all candidates were able to calculate the distance moved by the bubble.
- (b) (i) Candidates generally chose scales which were appropriate. Scales chosen should occupy at least half the grid. Some chosen scales were too small. When a candidate chooses (often correctly) not to start a scale at zero, the origin should be labelled. Many started their temperature scale at 10 but did not label this on the origin.

Plotting was generally correctly completed and almost all candidates earned credit for plotting.

A few candidates did not correctly label the axes with some omitting the unit. The correct labels could be found in the table headings and these should have been copied over onto the graph.

- (ii) Many straight lines were drawn using a ruler and most earned credit for this. Errors include using a dot-to-dot approach and joining each pair of points by a line. Some candidates drew feathered, double, broken or overly thick lines. Some drew a line or curve which was either above or below the majority of points.
- (c) (i) Most candidates were able to state that the distance increased as the temperature increased.

- (ii) Most candidates were able to state that the amount of water lost increased as the temperature increased.
- (d) Few candidates named two variables to keep constant, with many choosing temperature, water or equipment. Stronger candidates showed an understanding of factors that would affect transpiration such as humidity and light levels.
- (e) Most candidates realised that a leak in the apparatus would lead to more water loss but few went on to answer the question and say how the distance moved by the bubble would change.

Question 2

- (a) (i) Most candidates were able to measure the length of the magnesium ribbon.
 - (ii) Most candidates were able to read the volume shown in the measuring cylinder.
- (b) (i) Almost all candidates knew that the gas that makes a squeaky pop with a lighted splint is hydrogen.
 - (ii) Many candidates realised that magnesium remained to show that all the sulfuric acid had reacted. Some answered that the reaction had stopped fizzing but this observation was not provided so was not credited.
 - (iii) When asked to describe the appearance of a chemical substance, it is important that a colour and a state is given. The possible states to choose from are solid, liquid, gas and (aqueous) solution. In this case, the residue is a grey or silver solid and the filtrate is a colourless solution. It was common for candidates to give only a partial description by omitting the state or by using inappropriate terms such as precipitate (not relevant in this case) or residue (which was given in the question). Candidates should take care to ensure that appearance is always described in terms of colour and state.
- (c) Candidates did not typically know that dilute nitric acid and aqueous barium nitrate are used to test for sulfate ions.
- (d) This question was well answered. Candidates generally knew how to carry out a crystallisation. Many candidates correctly described heating to evaporate the water to crystallisation point and leaving to cool. Very few made the error of stating that the mixture should be heated to dryness. A relatively common error was to discuss filtering to remove crystals before any heating had taken place, implying that filtering would produce the crystals.
- (e) (i) Few candidates stated that water was being evaporated from the test-tube, with many incorrectly suggesting the crystals would melt and boil.
 - (ii) Many candidates correctly stated that the blue flame is hotter.

Question 3

- (a) Many candidates correctly stated 12.1 and 12.0 for the stop-watch readings.
- (b) This question was well answered with most candidates stating that experiment 3 was anomalous and able to explain that 14.6 was much higher than the other readings. Stronger candidates quoted the times from the table explaining that 14.6 seconds was over 2 seconds higher than the other readings of around 12 seconds.
- (c) An anomalous reading should not be included in an average value calculation. Some candidates included the result from experiment 3 and incorrectly gave the average reading as 12.6 seconds.
- (d) Candidates were able to divide their answer from (c) by 10 to give a correct value for one oscillation for their data.

- (e) Many candidates were able to substitute their values into the given equation, but a few failed to give their answer to two significant figures. Any errors from (c) and (d) were carried forward with credit given for correct calculated values for the candidate's previous answers. A few candidates attempted the calculation without using a calculator and these were often incorrect. A calculator can be used and candidates should show all working in an answer.

Question 4

Stronger candidates usually thought about how they could carry out a method which would lead to meaningful and repeatable measurements. The strongest answers suggested counting the number of pieces of paper that would be attracted after the rod had been rubbed for a certain length of time. Other points covered in these answers included a clear statement of the variables that would be kept constant, for example using the same size of paper pieces, the same distance between the rod and the paper and the same sized rods. Only the very strongest answers included clear strategies for meaningful measurements and processing of results.

Some common approaches to planning questions are more likely to lead to successful answers. It is recommended that:

- Every bullet point in the question is addressed. Candidates who tick off or cross out the aspects of the question as they answer are more likely to address all parts of the question. Weaker candidates commonly only address one or two areas of the questions, allowing themselves access to only some of the available credit.
- The answer clearly states which factors will be kept the same, what measurements will be made and how the results will be compared. These are the bullets which were most often omitted.
- To gain credit for describing repeats and averages, it is essential that the method is robust enough to generate meaningful and repeatable measurements. Stating an intention to 'repeat and take averages' when the measurements suggested are not repeatable is insufficient.