COMBINED SCIENCE

Paper 0653/11
Multiple Choice (Core)

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

General comments

Candidates did well on **Questions 2**, **3**, **9**, **26** and **40**. **Questions 5**, **14**, **16**, **23**, **27**, **32**, **36** and **37** proved challenging.

Comments on specific questions

Question 4

The correct answer was the most chosen response. Where candidates chose an incorrect option, they selected option **A** indicating that they understood the starch test but got confused with the test for fat.

Question 5

Many candidates found this question challenging. The most common incorrect answer corresponded to correct labels but on the wrong axes.

Question 6

The correct answer was the most chosen response. Where candidates chose an incorrect option, they indicated that chemical digestion only occurs in the small intestine. Candidates need to remember salivary amylase (chemical digestion in the mouth).

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Question 7

The correct answer was the most chosen response. Among incorrect candidates, there was a preference for option **C**: the volume of inspired air remaining the same after exercise.

Question 10

Incorrect candidates often selected option **B**. Candidates need to remember that shoots are negatively gravitropic. Also, as the root is in the soil, it is in the dark.

Question 11

Incorrect candidates often selected option **C**, recognising that the seeds need water, but incorrectly thinking that seeds need sunlight for germination and not requiring oxygen or a suitable temperature.

Question 12

All incorrect options were chosen by a similar number of candidates.

Question 13

Most candidates answered this correctly. Where candidates chose an incorrect option, they most often selected methane or nitrogen as the gas that increased as a result of deforestation.

Question 14

Candidates chose the incorrect **A**, **B** and **C** more often than the correct answer, **D**. Candidates are expected to be able to determine the number of neutrons in a nucleus by using the nucleon number and proton number, and to know that nuclei can only contain protons and neutrons.

Question 16

Candidates chose the incorrect **C** more often than the correct answer, **B**. Candidates are required to know the electrode products, using inert electrodes, in the electrolysis of dilute sulfuric acid.

Question 17

Candidates chose the incorrect **C** more often than the correct answer, **A**. Candidates are expected to understand that the temperature of exothermic reactions increases because they release thermal (heat) energy.

Question 23

Candidates chose the incorrect **C** and **D** more often than the correct answer, **A**. Candidates are reminded that the noble gases are monoatomic and unreactive because their outer shells are full of electrons.

Question 25

There was evidence that many candidates guessed at the answer as all options were popular choices. Candidates should be able to describe chemical tests for water using copper(II) sulfate and cobalt(II) chloride, including colour changes.

Question 27

Candidates chose the incorrect **A** more often than the correct answer, **C**. Candidates are reminded that the complete combustion of hydrocarbons produces carbon dioxide and water.

Question 28

A significant proportion of candidates opted for **B**. Although this method does produce a value for the period, option **C** provides a more accurate one, as specified in the question.

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Question 29

Many candidates did not take into account the runner's resting time, causing them to select the incorrect option **D**.

Question 30

Incorrect candidates often either added 10 to the mass to produce a weight of 12.4 N (option **A**) or divided the mass by 10 to produce 0.32 N (option **B**).

Question 32

The energy resource that uses energy stored as gravitational potential energy was not widely known, with many candidates choosing geothermal energy.

Question 33

Most candidates knew which molecules escape during evaporation, but some of these believed that the temperature of the remaining liquid increases.

Question 36

This question was only answered well by the strongest candidates. Other candidates did not identify the position of the image formed by a plane mirror. The most common incorrect choice was option **C**, a point on the surface of the mirror.

Question 37

In this question on electrostatic charging, many candidates were aware that the cloth becomes positively charged. However, a majority of these were confused about the charging process, opting for **B** because they thought that gaining electrons results in a positive charge.

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Paper 0653/12
Multiple Choice (Core)

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

General comments

Candidates answered **Questions 2**, **9**, **10**, **18**, **28**, **33** and **35** well. **Questions 4**, **6**, **14**, **16**, **25**, **26**, **27**, **29** and **32** proved most challenging.

Comments on specific questions

Question 3

Where candidates chose the incorrect option, they opted for **C** indicating that they understood the starch test but got confused with the test for fat and protein.

Question 4

Whilst the correct answer was the response chosen by most candidates, weaker candidates often incorrectly opted for **B**: the correct labels but on the wrong axes.

Question 5

Whilst most stronger candidates got this question correct, many candidates chose option **B**, incorrectly identifying the phloem and the spongy mesophyll, but correctly identifying the guard cell.

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Question 6

Candidates found this question challenging. Where candidates got this question wrong, they incorrectly chose an option indicating that fibre was digested in the stomach.

Question 7

The correct answer was the most chosen response. Where candidates selected an incorrect option, they incorrectly indicated that the erythrocytes produced antibodies.

Question 11

Incorrect candidates often went for option **A**. They identified two different parents, but incorrectly thought that two identical nuclei were involved.

Question 12

The most common incorrect answer to where male gametes are formed in a flower was the stigma.

Question 14

Candidates chose the incorrect options as often than the correct option, **C**. Candidates are expected to be able to determine the number of neutrons in a nucleus by using the nucleon number and proton number, and to know that nuclei can only contain protons and neutrons.

Question 16

The most common incorrect answer was **D**. Candidates are required to know the electrode products, using inert electrodes, in the electrolysis of concentrated aqueous sodium chloride.

Question 23

Candidates chose the incorrect **C** more often than the correct answer, **A**. Candidates are reminded that the noble gases are monoatomic and unreactive because their outer shells are full of electrons.

Question 24

Candidates chose the incorrect **D** more often than the correct answer, **C**. Candidates are required to know the methods of extraction of copper and of aluminium from their ores.

Question 25

Candidates chose the incorrect **A** and **B** more often than the correct answer, **D**. Many candidates also chose the incorrect **C**. Candidates should be able to describe chemical tests for water using copper(II) sulfate and cobalt(II) chloride, including colour changes.

Question 26

Candidates chose the incorrect **B** more often than the correct answer, **D**. Candidates are expected to be able to name the uses of the fractions listed in the specification.

Question 27

Candidates chose the incorrect **A** more often than the correct answer, **C**. A number of candidates chose the incorrect **B**. Candidates are reminded that the complete combustion of hydrocarbons produces carbon dioxide and water.

Question 28

This question about speed−time graphs was well answered.

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Question 29

The topic here was resultant force and option **B** was particularly popular with candidates. These candidates believed that a resultant force is needed for the car to keep moving, even though it is travelling at constant speed – a common misconception.

Question 30

Many candidates thought that the man exerts a greater force on the ground when standing up.

Question 32

Identifying a situation in which potential energy is increasing caused problems for many candidates, with roughly equal numbers opting for **B**, **C** and the correct option **A**.

Question 37

Here, considerably more candidates chose the incorrect option **A** than the correct option, **D**. The rods were identical and were rubbed with identical cloths, but candidates opting for **A** thought that this produces opposite charges on the rods and therefore causes attraction.

Question 39

Many candidates here believed the reading on ammeter 3 to be greater than that on ammeter 2, despite the second bulb in the upper branch of the parallel arrangement, and therefore a smaller current.

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Paper 0653/13
Multiple Choice (Core)

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

General comments

Candidates performed well on **Questions 2**, **8**, **9**, **10**, **18**, **20**, **28** and **33**. **Questions 6**, **7**, **16**, **25**, **26** and **29** proved most challenging.

Comments on specific questions

Question 1

The correct answer was the most chosen response. The most common incorrect response was option **A**, containing breathing.

Question 3

Most candidates answered this question correctly. Where candidates chose the incorrect option, they selected **C**, indicating that they understood the starch test but got confused with the test for fat and protein.

Question 4

Whilst the correct answer was the most chosen response, many candidates struggled with this question. The most common incorrect response was option **B**: the correct labels but on the incorrect axes.

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Question 5

Whilst the majority of candidates got this question correct, many gave option **B**, suggesting they had identified the guard cell.

Question 6

Candidates of all abilities found this question challenging. Many incorrectly chose an option indicating that fibre was digested in the stomach, predominantly **B**.

Question 7

Most candidates found this question difficult. Where candidates chose an incorrect option, they incorrectly indicated that the erythrocytes produced antibodies.

Question 9

The correct answer was by far the most chosen response, though some candidates had the colour of the limewater at the start and end the wrong way round.

Question 11

Some candidates incorrectly gave option **B**. They had identified that offspring were genetically identical, but incorrectly thought that sexual reproduction involved the fusion of two zygotes.

Question 12

Many candidates incorrectly chose the stigma as the place where male gametes are formed in a flower.

Question 16

Candidates chose the incorrect **A** and **D** more often than the correct answer, **B**. Candidates are required to know the electrode products, using inert electrodes, in the electrolysis of concentrated aqueous sulfuric acid.

Question 17

Candidates chose the incorrect **C** more often than the correct answer, **A**. Candidates are expected to be able to identify exothermic and endothermic reactions from temperature changes, and to be able to rank these changes in order of magnitude.

Question 18

Candidates understood the effect of concentration and particle size on the rate of reaction well.

Question 22

Candidates chose the incorrect **B** more often than the correct answer, **D**. Candidates are required to know that elements in Group I and transition elements are metals, and to know the properties of these metals.

Question 23

The correct answer, **A**, was the most chosen, but only just. Candidates are reminded that the noble gases are monoatomic and unreactive because their outer shells are full of electrons.

Question 24

Candidates chose the incorrect **B** more often than the correct answer, **C**. Candidates are required to know the methods of extraction of copper and of aluminium from their ores.

Question 25

Candidates chose the incorrect **A** and **B** more often than the correct answer, **D**. Candidates should be able to describe chemical tests for water using copper(II) sulfate and cobalt(II) chloride, including colour changes.

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Question 26

Candidates chose the incorrect **B** more often than the correct answer, **D**. Candidates are expected to be able to name the uses of the fractions listed in the specification.

Question 28

Speed−time graphs were well understood by a large majority of candidates.

Question 29

The topic here was resultant force and option **A** was more common than the correct answer. These candidates believed that the resultant force is equal to the weight of the car.

Question 32

Identifying a situation in which potential energy is increasing caused problems for many candidates, with many choosing a rock rolling down a hill.

Question 37

Some candidates chose the incorrect option **A** rather than the correct **D**. The rods were identical and were rubbed with identical cloths, but candidates opting for **A** thought that this produces opposite charges on the rods and therefore causes attraction.

Question 39

Many candidates here believed the reading on ammeter 3 to be greater than that on ammeter 2, despite the second bulb in the upper branch of the parallel arrangement, and therefore a smaller current.

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Paper 0653/21
Multiple Choice (Extended)

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

General comments

Candidates performed well on **Questions 9**, **10**, **13**, **18**, **20**, **28**, **31** and **37**. **Questions 5**, **11**, **15**, **24**, **25**, **27**, **30** and **34** proved most challenging.

Comments on specific questions

Question 3

The correct answer was the most chosen response. Where candidates chose the incorrect option, they opted for **C,** indicating that they understood the starch test, but got confused with the test for fat.

Question 5

A number of candidates chose the wrong answer, option **D**. In this option, the effect on the food particles is correct but the type of digestion is incorrect (mechanical rather than chemical).

Question 6

A number of candidates chose the wrong answer, option **C**. They identified that higher temperatures increase transpiration but did not link a decrease in humidity to an increase in transpiration.

Question 7

The correct answer was the most chosen response. Some weaker candidates incorrectly thought that arteries ensured the one-way flow of blood in the circulatory system.

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Question 8

The correct answer was the most chosen response. Some candidates incorrectly chose **C**, the volume of inspired air remaining the same after exercise.

Question 11

The correct answer was the most chosen response. The most common incorrect response was the option of the auxin moving to the light and causing cell elongation in X.

Question 12

Some candidates incorrectly gave option **C**, recognising that the seeds need water, but incorrectly thinking that seeds need sunlight for germination and not requiring oxygen or a suitable temperature.

Question 15

Some candidates chose the incorrect **C** rather than the correct answer, **D**. Candidates are expected to understand the difference in boiling point between ionic and covalent compounds in terms of the relative magnitudes of the attractive forces between ions and covalent molecules.

Question 18

Candidates understood why the rate of a reaction increases when the temperature is increased very well.

Question 20

Candidates knew that chlorine can be identified using damp litmus paper and that carbon dioxide can be identified using limewater.

Question 28

A large majority of candidates were familiar with an accurate method of determining the period of a pendulum.

Question 30

The topic here was pressure. Some candidates used the mass of the liquid in their calculation, rather than its weight and as a result they opted for the incorrect **B**.

Question 31

Very many candidates knew the different properties of mass and weight.

Question 32

The energy resource that uses energy stored as gravitational potential energy was not known by all candidates, with many choosing geothermal energy.

Question 33

In this question on kinetic theory, although it was well understood that the distance between the gas particles decreases, a significant number of candidates opted for **C**, not recognising that at constant temperature their average speed does not change.

Question 34

A number of candidates thought that energy transfer because of density changes occurs in solids as well as in liquids and gases.

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Question 36

Many candidates chose the distance corresponding to wavelength, but many of these identified Y, a compression, as a rarefaction (option **D**).

Question 37

Very many candidates could safely recall, rearrange and use the relationship $R = V \div I$.

Question 39

A common mistake here was not to convert the given time into seconds, leading to the choice of option **B**.

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Paper 0653/22
Multiple Choice (Extended)

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

General comments

Candidates performed well on **Questions 4**, **7**, **8**, **13**, **16**, **20**, **30**, **31** and **37**. **Questions 6**, **10**, **17**, **18**, **24**, **27**, **33** and **36** proved most challenging.

Comments on specific questions

Question 3

The correct answer was the most chosen response but where candidates chose the incorrect option, they opted for **C**, indicating that they understood the starch test but got confused with the test for fat.

Question 4

Most candidates correctly answered this question. A few candidates thought that carbon dioxide trapped the light energy for use in photosynthesis.

Question 5

Some candidates selected option **D**. They linked lack of fibre to constipation but had the incorrect vitamin for scurvy.

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Question 6

Some candidates selected the incorrect option **B** – that amylase was active in the stomach. The pH of the stomach would denature amylase.

Question 7

Most candidates correctly answered this question. A few candidates identified that carbon dioxide is in breath, but had the colour of the lime water the wrong way round at the start and finish of the test, and so gave option **C**.

Question 9

The correct answer was the most chosen response. Some candidates incorrectly thought that the effect of adrenaline on blood glucose levels was to lower it.

Question 10

The majority of candidates answered this question correctly. The most common incorrect response was to choose the option of the auxin moving to the light and causing cell elongation in X.

Question 11

The correct answer was the most chosen response. Where candidates chose as incorrect option, they were split between **A** and **B**.

Question 12

The correct answer was the most chosen response. Where candidates chose an incorrect option, they were split between **B** and **C**, options that had only one incorrect column in the table.

Question 13

Most candidates answered this correctly. However, some candidates correctly identified that a lizard was a quaternary consumer, but incorrectly identified the stoat rather than the fox as a quaternary consumer in the food web illustrated.

Question 17

Candidates chose the incorrect **C** more often than the correct answer, **D**. Candidates should be able to describe electrolysis in terms of the ions present and the reactions at the electrodes, in terms of gain of electrons by cations and loss of electrons by anions to form atoms. They should also be able to construct and use ionic equations.

Question 18

Candidates chose the incorrect **C** and **D** more often than the correct answer, **B**. Candidates are expected to understand that the same number of reacting particles in different volumes of solution produces different concentrations of reacting particles, and that concentration affects only the frequency of collisions, not the energy of the collisions or the proportion of collisions that results in reaction.

Question 20

Candidates generally knew that chlorine can be identified using damp litmus paper and that carbon dioxide can be identified using limewater.

Question 28

In this question about speed−time graphs, some candidates opted for **C**. This was found by multiplying the change in speed by the time.

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Question 29

The topic here was spring constant. A common mistake was to divide the extension by the force, rather than the other way round, leading to a choice of option **C**.

Question 31

Candidates were very secure in their knowledge of boiling and melting points.

Question 32

A significant number of candidates believed that increasing the volume of a gas at constant temperature causes its molecules to move closer together.

Question 33

Most candidates were aware that dull, black surfaces are better at absorbing thermal radiation, but the great majority also thought that shiny, white surfaces are better at emitting it.

Question 34

Most candidates answered this correctly. Weaker candidates often determined the wave frequency by multiplying the speed by the amplitude.

Question 36

Many candidates incorrectly opted for either **A** or **B**.

Question 39

Many candidates forgot to convert the time given into seconds, leading to them choosing option **B**.

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Paper 0653/23
Multiple Choice (Extended)

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

General comments

Candidates performed well on **Questions 1**, **3**, **11**, **14**, **15**, **19**, **31**, **32** and **36**. **Questions 5**, **8**, **13**, **16**, **18**, **25**, **27**, **30** and **38** proved most challenging.

Comments on specific questions

Question 2

Some candidates correctly identified that the red blood cells had no nucleus but thought that the cells lining the trachea had a small surface area.

Question 3

This question was answered correctly by most candidates. Candidates answering incorrectly were mostly split between the incorrect answers glucose and glycogen as the molecule enzymes were made from.

Question 5

The most common incorrect answer was vitamin D deficiency causing anaemia.

Question 6

Most candidates got this question correct. The most common incorrect answer was option **A**.

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Question 7

Although most candidates answered this correctly, the effect of humidity on the rate of transpiration was a common misconception.

Question 8

Many candidates found this question challenging. This was a question that candidates needed to work out. If valve 1 is open, then valve 4 will be open too – eliminating options **B** and **D**. Valves 2 and 3 will not be different, so this eliminates **C**.

Question 11

This question was answered correctly by most candidates. Some candidates thought that the effect of being frightened was to reduce the glucose concentration of the blood, a common misconception.

Question 12

Most incorrect candidates chose the option of the auxin moving to the light and causing cell elongation in X.

Question 13

Amongst the candidates who got this wrong, there was a slight preference for **D** as an incorrect answer. Whilst the urethra does transport sperm, it also transports urea.

Question 14

Candidates generally understood how to use nucleon numbers and atomic numbers to determine the numbers of protons, electrons and neutrons in an atom very well.

Question 16

Candidates chose the incorrect **C** and **D** more often than the correct answer, **A**. Candidates are expected to be able to construct and use ionic equations, with state symbols, to describe reactions.

Question 18

There was evidence to suggest that many candidates guessed at the answer. Candidates should be able to describe the effect of a change in the concentration of a reactant on the rate of a reaction. Candidates should also understand that if the concentration of a reactant that is not in excess is reduced, the amount of product will decrease.

Question 19

Candidates knew the reactions of metals and of bases with acids in terms of the products of each reaction very well.

Question 25

There was evidence to suggest that many candidates guessed at the answer. Candidates are expected to be able to describe the properties of molecules within a fraction obtained from petroleum.

Question 27

Candidates chose the incorrect **C** more often than the correct answer, **A**. Candidates are required to understand that thermal decomposition occurs through the action of heat alone, and not as a result of a reaction with other substances.

Question 29

In this question on density, a significant number of candidates found the rearrangement of the equation a challenge. They divided the density by the mass and arrived at the incorrect option **C**.

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Question 30

Here more candidates chose option **B** than the correct **D**, believing that the aircraft must have a resultant forwards force to be able to fly at constant speed – a common misconception.

Question 34

The most common mistake made by incorrect candidates was to divide the number of wave crests in 60 s by the wavelength, leading to option **A**.

Question 35

Although a very large proportion of candidates were aware that the speed of sound in water lies between that in air and that in steel, some thought that the greatest speed is in air and therefore chose option **C**.

Question 37

Incorrect candidates tended to be unaware of the inverse relationship between resistance and diameter, which led them to opt for **D**.

Question 38

The topic here was resistors in parallel. Generally, it was only stronger candidates who answered this correctly, with many others seeming to guess between options **C** and **D**.

Question 39

Despite recalling and using the correct equation to calculate energy transfer, many candidates did not convert the time to seconds and therefore chose option **B**.

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COMBINED SCIENCE

Paper 0653/31
Core Theory

Key messages

Candidates should read questions carefully before answering. Candidates should show their working and present their answers clearly.

Candidates should carefully consider questions which are set in an unfamiliar context and use their scientific knowledge to answer them.

Candidates are reminded that knowledge of various chemical tests is needed for this paper. Very few candidates knew a chemical test for water.

General comments

There were some good answers in this paper from candidates who showed a good knowledge of the syllabus. Generally, candidates did well with calculations. Candidates are reminded to show their working with these questions so that marks may be awarded for a correct formula even if the rest of the calculation contains an error.

Comments on specific questions

Question 1

(a) (i) (ii) The majority of candidates identified the stomach and the place where egestion occurs.

(b) (i) This question was challenging for most candidates. Many responses described chemical digestion as the breaking down of food into smaller pieces or particles. This is still physical digestion. Chemical digestion involves the breaking down of large insoluble molecules into small soluble molecules.

(ii) Most candidates circled enzymes correctly. The most common incorrect answer was acids.

(c) (i) The majority of candidates answered this question well.

(ii) The difference in iron requirements for 15-year-old males and females was calculated correctly by most candidates.

(iii) Most candidates answered this question well. The requirement of protein for growth was known by most candidates who connected this with the data for males and females. Common errors included calculation of the total nutrients, 106 g, and omitting protein.

(d) This question was answered correctly by most candidates.

Question 2

(a) (i) Some candidates answered this question correctly. There were many responses with arrows drawn to show electron transfer. The question asked for the structures of the two ions after the electron transfer had taken place. Therefore, credit was not awarded for any answers showing the original atoms.

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(ii) Some candidates answered this question correctly. Some stated that heat energy goes into the reaction.

(iii) Generally, candidates found this challenging. It was important to get the wording of the definitions correct. An element is a substance which contains only one *type* of atom. A single atom was not sufficient. More candidates correctly gave the definition of a compound. It was important to mention that the atoms which are combined are different. A common incorrect response was that a compound is when two or more atoms are combined. This definition could apply to a molecule of an element.

(b) (i) Many candidates correctly stated potassium sulfate.

(ii) This question was answered well overall. Candidates needed to specify how variables should be changed, not just state variables. For example, temperature and surface area alone were not acceptable, but increasing the temperature and increasing the surface area were both acceptable answers.

(c) Many candidates correctly named at least one product. Common errors included naming the gas produced as hydrogen.

Question 3

(a) There were several acceptable answers for force **R**, including friction and air resistance. Many candidates correctly gave these answers. Incorrect answers included weight and gravity.

(b) Most candidates correctly divided the weight by 10 to get the mass. A common error was multiplying the weight by 10.

(c) (i) Candidates were expected to change units from kilometres to metres and from hours to seconds. Many candidates found this question challenging.

(ii) This was answered correctly by many candidates who used the equation distance = speed × time. A common error was to use 100 km / h as the speed. The speed to be used in this calculation was the 28 m / s shown in **(c)(i)**.

(d) (i) Many candidates read the information in the question correctly and drew an accurate graph. The main errors seen were in the interpretation of the scale and the drawing of the first part of the graph. Many candidates started their graph at 36 (m / s) instead of 28 (m / s), and ended their graphs at 88 (m / s) instead of 84 (m / s). Some candidates started their graphs at 0 and had a diagonal line for the first 50 s.

(ii) The correct answer, gravitational (potential) energy, was given by many candidates.

Question 4

(a) (i) The majority of candidates correctly circled the aorta.

(ii) Many candidates found this question challenging. Incorrect answers included the pulmonary artery, which takes the blood to the lungs, and just ‘vein’ without including its name.

(iii) This was answered well by almost all candidates.

(b) (i) The width of the artery wall was successfully calculated by some stronger candidates. Some candidates did the calculation correctly but did not give their answers to one significant figure. Some candidates multiplied the numbers 25 and 85 together and arrived at 2125 mm. Candidates are reminded to check if their answers are realistic.

(ii) The correct interpretation of the photomicrograph was needed for this question. Therefore, only visible features were acceptable. Some responses referring to elastic tissue in the wall of the artery did not gain credit because this was not visible on Fig. 4.2.

(c) Most candidates correctly answered this question.

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Question 5

(a) (i) There was only one acceptable answer here, heating the reaction mixture to a high temperature. Many candidates misinterpreted this reaction as combustion and stated that oxygen was needed for the reaction to take place. If oxygen is present, any copper that is produced reacts with this oxygen to produce copper oxide again.

(ii) Candidates found this question challenging. The correct answer, given by stronger candidates, stated that since carbon dioxide is produced it leaves the reaction mixture. Incorrect responses included that oxygen is lost from the copper, and that the copper oxide is reduced and therefore loses mass.

(iii) Many candidates correctly stated that the copper ions lost oxygen as a definition of reduction. Incorrect answers included the copper losing electrons.

(iv) A few candidates correctly stated electrolysis. Incorrect answers included oxidation, reduction and the blast furnace. Candidates are reminded that aluminium is too reactive for its oxide to be reduced by carbon. Therefore, electrolysis is needed to get pure aluminium.

(b) (i) Some candidates found this question challenging. The properties of elements are their features that do not involve chemical reactions. Therefore, references to the reactivity of the metals were not accepted. Many candidates stated they are both metals. This was not sufficient because the statement does not describe any features of copper and aluminium.

(ii) This question tested the unique properties of transition elements compared with aluminium. Candidates found this question challenging. Many incorrect responses described the differences in reactivity of the two metals. Other common errors included being good conductors of heat and electricity. These properties are common to both aluminium and copper.

(c) Many candidates correctly answered this question. The main errors occurred when candidates tried to identify both metal **X** and metal **Y**. This was not the intention of the question. Most candidates could correctly place metal **X** as the most reactive element and copper as the least reactive. Fewer candidates gave magnesium and metal **Y** in the correct order.

Question 6

(a) Many candidates interpreted the circuit diagram correctly to conclude that the hairdryer blows out cold or unheated air.

(b) (i) Most candidates correctly calculated the resistance. Fewer candidates stated the unit correctly, with A and V both given as incorrect answers.

(ii) The function of a fuse was understood by some candidates but often explanations were not clear. Many candidates stated that the role of the fuse was to control the level of current, not to break the current if the current gets too high.

(iii) The correct answer, 13 A, was stated by many candidates. The most common incorrect answer was 10 A. This was not acceptable because the current selected for the fuse must leave a margin above the current in the circuit.

(c) The main properties of plastic that make it suitable for the hairdryer are that they are good insulators of both electricity and heat. Some candidates gave these answers. Other acceptable answers included the light weight of plastic. Incorrect answers included that plastic does not melt and does not burn.

Question 7

(a) (i) Most candidates correctly answered this question. The main error was giving cell membrane instead of cell wall. Candidates are reminded that the cell membrane is found just inside the cell wall in a plant cell. Fewer candidates identified the chloroplast correctly. The most common error was chlorophyll, the chemical that absorbs light, found inside the chloroplast.

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(ii) Many candidates correctly stated that the role of the nucleus is to control the activities of the cell. That the nucleus contains the DNA was also acceptable. The brain of the cell was considered too vague.

(b) The location of the spongy mesophyll was correctly identified by some candidates. Mesophyll cells are found between the lower epidermis and the line containing the vascular bundles. Many candidates did not label the spongy mesophyll correctly. Incorrect labels included the bottom layer of cells, the lower epidermis, and the palisade layer, above the spongy mesophyll layer.

(c) The equation for photosynthesis was correctly completed by stronger candidates. Incorrect responses included writing the three answers, water, glucose and oxygen in the wrong spaces. Light was frequently stated in the first space. Candidates were expected to state that the product of photosynthesis is glucose, not the more general term carbohydrate, which includes starch, for example.

(d) (i) Many candidates correctly stated respiration.

(ii) This question was generally answered correctly by stronger candidates. The most common incorrect response was pollution.

Question 8

(a) Only a few candidates recalled one of the two tests for water along with the correct positive result. Incorrect responses included boiling, freezing, limewater, electrolysis and lighted splints.

(b) Candidates found this question challenging. Most did not recall the terms alkene and alkane and of those who did recall the terms, many wrote them the wrong way round.

(c) (i) Very few candidates wrote natural gas. Fossil fuels and products from crude oil were seen as incorrect responses.

(ii) Many candidates showed one pair of electrons correctly. However, some candidates did not enter all the electron pairs, omitted the symbols of the remaining hydrogen atoms, or drew too many electrons.

Question 9

(a) Most candidates connected the boxes correctly.

(b) (i) Some candidates added visible light to the electromagnetic spectrum in the correct place.

(ii) Many candidates found this question challenging. Some of the reflected rays were drawn correctly, but some rays did not enter the driver's eye. Candidates are reminded that the angles of incidence and reflection are found between the rays and the normal, not between the rays and the mirror.

(iii) Only a small number of candidates placed infrared in the first space. More candidates wrote conduction and convection in the correct places.

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Paper 0653/32
Core Theory

Key messages

Candidates should read questions carefully before answering.

When questions are asked in an unfamiliar context, candidates should try to apply their knowledge to a new situation.

Candidates are reminded that the knowledge of analytical tests is required by theory papers. See **Question 5(a)(v)**.

When the function of a structure is requested in a question, it means 'what job does it do?' In **Question 4(a)**, many candidates gave the names of **X** and **Y** instead of what they do in the flower.

General comments

Some good responses were seen in this paper, with some candidates showing a good understanding of the Core syllabus. Most candidates wrote legibly and there was no evidence that they were short of time.

Candidates should show their working in questions involving calculations. A correct equation can gain some credit even if an arithmetical error occurs.

Comments on specific questions

Question 1

(a)(i) (ii) The majority of candidates successfully identified both the liver and the pancreas.

(iii) Most candidates labelled a salivary gland correctly. Incorrect labels showed the gall bladder and oesophagus.

(iv) Successful candidates stated the function of the salivary glands as to produce saliva. Some candidates described the function of saliva rather than the function of the salivary glands.

(b)(i) Many candidates answered this question correctly, stating glucose. Common errors included sucrose, amino acids and the three elements: carbon, hydrogen and oxygen. Candidates are reminded that the three elements, carbon, hydrogen and oxygen, are combined to make a glucose molecule, and it is many of these small molecules of glucose that then make up a large molecule of starch.

(ii) Iodine was successfully recalled by many candidates. Common errors were Benedict's solution and universal indicator.

(iii) Generally, candidates found this question challenging. The most important thing was to relate the time taken for the indicator to turn orange to the activity of the enzyme. This inverse relationship meant that the shorter the time taken, the more active the enzyme. Many candidates identified 35 °C as being the optimum (or near optimum) temperature for the reaction, meaning that the activity is at its highest. Some incorrect responses referred to the time taken for the reaction but did not relate it to activity of the enzyme.

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Question 2

(a) (i) A few candidates correctly stated that the solute was sodium chloride and the solvent was water. Many candidates incorrectly stated that the solvent was sodium chloride and water, and that the solute was iron filings. The solute, sodium chloride, must dissolve in the solvent, water, to make a solution of sodium chloride. The iron filings are insoluble in water.

(ii) This question was generally answered well.

(iii) Filtration was stated successfully by most candidates. Common errors included distillation and evaporation. Both of these separation methods would remove the water but would leave the sodium chloride solid and the iron filings together and not separated.

(b) Generally, candidates found the explanation challenging. Many could see that the loss of water would make the solution more concentrated, and this was stated in the question. The number of sodium chloride particles did not change but the number of molecules of water had reduced. Therefore, the more concentrated sodium chloride solution had more particles of sodium chloride per unit volume of solution.

(c) Only a few candidates successfully answered this question. Some candidates correctly stated that chlorine gas was produced at the anode. Some incorrect responses stated chloride. Very few candidates gave hydrogen as the product at the cathode. The most common incorrect response was sodium.

(d) Some candidates answered this question correctly. Candidates are reminded that the number of electrons in a neutral atom equals the proton number (26 in this case). To obtain the number of neutrons, the proton number is subtracted from the nucleon number (56 in this case). Most incorrect answers had incorrect combinations of the numbers 26, 30 and 56 on the answer lines.

Question 3

(a) (i) Some candidates answered this question correctly, stating weight. Others wrote gravity. Candidates are reminded that ‘gravity' alone is not accepted.

(ii) Generally, this question was answered well. The important idea here was that if the car is moving at a constant speed, the forces on it are balanced. So, the forward driving force, **T**, is balanced in magnitude by force **V**.

(b) (i) Candidates had to do two conversions in this question, kilometres to metres and hours to seconds. Stronger candidates did this successfully. Errors occurred when the wrong conversion factors were used, e.g. multiplying km by 100 to get m.

(ii) This question was answered successfully by most candidates.

(c) Most candidates answered at least one correctly, with many gaining both marks.

(d) Generally, this was answered well. Most candidates matched the boxes successfully.

Question 4

(a) Some candidates answered this question correctly. A common reason for incorrect responses was naming the flower parts instead of stating their functions.

(b) Most candidates knew that water is required for the germination of seeds. The second condition, oxygen, was rarely seen. The most common error stated was light. Candidates are reminded that germination of seeds can occur below the soil in the dark, and it is only after germination when the shoot appears above the ground that light is needed for photosynthesis.

(c) (i) Candidates found this question challenging. Once water has been absorbed by the root hair cells, it moves through the cells of the cortex, across the root, until it reaches the xylem in the centre of the root. The most common mistake was xylem, circled by most candidates.

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(ii) Some candidates answered this question correctly. The most common incorrect answer was xylem. Candidates are reminded that the xylem vessels supply water to the cells of leaves, including the mesophyll cells where evaporation occurs

(d) (i) (ii) Most candidates used the information in Fig. 4.2 to answer these questions correctly.

(iii) Some candidates recalled that magnesium ions are needed to make the molecule chlorophyll. A number of incorrect answers were seen including starch, food and photosynthesis.

Question 5

(a) (i) Most candidates used the information given to state both hydrochloric acid and magnesium chloride. The most common errors were magnesium hydroxide or magnesium oxide. The gas produced was identified correctly by stronger candidates. Some wrote carbon dioxide or oxygen, and some candidates did not mention a gas at all. Candidates are reminded to read the questions carefully.

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

(iii) To answer this question, candidates had to use their knowledge of the reactivity series of metals and their reactions with dilute acid. Metals below magnesium in the series, apart from copper, were accepted. Group I metals were not accepted because the rate of reaction of these metals with dilute acid is higher than with magnesium.

(iv) This question was answered correctly by many candidates who knew that the salt formed from sulfuric acid is a sulfate. Incorrect responses included sulfur and hydrochloric acid.

(v) Very few candidates recalled the chemical test for chloride ions. Common incorrect responses included testing with lime water, universal indicator, and litmus. Many candidates did not attempt this question.

(b) (i) Stronger candidates correctly stated that the magnesium reacted with the oxygen in the air, and not just the air. Some candidates did not attempt this question.

(ii) There were many correct answers to this question because candidates could identify one of the forms of carbon, e.g. graphite, or a fuel that produced carbon dioxide on combustion. Some candidates described the thermal decomposition of a carbonate such as calcium carbonate. Although this reaction produces carbon dioxide, it is not a combustion reaction.

(iii) Stronger candidates stated methane as the greenhouse gas. Incorrect responses included nitrogen and oxygen.

Question 6

(a) (i) Only a few candidates knew the symbol for a fuse and the most common error was the symbol for a resistor.

(ii) Some candidates correctly stated the name of the unit of current. A common incorrect answer was I, the symbol for current.

(iii) This question tested the fact that the current is the same at all points in a series circuit. A few candidates stated this. Of the few candidates who selected 5.4A, only a few gave correct explanations. Those candidates who selected 2.7A gave explanations that the current would reduce after passing through heating element 1, which is not the case in a series circuit.

(iv) This was generally answered well.

(b) (i) Some candidates correctly answered this question. Switch 1 has to be closed for the circuit to run at all, and this makes heating element 1 work. Switch 2 must remain open for it to remain switched off. Those candidates who wrote two identical answers either had both heating elements on, with both switches closed, or no heating elements on with both switches are open.

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(ii) Many candidates found this question challenging. The inverse relationship between resistance and current was not understood well. Incorrect responses included the current increasing as the resistance increases, and general statements about the variable resistor controlling the current with insufficient detail to explain how this is achieved.

(iii) Only a few candidates answered this question correctly. The most important concept was that the combined resistance of the heating elements in parallel is less than the resistance of one heating element on its own. Many candidates stated that the current had to be increased to go through heating element 2 in addition to heating element 1. Others stated that more voltage is needed to allow the current to go through both heating elements.

(iv) This question was answered well by most candidates who recognised the independent operation of the two heating elements in the parallel circuit.

Question 7

(a) The majority of candidates answered this question correctly.

(b) Very few candidates answered this question correctly. Many described breathing instead of respiration in cells when glucose is broken down to release energy. The use of this released energy for muscle contraction was omitted by most candidates. Candidates are reminded that one of the uses of the energy released by respiration stated in the syllabus is for muscle contraction.

(c) (i) The nucleus was correctly identified by some candidates. The most common incorrect answer was red blood cell. The structure labelled **Q** is clearly inside the cells illustrated. Red blood cells would not be contained within the cell membrane.

(ii) Most candidates correctly stated that hormones are transported in the blood (plasma). The most common misconception was that hormones are transported by the red blood cells.

(d) (i) The sentence about diffusion was answered well by only a few candidates. Some candidates correctly completed concentration gradient. The random movement of the particles was not stated by many candidates.

(ii) Many stronger candidates answered this question correctly.

Question 8

(a) Many stronger candidates answered this question correctly. The most frequent incorrect responses referred to differences in reactivity, group number and electronic structure across the Periodic Table.

(b) There were several possible answers possible for this question. More candidates correctly suggested a transition metal, the first answer, than the group I metal needed for the second answer. The key to suggesting a suitable second metal was that it is soft, a property of group I metals.

(c) (i) Only a few candidates stated the correct answer, 21 per cent. Incorrect percentages covered a wide range of values.

(ii) Many candidates correctly stated water. The most common incorrect answer was hydrogen, but nitrogen was also seen less frequently.

(d) (i) Some candidates found this question challenging. Instead of stating that a substance consists of single atoms, they stated characteristics of these substances, for example that they have a full outer shell, they are unreactive, and they are inert gases.

(ii) The focus of the question was to concentrate on electronic structure. Some candidates stated that the outer shell of electrons is full, which makes it unreactive. Incorrect responses included that it is a noble gas, but without any reference to electronic structure, as asked for in the question.

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Question 9

(a) (i) Many candidates answered this question correctly.

(ii) Stronger candidates correctly answered this question. Candidates are reminded to learn the correct units for frequency, in this case Hz, not hz or hZ.

(b) (i) Some candidates correctly answered this question, stating radiation. Candidates are reminded that the three methods of energy transfer are conduction, convection, and radiation. Coming from the Sun through space, where there is no medium, the method of energy transfer must be radiation. Some incorrect answers given were thermal energy and light energy.

(ii) Some candidates correctly stated conduction. Incorrect responses included heat energy and thermal energy. Candidates are reminded that the main method of energy transfer through solids is conduction.

(iii) The majority of candidates correctly answered this question.

(iv) Most candidates answered this question well, drawing the three rays correctly. Some candidates had a discontinuity in their rays through the lens but brought the rays to a focus correctly.

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COMBINED SCIENCE

Paper 0653/33
Core Theory

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(iii) The majority of candidates correctly answered this question.

(iv) Most candidates answered this question well, drawing the three rays correctly. Some candidates had a discontinuity in their rays through the lens but brought the rays to a focus correctly.

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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 *describe, explain* and *suggest*
- were able to use particle theory in explanations, particularly in biological contexts
- were able to give the correct number of significant figures in a numerical answer and could carry out calculations involving large numbers in standard form
- were familiar with the energy changes when chemical bonds are broken or formed and understood an energy level diagram for a chemical reaction
- understood the concept of the rate of processes, particularly in biological and chemical contexts
- were familiar with definitions of scientific terms as they appear in the syllabus.

General comments

Many candidates showed excellent understanding of all sections of the syllabus and presented clear, well-organised answers. Knowledge of the three science disciplines was usually well-balanced. Candidates usually showed their working in questions requiring calculation, which is good practice. This very often makes it possible for candidates to be awarded some marks even if the final answer is incorrect. In questions such as **6(a)(i)**, in which candidates needed to show the steps leading to a given value of a variable, stronger responses were set out clearly and included the relevant formula as the starting point.

The majority of candidates were able to answer all questions within the time allowed, though some candidates may have been more appropriately entered for the Core paper.

Comments on specific questions

Question 1

(a) (i) The majority of candidates identified atrium. The most common mistake was ventricle.

(ii) Vena cava was recognised by many candidates. The most common incorrect answer was ‘vein’.

(iii) Many candidates correctly described the double circulation system. Some candidates included correct information about the advantages of the double circulation system though this was not required by the question. An incorrect suggestion that was seen several times was that blood circulates twice through the body. Another incorrect response was to describe the route followed by blood through the chambers of the heart without referring to either lungs or body.

(b) (i) This was correctly calculated by most candidates, but many missed the instruction to give the final answer to two significant figures. When candidates did not show any working, they could only be awarded marks for a fully correct answer.

(ii) Most candidates correctly answered this question. Some incorrect answers included “it’s a positive correlation” or “they both increase”. Some candidates stated that a high incidence of CHD caused a high waist-to-hip ratio, and some commented on only one age group.

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(iii) Many candidates gave the correct definition of malnutrition and identified excessive fat in the diet as a cause of CHD. Stronger candidates were also able to describe CHD as the blockage or narrowing of coronary arteries. Some incorrect responses showed that malnutrition had been interpreted as only a lack of nutrients, and in some responses the coronary artery was not specified. Atherosclerosis and wording which clearly implied reduced blood flow in arteries supplying the heart muscle were acceptable alternative answers.

Question 2

(a) Only the stronger candidates correctly described these chemical tests. The most common mistake made was to give the test for chloride ions rather than chlorine. Generally, the test for hydrogen was better known, but some incorrect responses suggested the use of a glowing splint, and some responses were too vague such as “use a wooden splint” or “it’s the pop test”.

(b) (i) Candidates found this question challenging. The most common mistake was to suggest that one or both of the sodium compounds would be solid. Many candidates either made no attempt to answer or suggested stoichiometric numbers or chemical formulae. Candidates are reminded that state symbols are written using lower case letters.

(ii) Most candidates named sodium hydroxide. The most common error was sodium oxide.

(c) Many candidates answered this question correctly. The most common mistake was the idea that hydrogen is made when hydroxide ions lose electrons.

(d) This was answered correctly by many candidates. The answers orange or yellow were not accepted as alternatives for red, and pH values greater than 3 were not accepted.

Question 3

(a) This was answered correctly by most candidates. The most common error was that forces **P** and **R** were reversed.

(b) (i) Most candidates correctly stated 1200 000 (N). The most frequently suggested incorrect answer was 12 000 (N).

(ii) Most candidates recalled the relationship *pressure* = *force* ÷ *area* and many successfully worked through to the correct numerical answer. A number of candidates multiplied *force* × *area* or used the mass of the aircraft instead of its weight. Stronger candidates stated the correct number of zeroes in the final answer and also gave the correct units. Units such as P, PA or pa were not accepted.

(iii) Most candidates recalled the relationship *work* = *force* × *distance* and many successfully worked through to the correct final answer. The most common mistake was to calculate *force* ÷ *distance*.

(iv) A large number of candidates correctly recalled and used the formula for kinetic energy. Common mistakes included not calculating the square of the velocity and not multiplying by half, though sometimes these had been correctly stated in the formula.

(v) Many stronger candidates recognised that some of the energy supplied by the engines would be used to overcome resistive forces. The suggestion that some energy would be transferred as heat or sound was also accepted. The answer “energy is wasted” was too vague to be accepted. A significant number of candidates wrote answers such as “one is work and the other is energy so they are different”, revealing a common misconception.

Question 4

(a) (i) Most candidates correctly answered this question. Several alternative terms were accepted including glucose, maltose, mono and di saccharide. Sucrose was not accepted.

(ii) Many candidates correctly stated or implied that the activity of amylase increases with increasing temperature. Stronger candidates knew that this was caused by increases in particle kinetic energy which in turn leads to an increase in collision frequency. An allowed alternative to increased

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collision frequency was a reference to an increase in the number of active site – substrate complexes.

(iii) Stronger candidates included the key idea that enzymes have specific activity and used the term 'active site' correctly. Many candidates made correct statements including the idea that proteins need protease and not amylase but lacked essential detail. Answers such as "the lock and key mechanism would not work" and "amylase would not fit protein" lacked appropriate scientific precision.

(b) (i) Many candidates answered correctly, with respiration and combustion being the most popular answers. Suggestions such as breathing or exhaling which were not accepted as alternatives for respiration in this context. Fairly common incorrect suggestions included photosynthesis, transpiration, death and excretion.

(ii) The term fossilisation was known by stronger candidates. Answers which described or implied the process were accepted and so "creation of fossil fuel" was allowed. However, the unqualified term "fossil fuel" was not. The most common incorrect answers were decomposition and decay.

(c) Stronger candidates explained that the snake was a secondary consumer because it ate the insect and that it was a tertiary consumer because it ate the toad. A large number of candidates gave incomplete answers such as "the snake eats both insect and toad" or "the snake eats a primary consumer and a secondary consumer" or "the snake can be considered to be at the third and fourth trophic levels".

Question 5

(a) Stronger candidates correctly stated arrow **C**. Of the many incorrect responses, **B** was most frequently suggested.

(b) A fairly large number of candidates completed the table correctly. However, many candidates appeared to guess and there was no obvious pattern in the incorrect responses.

(c) (i) Some candidates gave answers that correctly described one similarity and one difference in the products of combustion. Many candidates wrote about the need for oxygen or that the reaction was exothermic when describing the similarity. Some candidates may have missed the reference to complete combustion of diesel and suggested that carbon monoxide would be formed. Some candidates used the term carbon instead of carbon dioxide.

(ii) When candidates had identified the production of carbon dioxide in **(c)(i)**, they usually answered this question correctly. Stronger responses referred to an enhanced greenhouse effect caused by carbon dioxide.

(iii) Many candidates stated that at 20°C hydrogen is a gas and diesel is a liquid. Some candidates missed the significance of 20°C and described how hydrogen would need to be liquefied at a very low temperature in order to store it. Only a very small number identified the pressure and volume disadvantages when storing hydrogen.

Question 6

(a) (i) A large number of candidates answered this question correctly. The relationship *current* = *power* ÷ *voltage* was often stated or seen in substitutions. It was important that candidates included '= 9.8(3)A' in their final step. Incorrect responses sometimes stated *current* = *voltage* ÷ *resistance* but then made no further progress.

(ii) For many candidates, this proved to be a challenging question. Many wrote lengthy descriptions of how fuses work and why they are included in a circuit. The question required candidates to make a simple statement comparing the fuse rating to the normal current of 9.8A and then to develop this by describing the consequence of the comparison, for example, "The fuse rating of 10A is greater than the current in the circuit and so will allow the hairdryer to work" or "the fuse rating is only 0.2A greater than the current in the circuit and so a small fluctuation may cause the fuse to blow".

(b) Many candidates correctly labelled the diagram. Incorrect responses included unlabelled switches, incomplete circuits, and unnecessary connections that would cause short circuits.

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Question 7

(a) (i) Most candidates correctly labelled an ovary.

(ii) Most candidates chose the correct words for both gaps. Toxins was correctly stated more often than excretory.

(b) Candidates needed to state or imply that the vitamin D supplement is needed because this vitamin is needed by the fetus. The other key idea was that vitamin D is required for healthy bone development. The importance of vitamin D for absorption of calcium was accepted as an alternative. In general, this question was answered well.

(c) This was answered very well and large numbers of candidates stated that nicotine is addictive. Candidates generally knew that tar was carcinogenic or that it damaged the cilia and alveoli. Any of the known harmful effects of nicotine or tar were accepted as alternatives. Most candidates avoided vague answers such as it (nicotine or tar) damages the lungs.

Question 8

(a) Almost all candidates were able to select two metals and two non-metals. A small number missed the requirement to limit their choices to Period 3.

(b) This question was quite challenging for candidates. They had to state the number of outer electrons in both sodium and chlorine atoms and then state that sodium atoms lost one electron and chlorine atoms gained one. For the third mark, they had to explain that electrons were gained or lost in order to complete the outer shell. Many stronger candidates wrote complete answers. Some responses confused the terms atom and ion. Some responses discussed the idea of stability rather than completion of the outer shell.

(c) (i) The diagram showing the arrangement of ions in sodium chloride was correctly completed by most candidates.

(ii) This was answered very well by many candidates who explained that oppositely charged ions exert a high attractive force on each other and so their separation requires a large amount of energy. Candidates needed to specify that high energy rather than high temperature is required to separate the particles during melting. One misconception was that the high melting point of sodium chloride arises because sodium is a metal and metals have high melting points. Some candidates suggested that the high melting point occurs because sodium chloride exists as a lattice or because the particles are closely packed together.

(iii) Most candidates correctly answered this question on the trend in reactivity within Group 1.

(iv) The reactivity trend within Group 7 was not quite as familiar as that within Group 1 but large numbers of candidates correctly identified fluorine.

Question 9

(a) (i) Most candidates placed microwaves in the correct place.

(ii) Many candidates understood the relationship of volume to amplitude and pitch to frequency. The most common mistake was to reverse the relationships. Some candidates attempted to include changes in both amplitude and frequency for both volume and pitch.

(b) A large number of candidates correctly answered this question. Examples of longitudinal and transverse waves were accepted as alternative answers.

(c) (i) Most stronger candidates correctly stated the value of the speed of light. Although the answer 3×10^8 m / s was expected, 3×10^5 km / s was accepted provided the units were correctly stated.

(ii) Most candidates correctly stated the relationship *speed = distance ÷ time*. Most candidates worked through to the required final answer. Some candidates made mistakes when dividing large

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numbers expressed in standard form. An error in the speed of light in **(c)(i)** was allowed to be carried forward.

(iii) The majority of candidates correctly answered this question.

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Paper 0653/42
Extended Theory

Key messages

Candidates who did well on this paper:

- demonstrated knowledge and understanding in all three science disciplines
- recalled equations and showed the steps taken when making calculations
- interpreted diagrams and data by providing explanations as well as descriptions
- used data provided in the rubric to explain or justify conclusions.

General comments

Many excellent responses displaying a strong understanding of the syllabus were seen from candidates. These candidates often gave well developed answers combining definitions of scientific concepts with descriptions and explanations. Most candidates interpreted command words and phrases appropriately, recognising, for example, that 'show that' requires clearly setting out the steps in a calculation. Another common feature of these candidates was the understanding of rate. The concept of something happening per unit time enabled candidates to provide higher-level explanations. A very small number of candidates may have been better suited to the Core paper.

Comments on specific questions

Section A

Question 1

(a) (i) Some candidates mistook the ventricle for the atrium. Almost all candidates correctly identified the septum. Many candidates correctly named structure **F** as a valve.

(ii) Most candidates indicated the correct direction of blood flow and understood what is meant by the left side of the heart.

(iii) Very few candidates gave both advantages here. Many referred to the maintenance of high blood pressure throughout and/or the need to reoxygenate the blood returning from the body. Complete answers recognised that double circulation separates oxygenated from deoxygenated blood and allows blood to be pumped to the lungs at low pressure and to the rest of the body at high pressure.

(b) (i) Here, candidates applied some of the mathematical requirements of the syllabus. Almost all candidates interpreted the bar chart correctly.

(ii) Most candidates correctly obtained data from the graph to determine the total for males and females and then calculated the percentage of females appropriately.

Question 2

(a) (i) Most candidates identified O_2 in the first equation. A common misconception in equation 3 was Fe_2.

(ii) Occasionally, some quite random answers were seen here. Some candidates did not link the iron compound to its ore, hematite.

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(iii) Most candidates recognised the air as the source of nitrogen.

(iv) Most candidates were able to name one of the common pollutants in air.

(b) (i) Most candidates recognised that alloys are a mixture of metals. Some candidates didn't refer to mixture and some described them as compounds. Some candidates misunderstood the question and described a property of an alloy or listed some common alloying metals.

(ii) Most candidates recognised at least one relevant property of stainless steel that makes it more suitable for making cutlery. Many correctly gave two.

Question 3

(a) Almost all candidates identified the force arrow indicating weight.

(b) (i) Most candidates correctly converted metres to kilometres and hours to seconds to demonstrate this speed equivalence.

(ii) Most candidates showed their working and calculated the correct acceleration. Some candidates did not give the correct units of acceleration. The units could be either recalled or derived from the dimensions of speed (m / s) and time (s).

(iii) Most candidates recalled and applied the equation for kinetic energy. A very small number of candidates did not square the velocity and/or use the ½ term.

(iv) Almost all candidates used their answer to **(b)(iii)** but weaker candidates multiplied by time.

Question 4

(a) (i) Only a few candidates correctly stated root cortex cells. Many candidates describe them as root xylem cells. Similarly, very few candidates identified the mesophyll cells as the destination of the water. A few stated palisade cells, but this was not sufficient.

(ii) Most candidates explained that root hair cells are adapted to have a large surface area for their size. Fewer candidates recalled the term absorb/absorption.

(b) Only the strongest candidates explained this graph well. "The rate of transpiration decreases as humidity increases" was a description that was commonly given instead of an explanation. Stronger responses explained humidity in terms of the amount of water vapour in the air around the plant and/or related transpiration to the movement of water out of the plant either by diffusion or evaporation. Only a few candidates also applied the concept of decreasing water potential between the inside and outside of the leaf to explain the trend.

(c) Most candidates identified at least one of the features of these pollen adaptations. Incorrect responses often described the adaptations of the flowers rather than the pollen.

Question 5

(a) Most candidates identified that both ethane and ethene are hydrocarbons. The term saturated and the reaction with aqueous bromine were less well known.

(b) Most candidates identified four electrons and that it was a double bond. A common error was to count all the bonds in ethene. A misconception amongst some candidates was that carbon has six valence electrons. Candidates are reminded that a periodic table is provided in the question paper for reference.

(c) (i) Very few candidates recalled the reaction of cobalt(II) chloride with water vapour, but water as one of the products of this combustion reaction was recalled more often.

(ii) Most candidates correctly explained how limewater is used to identify carbon dioxide.

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(d) Stronger candidates referred to molecules of ethene. Correct references to monomers or polymerisation were seen infrequently.

Question 6

(a) (i) Many candidates were able to show how the combined resistance of the two parallel resistors was equal to 24 Ω. Often, candidates who did not recall the equation for resistors in parallel applied $V = IR$ in both branches to determine the total current. Some weaker candidates did not perform well on this question.

(ii) Most candidates calculated the current using the supply voltage from the diagram and the resistance stated in **(a)(i)**.

(b) Many candidates stated that the thermal output would decrease but did not provide an explanation. Stronger candidates recognised that increasing resistance decreases the current in the circuit and also linked this to less thermal output. Only a few candidates justified this explanation with reference to a relevant equation $E = VIt$ or $P = VI$. Candidates are reminded that reference to an equation is often a very useful way of explaining physics.

(c) Stronger candidates recalled the inverse proportionality between resistance and cross-sectional area. A common misconception was that the lower resistance of element 2 is due to it being closer to the power supply.

Question 7

(a) Most candidates identified at least one correct statement about chemical and mechanical digestion. A common error was to select one additional incorrect statement.

(b) (i) Pancreatic enzymes amylase or lipase were identified frequently by stronger candidates. A common misconception was pepsin.

(ii) Candidates who linked protease to protein also generally knew that amino acids are the product of this chemical digestion.

(c) (i) Weaker responses often gave descriptions rather than explanations of this enzyme activity graph, but many recalled that denaturing is the explanation for the activity at pH 10.5. Many more made some reference to the active site of the enzyme. A few candidates referred to the substrate and the enzyme not fitting. Some strong candidates used the idea of complementarity of shape to gain full marks.

(ii) Candidates answered well, recognising that this pancreatic protease works best at pH 8 and would not work in gastric juice which is too acidic.

Question 8

(a) (i) Most candidates were able to use ideas about ions in their responses. A common misconception here was that electrons can move when the ions are mobile. Another common misconception was that the molten lead bromide is aqueous.

(ii) Most candidates correctly justified their suggestion with reference to the melting point data provided in the rubric.

(iii) Few candidates correctly answered this question. Incorrect responses included that lead would form as a solid because it is a metal.

(b) Most candidates correctly answered at least one part of this question about electrolysis.

(c) Almost all candidates knew the colour of bromine gas.

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Question 9

(a) (i) Most candidates recalled the position of X-rays and/or microwaves in the electromagnetic spectrum.

(ii) Most candidates who recalled the wave equation $v = f\lambda$ substituted the frequency and speed and rearranged the equation correctly. An equation sometimes seen was $w = f\lambda$. It was unclear where the w symbol had come from, though candidates recalling the equation in this form regularly produced errors in calculations.

(iii) Most candidates stated that exposure to X-rays increases the risk of cancer.

(b) (i) Most candidates gave at least one mechanism of thermal energy loss. Many gave two.

(ii) Most candidates identified the larger surface area as the feature of cup B that explains why it cools more quickly. Many candidates also explained how, in the evaporation of water, energetic molecules leave the surface and take the energy with them. Candidates who understood that it is the rate at which the evaporation happens explained the phrase ‘more quickly’ used in the question.

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COMBINED SCIENCE

Paper 0653/43
Extended Theory

Key messages

Candidates who did well on this paper:

- were familiar with the definitions of scientific terms and required physics equations as they appear in the syllabus.
- understood the different requirements of the command words 'describe' and 'explain', for example in **Question 4(b)(ii)**.
- set out clear and precise answers using correct scientific terminology.
- ensured that they included working and formulas in questions involving calculations and that this was set out clearly.

General comments

Generally, candidates used all the space available to answer the question and took note of the number of marks allocated. Most candidates attempted all questions. Occasionally, candidates missed out question parts involving the labelling of a diagram, for example **Question 1(a)(ii)**. Some candidates also tended to miss out the calculation questions.

Comments on specific questions

Question 1

(a) (i) Most candidates were familiar with the parts of the flower labelled. However, a few candidates identified the stigma as anther and the anther as stigma.

(ii) The majority of candidates successfully identified the ovary as the part that produces ovules. A few candidates did not attempt this question.

(iii) Stronger candidates were able to describe two adaptations visible in Fig. 1.1. A few candidates chose adaptations not visible such as absence of colour or nectar. Candidates were required to provide precise adaptations using the correct scientific terminology. These adaptations needed to be specific to wind-pollinated flowers. Therefore "long anthers" was insufficient as it should have been clear the anthers are outside the flower.

(b) (i) Most candidates successfully constructed a food chain. A common error was to list the organisms without including the arrows indicating direction of energy flow.

(ii) Most candidates correctly identified either the wolf or coyote, with elk being the most common incorrect response.

(iii) Most candidates correctly identified the coyote, with vole being the most common incorrect answer.

(c) Stronger candidates were able to recall the balanced symbol equation for photosynthesis. Some candidates stated the equation for respiration. A few candidates used incorrect symbols for carbon dioxide or water, for example Co_2, CO^2 or H2O, and some others failed to correctly balance the equation.

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Question 2

(a) The majority of candidates were able to state at least one difference between the atom and the ion. When answering such questions, candidates are encouraged to state clearly which electronic structure they are referring to and avoid answers that start with 'it'.

(b) (i) Successful candidates clearly explained that the number of electrons in the atom equalled the number of protons. A few candidates did not provide explanations and instead gave answers such as "count the number of electrons", which were too vague. Candidates were expected to make it clear in their answers that they were referring to either chlorine or the atom and not the ion.

(ii) Stronger candidates understood the link between the number of electron shells and the period number. Many candidates confused period number with group, incorrectly referring to the number of electrons in the outer shell.

(iii) Few candidates correctly identified element X as fluorine. Others seemed to assume that reactivity increased down the group rather than decreased. Those candidates that identified either bromine or iodine also tended to provide a correct explanation.

(c) Only the strongest candidates provided a complete explanation of the difference in the melting points. Candidates tended to confuse the idea of structure with bonding. Common errors included references to strong bonds or ionic bonds. Very few candidates referred to the lattice structure of sodium chloride or that more energy is required to overcome the strong attractive forces and separate the ions. One misconception was that melting requires covalent bonds to be broken between the atoms rather than the attractive forces between molecules.

Question 3

(a) (i) The majority of candidates correctly identified N as the letter representing friction.

(ii) Most candidates simply calculated the net force and stated that the boat would be moving forward. Very few described the boat as accelerating.

(b) (i) Most candidates correctly converted m / s to km / h. Those candidates that were unsuccessful tended to miss out a step or multiplied rather than divided by 1000.

(ii) There was clear evidence that candidates were able to recall and use the formula for work done. Some candidates divided rather than multiplied. Recalling the unit proved a challenge for less successful candidates. A number of candidates made no attempt to answer the question.

(c) (i) The majority of candidates correctly interpreted the graph to state the maximum speed.

(ii) Many candidates successfully used the area under the graph to calculate distance. Those candidates that struggled with this question tended to start their answer with $d = s \times t$.

Question 4

(a) (i) Most candidates understood the link between coronary heart disease and a blockage in the blood vessel. Fewer candidates could name the blood vessel labelled.

(ii) Candidates usually stated two correct risk factors. Some candidates stated only "exercise" rather than "lack of exercise" or "no exercise".

(b) (i) Candidates were usually able to interpret the graph to identify the heart rate at 0 and 10 minutes. Some candidates stated the heart rate at 5 minutes instead of 0 minutes and some misread the *y*-axis. One common error was not calculating the difference in heart rate before calculating the final percentage. These candidates therefore stated an answer of 240 per cent rather than the correct answer of 140 per cent. A few candidates did not show their working.

(ii) Few candidates gave a complete explanation of why the shape of the graph changed. Many candidates simply described the shape of the graph, quoting data that was not required. The strongest candidates included ideas about muscle contraction and removal of carbon dioxide.

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Common misconceptions included the idea is that respiration provides the body with oxygen or that respiration produces rather than releases energy.

Question 5

(a) (i) Those candidates that understood that carbon dioxide had been produced usually also correctly balanced the equation. There were a few candidates that incorrectly stated the formula as CO_3 or CO_4.

(ii) Candidates seemed to struggle with the term 'reducing agent'. Many candidates thought the answer was iron or iron oxide, confusing reducing agent with the substance being reduced.

(b) (i) Only stronger candidates clearly explained why the reaction is an oxidation reaction.

(ii) Most candidates correctly stated and described a method. Most answers involved either galvanising or painting. Weaker responses incorrectly assumed it was enough to not put the object in a damp place.

(c) (i) Some candidates were able to state the correct formula for iron(II)oxide. The most common incorrect answer was Fe_2Cl. A few candidates incorrectly thought they needed to provide a balanced symbol equation for the reaction.

(ii) The majority of candidates successfully communicated the idea of energy being released. Very few candidates provided a completely correct explanation. Many incorrectly stated that energy was released when the bonds were broken.

Question 6

(a) The majority of candidates knew the correct symbol for the voltmeter, but many candidates placed the voltmeter in series rather than in parallel.

(b) (i) This question was answered correctly by most candidates.

(ii) Many candidates understood that decreasing resistance would increase current. However, very few went onto explain that thermal energy is proportional to current.

(c) (i) Successful candidates were able to show why the combined resistance was 23.1 Ω. Weaker responses either missed out the question or added the two numbers together.

(ii) Stronger candidates correctly calculated the current in heating element 2. A number of candidates gained partial credit by stating $I = V \div R$ or by calculating the current in the whole circuit. Candidates are encouraged to set out their calculations clearly and not to cross out their working.

Question 7

(a) (i) Some candidates provided a full explanation as to the effects of the tar on the cells. However, many candidates assumed that the tar just clogged up the airways and prevented gas exchange. Common misconceptions included the idea that tar prevents goblet cells producing mucus and the idea that cilia trap and digest the pathogens.

(ii) Most candidates understood that red blood cells were linked in some way to oxygen. The explanation that there would be less oxygen transported around the body proved more challenging. Very few candidates stated that the carbon monoxide binds to haemoglobin.

(b) Only stronger candidates stated two features not already given to them in the question.

Question 8

(a) (i) Most candidates correctly identified argon as the monoatomic gas.

(ii) Candidates found it challenging to explain the difference between mixtures and compounds. Many seemed to have an idea of the difference but could not express their answer in enough detail. Candidates are encouraged to use scientific terms such as 'elements' and 'chemically combined'.

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"Compounds contain two or more elements chemically combined; mixtures contain two or more substances not chemically combined" is a more precise answer than "Compounds are combined elements and mixtures are substances mixed together".

(b) Many candidates stated that the oxygen had been used in a reaction but did not name the reaction as combustion. Very few candidates stated it was combustion of a fuel, with many incorrectly assuming the oxygen itself was burnt. Some candidates incorrectly stated the oxygen had been used by the passengers in the car rather than the engine.

(c) Most candidates stated one impact of the enhanced greenhouse effect, usually global warming.

(d) Very few candidates identified sulfur dioxide as the correct gas. The most common incorrect answer was carbon monoxide. A few candidates incorrectly stated sulfur or sulfuric acid rather than naming a gas.

Question 9

(a) (i) The majority of candidates correctly placed infrared in the electromagnetic spectrum.

(ii) Some candidates knew the speed of infrared radiation.

(iii) Most candidates were able to provide a use for infrared radiation. A common incorrect answer was microwave ovens.

(b) (i) Candidates found the concept of heat transfer difficult. Stronger candidates provided correct answers of vacuum and plastic stopper to reduce convection and the silver coating to reduce radiation. One common misconception was that radiation does not pass through a vacuum.

(ii) Only stronger candidates described the transfer of thermal energy by conduction. Although answers sometimes referred to vibrations, they did not always mention vibrations of particles. Instead the answers implied the whole solid vibrated.

(iii) The most common answer to this question was oxygen rather than the correct answer of nitrogen.

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COMBINED SCIENCE

Paper 0653/51
Practical Test

Key messages

- Candidates should ensure they read through the whole of each question before starting an answer.
- For planning tasks, it is important that candidates take care that they are investigating the relationship in the question. Some plans investigated other variables, e.g. rate.
- For graph questions, candidates need to take care with scales.

General comments

There were some strong responses seen and few omissions. A number of candidates attempted the planning question at some length.

A pencil, rubber and ruler are essential for any practical exam. There was evidence that some candidates did not have these and therefore were not able to correct errors when plotting the graph or drawing the line of best fit.

The importance of covering all practical opportunities when teaching the course must be emphasised. Questions are based on methods and approaches that candidates are expected to be familiar with, even though information is provided so that full credit can be gained without any prior knowledge.

Guidance on the requirements for the practical component can be found in the syllabus. Teachers are also referred to Appendix 7.

Comments on specific questions

Question 1

(a) (i) Candidates demonstrated they could use a thermometer with the reading nearly always in line with the Supervisor's value.

(ii) There was an instruction here to give the answer to 0.5 °C. This was not always followed.

(iii) Most candidates obtained a reading for the final volume that was greater than the initial volume.

(iv) Candidates demonstrated they were able to obtain values for the cold water.

(v) Almost all candidates correctly subtracted the values to work out the volume of gas collected. Most had collected more gas with the warm water. A few had a lower value for the final volume, indicating they had not read the scale on the syringe correctly or had allowed gas to escape from the apparatus. This resulted in a negative value for the gas volume collected.

(vi) The question asked candidates to state the effect of temperature on the rate of respiration. Many had carried out the procedure carefully and obtained the expected results. They were able to state that as the temperature increases, the rate of respiration increases. Answers which referred only to the effect of temperature on the volume of gas collected were insufficient because they did not refer to rate, which was what the question asked.

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(vii) Stronger candidates recognised that the yeast suspension settles when left to stand and so identified that stirring ensured that both test tubes had an even distribution of yeast cells. Incorrect answers often referred to temperature.

(b) (i) Some graphs were drawn with labelled axes and care taken to plot points precisely using crosses. Some common errors seen included:

- The omission of labels or units from axes.
- Inverting the axes so that they were the wrong way around.
- Choosing inappropriate axis scales. Scales should be chosen so that more than half of the graph grid is used in both directions.
- Not using linear scales but instead entering the values from the table directly onto the gridlines of the graph.
- Choosing scales that were difficult to read. Scales should increase in standard intervals such as 5.0 or 1.0. Scales increasing in non-standard intervals, such as 3.0, were not accepted.
- Not plotting points clearly. Points needed to be drawn precisely using small crosses or dots in circles.

Another common error in this question was to plot 5.0 instead of 4.5 and 9.0 instead of 8.5 for the volume of gas collected.

Appendix 7(b) of the syllabus gives further information on the appropriate presentation of data in graphs.

(ii) In this question, the best-fit curve should be a smooth curve between 5.0 and 20.0 °C with a flat section above 20.0 °C. Some candidates drew this well with a fine line. However, errors in drawing the line of best fit included:

- Joining values dot to dot either using a ruler or freehand. This typically resulted in a straight area of the curve between 15.0 and 20.0 °C. A correctly drawn curve should follow a single, continuous curve.
- Drawing a curve between 20.0 and 25.0 °C which deviated significantly above 10.0 cm^3.
- Attempting to force the curve to go through the origin. This typically resulted in the curve curving in the wrong direction between 5.0 and 10 °C.

(iii) Many candidates correctly related the results of their experiments to those of the student's and so discussed how as temperature increased, rate increased in both cases.

(iv) Many candidates were able to cover one of the options on the mark scheme. The maximum capacity of the syringe was the most popular. It was clear from some answers that some candidates thought yeast was a substrate or an enzyme, despite the question clearly introducing yeast as respiring cells and therefore a living organism.

Question 2

(a) Most candidates observed the blue solution that was expected.

(b) (i) Most candidates described fizzing or bubbles, but few commented on a blue solution being formed. Candidates should use the number of marks available as a guide to how much detail is needed. In this case the marks available indicated that at least 2 observations were expected.

(ii) Many candidates struggled with expressing the idea that when a carbonate and acid are mixed, fizzing or bubbles are seen. Those identifying that when carbonates and acid are mixed, carbon dioxide gas is evolved were also given credit.

(c) (i) Many candidates correctly commented that the test-tube got warm or the solid disappeared.

(ii) Candidates should expect to carry out tests that have negative as well as positive results. Those that carried out the gas test as instructed observed that the glowing splint did not relight. A number of candidates stated, "squeaky pop", indicating the test had been carried out with a lighted splint.

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(iii) Many candidates were able to link their negative result in **(ii)** by stating the test they had carried out had not produced a positive result. Some candidates extended their answer to state that the test for hydrogen required a lighted not glowing splint or that the test used was for oxygen not hydrogen. Either of these two statements was sufficient to gain credit.

Question 3

Many candidates found this question a challenge. The most successful candidates considered the relationship which was to be investigated (in this case between the mass of manganese(IV) oxide and the volume of oxygen produced). They took care to write a plan to address each bullet point. The bullet points are intended to support candidates in their answers, so it is very important that they do this. There was evidence that some candidates made notes against the bullet points before writing their answer. This is good practice.

Weaker responses sometimes did not recognise the intention of the investigation. The intention of the investigation was to determine how the total volume of oxygen produced varied when using different masses of manganese(IV) oxide. Many candidates wrote plans to investigate the rate of the reaction or the volume of oxygen given off in a fixed time. A second issue was that some procedures did not fully address the question. Some candidates did not make it clear that the mass of manganese(IV) oxide needed to be varied. Some appeared to only do one experiment at one single mass.

The following points should be noted:

- The method needed to include how candidates would do the experiment. It needed to be workable so that another candidate could follow the instructions. The method needed to include what would be varied.
- Marks could be awarded from a results table and/or from the labelled axis of a sketch graph.
- When discussing processing of values, it was important to be specific. Some candidates said they would repeat the experiment and take an average. This suggested all of the results would be averaged to give a single value. It would have been better to identify how the repeats would be carried out, for example by saying, “Experiments will be repeated at each mass of manganese(IV) oxide, anomalies will be excluded and then an average taken.”
- The question wording used the phrase “to determine the relationship between…”. Answers which said “draw a graph to determine the relationship between…” were only repeating the question. More detail was needed on how the graph would be used.

Question 4

(a) Stronger responses showed working that included measuring the diameter of the mass and dividing by two in order to establish the centre point of the mass. These candidates then explained how to line up that centre point with the 15 cm mark.

(b) (i) Most candidates gave a sensible value for *p*. A few did not give their answer to the nearest 0.1 cm.

(ii) The calculation of *u* was almost always correct. Error carried forward from an incorrect answer in **(b)(i)** was allowed.

(iii) Again, almost all answers were correct. Error carried forward was allowed here too.

(c) In this question, there was an instruction to record the answer to two significant figures. Although most candidates correctly substituted their earlier values into the equation and computed the answer on their calculators correctly, some did not follow the significant figures instruction.

(d) Many candidates were able to describe difficulty in achieving a perfect balance. A few commented on the rule sliding off the pivot.

(e) (i) Nearly all candidates had a value that was in the expected range. The value obtained by the Supervisor was consulted in the event that the rule was unexpectedly heavy or light. It was clear that a few candidates had not read the scale on the newton meter correctly.

(ii) Candidates were generally able to calculate the weight correctly.

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(f) Candidates found this a challenging question and approached it in different ways. To fully answer the question, a mathematical analysis was required, along with a concluding statement consistent with the mathematical analysis shown.

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Paper 0653/52
Practical Test

Key messages

- Candidates should ensure they read through the whole of each question before starting an answer.
- For planning tasks, it is important that candidates take care that they are investigating the relationship in the question. Some plans investigated other variables, e.g. rate.
- For graph questions, candidates need to take care with scales.

General comments

There were some strong responses seen and few omissions. A number of candidates attempted the planning question at some length.

A pencil, rubber and ruler are essential for any practical exam. There was evidence that some candidates did not have these and therefore were not able to correct errors when plotting the graph or drawing the line of best fit.

The importance of covering all practical opportunities when teaching the course must be emphasised. Questions are based on methods and approaches that candidates are expected to be familiar with, even though information is provided so that full credit can be gained without any prior knowledge.

Guidance on the requirements for the practical component can be found in the syllabus. Teachers are also referred to Appendix 7.

Comments on specific questions

Question 1

(a) (i) Candidates demonstrated they could use a thermometer with the reading nearly always in line with the Supervisor's value.

(ii) There was an instruction here to give the answer to 0.5 °C. This was not always followed.

(iii) Most candidates obtained a reading for the final volume that was greater than the initial volume.

(iv) Candidates demonstrated they were able to obtain values for the cold water.

(v) Almost all candidates correctly subtracted the values to work out the volume of gas collected. Most had collected more gas with the warm water. A few had a lower value for the final volume, indicating they had not read the scale on the syringe correctly or had allowed gas to escape from the apparatus. This resulted in a negative value for the gas volume collected.

(vi) The question asked candidates to state the effect of temperature on the rate of respiration. Many had carried out the procedure carefully and obtained the expected results. They were able to state that as the temperature increases, the rate of respiration increases. Answers which referred only to the effect of temperature on the volume of gas collected were insufficient because they did not refer to rate, which was what the question asked.

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(vii) Stronger candidates recognised that the yeast suspension settles when left to stand and so identified that stirring ensured that both test tubes had an even distribution of yeast cells. Incorrect answers often referred to temperature.

(b) (i) Some graphs were drawn with labelled axes and care taken to plot points precisely using crosses. Some common errors seen included:

- The omission of labels or units from axes.
- Inverting the axes so that they were the wrong way around.
- Choosing inappropriate axis scales. Scales should be chosen so that more than half of the graph grid is used in both directions.
- Not using linear scales but instead entering the values from the table directly onto the gridlines of the graph.
- Choosing scales that were difficult to read. Scales should increase in standard intervals such as 5.0 or 1.0. Scales increasing in non-standard intervals, such as 3.0, were not accepted.
- Not plotting points clearly. Points needed to be drawn precisely using small crosses or dots in circles.

Another common error in this question was to plot 5.0 instead of 4.5 and 9.0 instead of 8.5 for the volume of gas collected.

Appendix 7(b) of the syllabus gives further information on the appropriate presentation of data in graphs.

(ii) In this question, the best-fit curve should be a smooth curve between 5.0 and 20.0 °C with a flat section above 20.0 °C. Some candidates drew this well with a fine line. However, errors in drawing the line of best fit included:

- Joining values dot to dot either using a ruler or freehand. This typically resulted in a straight area of the curve between 15.0 and 20.0 °C. A correctly drawn curve should follow a single, continuous curve.
- Drawing a curve between 20.0 and 25.0 °C which deviated significantly above 10.0 cm^3.
- Attempting to force the curve to go through the origin. This typically resulted in the curve curving in the wrong direction between 5.0 and 10 °C.

(iii) Many candidates correctly related the results of their experiments to those of the student's and so discussed how as temperature increased, rate increased in both cases.

(iv) Many candidates were able to cover one of the options on the mark scheme. The maximum capacity of the syringe was the most popular. It was clear from some answers that some candidates thought yeast was a substrate or an enzyme, despite the question clearly introducing yeast as respiring cells and therefore a living organism.

Question 2

(a) Most candidates observed the blue solution that was expected.

(b) (i) Most candidates described fizzing or bubbles, but few commented on a blue solution being formed. Candidates should use the number of marks available as a guide to how much detail is needed. In this case the marks available indicated that at least 2 observations were expected.

(ii) Many candidates struggled with expressing the idea that when a carbonate and acid are mixed, fizzing or bubbles are seen. Those identifying that when carbonates and acid are mixed, carbon dioxide gas is evolved were also given credit.

(c) (i) Many candidates correctly commented that the test-tube got warm or the solid disappeared.

(ii) Candidates should expect to carry out tests that have negative as well as positive results. Those that carried out the gas test as instructed observed that the glowing splint did not relight. A number of candidates stated, "squeaky pop", indicating the test had been carried out with a lighted splint.

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(iii) Many candidates were able to link their negative result in **(ii)** by stating the test they had carried out had not produced a positive result. Some candidates extended their answer to state that the test for hydrogen required a lighted not glowing splint or that the test used was for oxygen not hydrogen. Either of these two statements was sufficient to gain credit.

Question 3

Many candidates found this question a challenge. The most successful candidates considered the relationship which was to be investigated (in this case between the mass of manganese(IV) oxide and the volume of oxygen produced). They took care to write a plan to address each bullet point. The bullet points are intended to support candidates in their answers, so it is very important that they do this. There was evidence that some candidates made notes against the bullet points before writing their answer. This is good practice.

Weaker responses sometimes did not recognise the intention of the investigation. The intention of the investigation was to determine how the total volume of oxygen produced varied when using different masses of manganese(IV) oxide. Many candidates wrote plans to investigate the rate of the reaction or the volume of oxygen given off in a fixed time. A second issue was that some procedures did not fully address the question. Some candidates did not make it clear that the mass of manganese(IV) oxide needed to be varied. Some appeared to only do one experiment at one single mass.

The following points should be noted:

- The method needed to include how candidates would do the experiment. It needed to be workable so that another candidate could follow the instructions. The method needed to include what would be varied.
- Marks could be awarded from a results table and/or from the labelled axis of a sketch graph.
- When discussing processing of values, it was important to be specific. Some candidates said they would repeat the experiment and take an average. This suggested all of the results would be averaged to give a single value. It would have been better to identify how the repeats would be carried out, for example by saying, “Experiments will be repeated at each mass of manganese(IV) oxide, anomalies will be excluded and then an average taken.”
- The question wording used the phrase “to determine the relationship between…”. Answers which said “draw a graph to determine the relationship between…” were only repeating the question. More detail was needed on how the graph would be used.

Question 4

(a) Stronger responses showed working that included measuring the diameter of the mass and dividing by two in order to establish the centre point of the mass. These candidates then explained how to line up that centre point with the 15 cm mark.

(b) (i) Most candidates gave a sensible value for *p*. A few did not give their answer to the nearest 0.1 cm.

(ii) The calculation of *u* was almost always correct. Error carried forward from an incorrect answer in **(b)(i)** was allowed.

(iii) Again, almost all answers were correct. Error carried forward was allowed here too.

(c) In this question, there was an instruction to record the answer to two significant figures. Although most candidates correctly substituted their earlier values into the equation and computed the answer on their calculators correctly, some did not follow the significant figures instruction.

(d) Many candidates were able to describe difficulty in achieving a perfect balance. A few commented on the rule sliding off the pivot.

(e) (i) Nearly all candidates had a value that was in the expected range. The value obtained by the Supervisor was consulted in the event that the rule was unexpectedly heavy or light. It was clear that a few candidates had not read the scale on the newton meter correctly.

(ii) Candidates were generally able to calculate the weight correctly.

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(f) Candidates found this a challenging question and approached it in different ways. To fully answer the question, a mathematical analysis was required, along with a concluding statement consistent with the mathematical analysis shown.

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Paper 0653/61
Alternative to Practical

Key messages

- Candidates should ensure they read through the whole of each question before starting an answer.
- For planning tasks, it is important that candidates take care that they are investigating the relationship in the question. Some plans investigated other variables, e.g. rate.
- In all questions, candidates need to take care with measurement scales. They need to ensure they know whether the scale is increasing or decreasing and also what each division of the scale represents. Many assumed each division represented 1.0, 0.1 or 0.5. Scales where the division was 0.2 were often read incorrectly.

General comments

There were some strong responses to questions and few omissions. Almost all candidates attempted the planning question at some length.

Although the Alternative to Practical is a paper-based assessment, it is still intended that candidates do a substantial amount of practical work integrated into their course. This will assist the candidates in accessing the questions, even though information is provided so that full credit can be gained without any prior knowledge.

Guidance for the requirements for the practical component can be found in the syllabus. Teachers are also referred to Appendix 7.

Comments on specific questions

Question 1

(a) (i) Almost all candidates correctly identified a piece of apparatus suitable for measuring 10 cm^3 of yeast suspension (typically either a measuring cylinder or syringe). It should be noted that a pipette is not accepted for measuring liquids, as there is ambiguity with a dropping pipette. A graduated pipette is accepted.

(ii) Most candidates read the thermometers correctly, but not all followed the instruction to record the temperature to the nearest 0.5 °C. Therefore, 11 (rather than 11.0) was a common incorrect answer.

(iii) Candidates needed to consider the direction of the scale carefully. In this case, the scale needed to be read downwards from the top, to give a value of 2.6 cm^3. A common incorrect answer was 3.4 cm^3. A second factor to consider was the graduations on the syringe - each graduation represented 0.2 cm^3. A common incorrect answer was 2.3 cm^3, implying the graduations had been misread as 0.1 cm^3.

(iv) Almost all candidates correctly subtracted the values to work out the volume of gas collected. Error carried forward was allowed on incorrect earlier values.

(v) The question asked candidates to state the effect of temperature on the rate of respiration. Many were able to state that as the temperature increases, the rate of respiration increases. Answers which referred only to the effect of temperature on the volume of gas collected were insufficient because they did not refer to rate, which was what the question asked.

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(vi) The question asked about methods to reduce cooling. Most answers correctly suggested means of insulating the beaker or providing a lid. However, it was not appropriate in this context to instead suggest means of providing an external heat source. Answers such as using a Bunsen burner were incorrect.

(b) (i) Some graphs were drawn with labelled axes and care taken to plot points precisely using crosses. Some common errors seen included:

- The omission of labels or units from axes.
- Inverting the axes so that they were the wrong way around.
- Choosing inappropriate axis scales. Scales should be chosen so that more than half of the graph grid is used in both directions.
- Not using linear scales but instead entering the values from the table directly onto the gridlines of the graph.
- Choosing scales that were difficult to read. Scales should increase in standard intervals such as 5.0 or 1.0. Scales increasing in non-standard intervals, such as 3.0, were not accepted.
- Not plotting points clearly. Points needed to be drawn precisely using small crosses or dots in circles.

Appendix 7(b) of the syllabus gives further information on the appropriate presentation of data in graphs.

(ii) In this question, the best-fit curve should be a smooth curve between 5.0 and 20.0 °C with a flat section above 20.0 °C. Some candidates drew this well with a fine line. However, errors in drawing the line of best fit included:

- Joining values dot to dot either using a ruler or freehand. This typically resulted in a straight area of the curve between 15.0 and 20.0 °C. A correctly drawn curve should follow a single, continuous curve.
- Drawing a curve between 20.0 and 25.0 °C which deviated significantly above 5.0 cm^3.
- Attempting to force the curve to go through the origin. This typically resulted in the curve curving in the wrong direction between 5.0 and 10 °C.

(iii) This question was answered well. Most candidates correctly related the results of both experiments to each other and so either discussed how as temperature increases, rate increases, or identified that this pattern does not continue past 20.0 °C.

(iv) Many candidates noticed that the maximum volume of the syringe is 5.0 cm^3. Others identified that a limiting reagent, for example sugar, must be used up. In both cases, the key idea is that the reaction has stopped. A common misconception was that the reaction had reached a maximum rate, rather than that it had stopped, and a common incorrect answer was that the reaction had reached an optimum temperature.

Question 2

(a) A range of responses were accepted as a means of making the reaction faster. Most candidates gave at least one correct answer. A common error was to state that the amount of reactants should be increased, by either increasing the mass of solid K or the volume of the dilute acid.

(b) (i) Almost all candidates correctly identified carbon dioxide. Hydrogen and oxygen were occasional incorrect answers.

(ii) Again, many candidates answered this correctly. Most candidates identified that carbon dioxide indicates the presence of a carbonate ion.

(c) In questions which ask for observations, it is important that candidates take care to provide observations rather than identify features that cannot be observed. Correct answers included fizzing, a squeaky pop (with a lighted splint), an increase in temperature (on the thermometer). Incorrect answers included statements that an exothermic reaction takes place or hydrogen is made because neither are observations.

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Question 3

Candidates typically answered the planning question very well. Most addressed all of the bullets and described an experiment with attention to apparatus, method, control of variables and how results would be processed.

Strong responses considered the relationship to be investigated (in this case the relationship between the mass of manganese(IV) oxide and the volume of oxygen produced). They addressed each bullet point. It should be noted that the bullet points are intended to support candidates in their answers. There was evidence that some candidates made notes against the bullet points before writing their answer. This is good practice.

Weaker responses sometimes did not recognise the intention of the investigation. The intention of the investigation was to determine how the total volume of oxygen produced varied when using different masses of manganese(IV) oxide. Many candidates wrote plans to investigate the rate of the reaction or the volume of oxygen given off in a fixed time. A second issue was that some procedures did not fully address the question. Some candidates did not make it clear that the mass of manganese(IV) oxide needed to be varied. Some appeared to only do one experiment at one single mass.

The following points should be noted:

- The method needed to include how candidates would do the experiment. It needed to be workable so that another candidate could follow the instructions. The method needed to include what would be varied.
- Marks could be awarded from a results table and/or from the labelled axis of a sketch graph.
- When discussing processing of values, it was important to be specific. Some candidates said they would repeat the experiment and take an average. This suggested all of the results would be averaged to give a single value. It would have been better to identify how the repeats would be carried out, for example by saying, "Experiments will be repeated at each mass of manganese(IV) oxide, anomalies will be excluded and then an average taken."
- The question wording used the phrase "to determine the relationship between…". Answers which said "draw a graph to determine the relationship between…" were only repeating the question. More detail was needed on how the graph would be used.

Question 4

(a) Most candidates stated correctly that the centre of the mass was at 15.0 cm^3 but not all went on to explain how they knew this. Answers such as "because it's between 14.0 and 16.0 cm^3" were insufficient because there are many values between these two numbers. The strongest responses showed that working needed to include some division by two, for example by adding 14.0 and 16.0 and dividing by two.

(b) (i) Most candidates measured *p* correctly. Common errors included stating that *p* = 46 cm.

(ii) The calculation of *u* was almost always correct. Error carried forward from an incorrect answer in **(b)(i)** was allowed.

(iii) Again, almost all answers were correct. Error carried forward was allowed here too.

(c) In this question, candidates were asked to record the answer to two significant figures. Although most candidates correctly substituted their earlier values into the equation and computed the answer on their calculators correctly, some did not record to two significant figures.

(d) Candidates were asked to give the answer to 0.1 N. Again, this instruction was sometimes not followed. Another common error was to misread the newton meter. Rather than taking the reading at the arrow marker, some candidates took the reading at the bottom of the spring, leading to an incorrect value of 0.9.

(e) Almost all candidates stated that a balance is suitable for measuring mass.

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(f) Candidates found this a challenging question and approached it in different ways. To fully answer the question, a mathematical analysis was required, along with a concluding statement consistent with the mathematical analysis shown.

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Paper 0653/62
Alternative to Practical

Key messages

- Candidates should ensure they read through the whole of each question before starting an answer.
- For planning tasks, it is important that candidates take care that they are investigating the relationship in the question.
- For graph questions, candidates need to take care with scales.

General comments

There were some strong responses to questions and few omissions. Almost all candidates attempted the planning question at some length.

A pencil, rubber and ruler are essential for any practical exam. There was evidence that some candidates did not have these and therefore were not able to correct errors when plotting the graph or drawing the line of best fit.

Although the Alternative to Practical is a paper-based assessment, it is still intended that candidates do a substantial amount of practical work integrated into their course. This will assist the candidates in accessing the questions, even though information is provided so that full credit can be gained without any prior knowledge.

Guidance for the requirements for the practical component can be found at the back of the syllabus. Teachers are referred to Appendix 7.

Comments on specific questions

Question 1

(a) (i)(ii) Most candidates correctly recorded the balance display to one decimal place and calculated the change in mass.

(b) (i) Most candidates circled at least one, and often both, correct values. Candidates should use the number of marks available as a guide to how much information is needed. In this scenario, as two marks were available, two values were expected.

(ii) Many candidates deduced that the volume would decrease. A number gave their answer in relation to mass rather than volume as the question asked.

(c) Most candidates noted that not drying the potato would leave excess solution on the outside of the potato and so cause an increase in the value of mass recorded.

(d) Stronger candidates were able to state that while anomalous results may still occur, repeating the experiment allows for them to be identified and excluded. Common errors included stating that this makes the experiment more accurate or that this prevents anomalous results.

Question 2

Stronger candidates considered the relationship which was to be investigated, in this case between recovery time and the age of a person. They wrote a plan which addressed each bullet point. It should be noted that the bullet points are intended to support candidates in their answers. There was evidence that some candidates made notes against the bullet points before writing their answer. This is good practice.

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A common issue seen in responses was that the relationship to be investigated was misinterpreted or misunderstood. Many candidates stated that the recovery time would be recorded without describing how this would actually be done and how the apparatus would be used to do this. Another issue was that some procedures did not fully address the question. Some candidates did not make it clear that people of different ages needed to be tested, and some specified only one experiment with one person.

The following points should be noted:

- The method needed to include how candidates would do the experiment. It needed to be workable so that another candidate could follow the instructions. The method needed to include what would be varied.
- When discussing processing of values, it was important to be specific. Some candidates said they would repeat the experiment and take an average. This suggested all of the results would be averaged to give a single value. It would have been better to identify how the repeats would be carried out, for example by saying, "Experiments will be repeated at each age, anomalies will be excluded and then an average taken."
- The question wording used the phrase "to determine the relationship between…". Answers which said "draw a graph to determine the relationship between…" were only repeating the question. More detail was needed on how the graph would be used.

Question 3

(a) There was an instruction to give the answer to the nearest 0.5ºC. This instruction was often not followed for the temperature of the distilled water. Most candidates read and recorded the temperature of the solution correctly. Most candidates correctly calculated the temperature change for the values they recorded.

(b) Most candidates correctly deduced that the pH value was above 10 and below 14, with 12 being a popular choice.

(c) (i) Many candidates correctly identified 91.5 because it had not been rounded to the nearest second.

(ii) Candidates found this question challenging. A common error was to make sure the temperature was even throughout. A few candidates identified that it ensured the reaction was complete.

(iii) Many candidates correctly identified the relationship between the mass of solid and the reaction time.

(iv) Candidates generally calculated the rate of reaction correctly. Only stronger candidates correctly expressed their answers to two significant figures.

(v) Many candidates identified the test and stated the observation for the presence of carbon dioxide.

(d) (i) Some candidates gave more details than required for the flame test, such as references to cleaning the nichrome wire. The reference to the need for a blue flame was often omitted.

(ii) Many candidates either stated the colour expected for sodium or identified potassium as the metal that gives a lilac colour. Some just stated that it was the incorrect colour for sodium, which was not sufficient.

Question 4

(a) (i) Most candidates demonstrated correct calculation of the value for r^2.

(ii) Nearly all candidates correctly recorded the time to the nearest 0.1s.

(iii) Many candidates correctly calculated the average value to the nearest 0.1s. Error carried forward from **(i)** was permitted.

(b) Candidates were generally able to identify the anomalous result. Some did not note that the longer time was specifically as a result of starting the stop-watch too early or stopping it too late.

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(c) (i) It was usual to see graphs drawn with labelled axes and candidates generally took care to plot points precisely using crosses. Common errors included:

- Inverting the axes so that they were the wrong way around.
- Choosing inappropriate axis scales. Scales should be chosen so that more than half of the graph grid is used in both directions.
- Not using linear scales but instead entering the values from the table directly onto the gridlines of the graph.
- Choosing scales that were difficult to read. Scales should increase in standard intervals such as 5.0 or 1.0. Scales increasing in non-standard intervals, such as 3.0, were not accepted.

Appendix 7(b) of the syllabus gives further information on the appropriate presentation of data in graphs.

(ii) Only stronger candidates did this well. Other candidates did not draw a straight line as instructed or joined values dot-to-dot, either using a ruler or freehand.

(iii) Many candidates were able to correctly state the relationship between the average time and r^2.

(d) (i) The majority of candidates correctly measured the radius.

(ii) Only stronger candidates identified that the small size of the parachute would mean a very short time that could not easily be measured.

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Paper 0653/63
Alternative to Practical

Key messages

- Candidates should ensure they read through the whole of each question before starting an answer.
- For planning tasks, it is important that candidates take care that they are investigating the relationship in the question. Some plans investigated other variables, e.g. extension.
- For graph questions, candidates need to take care with scales.

General comments

There were some strong responses seen and few omissions. Almost all candidates attempted the planning question at some length.

Although the Alternative to Practical is a paper-based assessment, it is still intended that candidates do a substantial amount of practical work integrated into their course. This will assist the candidates in accessing the questions, even though information is provided so that full credit can be gained without any prior knowledge.

Guidance for the requirements for the practical component can be found in the syllabus. Teachers are also referred to Appendix 7.

Comments on specific questions

Question 1

(a) (i) Almost all candidates correctly measured the distance between points P and Q.

(ii) Most candidates were able to correctly use the magnification equation provided to calculate the magnification of the photograph. Error carried forward was allowed from an incorrect measurement.

(iii) Candidates made a large drawing of the star fruit that easily filled at least half of the box provided. Details were usually included, such as the five points and the three seeds. The most common error was to make the outline sketchy so that it was not clear and continuous. Some candidates produced a large amount of shading which was not required in this response.

(iv) Almost all candidates correctly labelled one of the seeds.

(b) (i) Most candidates were able to state the colour of the Benedict's and biuret solutions before testing. Many candidates stated orange or red for the initial colour of iodine, which was incorrect.

(ii) Candidates generally performed better on the second part of the table, often correctly stating that starch was present, protein was not present and that the fruit was acidic. The most common error was to state that all the tests were for reducing sugar.

(iii) Only a few candidates identified that the fruit was not heated during the procedure, meaning that the Benedict's test may not be correct.

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Question 2

(a) The balance readings were correctly recorded to one decimal place (5.0 and 5.8) by nearly all candidates.

(b) (i) Some graphs were drawn with labelled axes and care taken to plot points precisely using crosses. Some common errors included:

- The omission of labels or units from axes.
- Inverting the axes so that they were the wrong way around.
- Choosing inappropriate axis scales. Scales should be chosen so that more than half of the graph grid is used in both directions.
- Not using linear scales but instead entering the values from the table directly onto the gridlines of the graph.
- Choosing scales that were difficult to read. Scales should increase in standard intervals such as 5.0 or 1.0. Scales increasing in non-standard intervals, such as 3.0, were not accepted.
- Not plotting points clearly. Points needed to be drawn precisely using small crosses or dots in circles.

(ii) The point at 2.0 g should have been circled as the anomalous point. Almost all candidates identified this point clearly on their graph.

(iii) In this case, the best fit line should have been a solid, ruler-drawn line including all the points apart from the result for 2.0 g. Some candidates drew this well with a fine line. Some responses displayed errors such as joining the values dot to dot, unevenly drawing the line freehand, and including the anomalous point.

(iv) Many candidates successfully stated that as the mass of solid sodium hydrogencarbonate heated increases, the mass of solid remaining in the test-tube increases. It is good technique to closely follow the two variables stated in the question. This answer showed that candidates had interpreted the results in the graph correctly.

(v) Many candidates were able to use their graph to estimate the mass of solid remaining in the test-tube when 4.7 g of solid sodium hydrogencarbonate is heated. The most common error was reading the 4.7 g from the mass of solid remaining axis. Candidates are reminded to draw a straight line from one axis to the line of best fit and then a straight line across to the other axis. This will allow for more accurate readings from graphs.

(c) (i) Only a few candidates linked the decrease in mass given in the results table to the conclusion that a gas had been formed. Common incorrect answers referred to smaller amounts, or not as much of the chemical being left rather than using the correct term ‘mass’.

(ii) Most candidates correctly stated that limewater turns milky when testing for carbon dioxide. However, many candidates confused this with the test for hydrogen and stated that a squeaky pop would be heard. This question was often omitted by weaker candidates.

(d) Many candidates correctly stated that the blue flame is hotter than the yellow flame, or that the yellow flame would leave soot on the test-tube. Some candidates stated that the reaction would be quicker with the blue flame. Whilst this is true, it does not provide a reason why the reaction would be quicker.

(e) Candidates found this a challenging question and only a few were able to suggest how to test for any unreacted sodium hydrogencarbonate left in the test-tube. Some stated that it should be re-heated but did not go on to state that they would then look for a loss of mass.

Question 3

(a) Many candidates correctly stated that a measuring cylinder should be used. Syringes and burettes are not suitable for measuring this volume of liquid.

(b) Most candidates correctly recorded the reading on the thermometer. A common incorrect answer was 27 (rather than 27.5).

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(c) In general, candidates correctly stated that stirring the water would ensure that it was all at the same temperature (and so improve the accuracy of the temperature measurement). A common error was to state that stirring would make sure the ice melted, and not to link this to the temperature.

(d) Candidates were able to use the equation provided to calculate the change in temperature. Error carried forward was allowed from the thermometer readings in **(b)**.

(e) Again, candidates were generally able to use their figure from **(d)** and the equation provided to calculate the thermal energy lost. However some candidates did not follow the instruction to give the answer to two significant figures.

(f) Most candidates correctly stated that the extra thermal energy comes from the surroundings or specified a suitable named example of the surroundings, e.g. room.

Question 4

Candidates typically answered the planning question very well. Most addressed all of the bullets and described an experiment with attention given to apparatus, method, control of variables, a results table and how results would be processed. There was evidence that some candidates made notes against the bullet points before writing their answer. This is good practice.

Some candidates wrote plans that incorrectly investigated the resistance of different lengths or thicknesses of wires. A second common issue was that some procedures did not fully address the question. For example, some responses did not make it clear that only the metal used to make the wire needed to be varied, and some plans changed more than one variable.

The following points should be noted:

- Candidates need to ensure that the experiment they plan investigates the relationship given in the question. In this experiment, both potential difference and current needed to be measured, as given in the equation.
- The method needs to include how candidates would do the experiment. It needs to be workable so that another candidate could follow the instructions. The method needs to include what would be varied.
- The method should include which variables are to be controlled or kept the same. In this case, this was the length and thickness of the wires. Good methods stated values for these, e.g. 5 cm length wires of constantan, nichrome and tungsten.
- A results table should follow the format of the independent variable in the first column and the dependent variables in the following columns. Units should be included in the column headings. Many candidates drew a table containing their calculated resistance value only.
- When discussing processing of values, it is important to be specific. Some candidates said they would repeat the experiment and take an average. This suggested that all of the results would be averaged to give a single value. It is better to identify how the repeats will be carried out, for example by saying “experiments will be repeated for each type of wire, anomalies will be excluded and then an average taken”.

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