Principal examiner reports for teachers

Principal examiner reports for teachers summarise what candidates did well and what candidates needed to improve for this examination series only.

This report is to be used in conjunction with the question paper and mark scheme.

For guidance on teaching and learning we provide resources for many of our syllabuses.

Resource	Where to find it
Grade descriptions – Grade descriptions describe the level of performance typically demonstrated by candidates achieving the different grades awarded for a qualification.	School support hub Select: Subject > Resource finder > Syllabus and specimen materials
Schemes of work – Schemes of work are designed to support you in your teaching and lesson planning.	School support hub Select: Subject > Resource finder > Teaching and learning
Lesson planning – Guidance on how to plan a lesson.	Lesson planning
Resource plus – There may be additional resources such as teaching packs containing lesson plans, resources and worksheets and videos for aspects of your syllabus.	School support hub Select: Subject > Resource finder > Teaching and learning
Teaching tools	Teaching Tools
Exemplar candidate responses	School support hub Select: Subject > Resource finder > Teaching and learning
Learner guide – A guide for students to help them understand what the course involves.	School support hub Select: Subject > Resource finder > Teaching and learning
Community forums – Do you have a question or something to share? Our online forums are great way to keep up to date with your subject and the global Cambridge community.	Community forum on the school support hub
Access to scripts for this series.	Access to scripts service
Results analysis is available for some syllabuses.	Results analysis
Test maker is available for some subjects.	Test maker

Other services from Cambridge International Education

- **Digital mocks service**
- **Insight assessments**
- **Professional development**
  - Focus on assessment
  - Online marking workshops

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Paper 0653/11
Multiple choice Core

Key messages

Candidates performed well on **Questions 5**, **28** and **29**.

Candidates performed less well on **Questions 7**, **12**, **14**, **15**, **16**, **17**, **18**, **19**, **22**, **32**, **33**, **36**, **37** and **38**.

Candidates performed most well on **Question 29** and least well on **Question 36**. There was evidence of guessing on **Questions 7** and **33**.

Comments on specific questions

Question 7

- All the options were equally popular, indicating guessing by candidates when they described the features of a capillary.

Question 12

- Option **A** was a common incorrect answer.
- Anthers hanging outside of a flower is a characteristic of a wind-pollinated flower rather than an insect-pollinated flower.

Question 14

- Option **B** was as popular as the key.
- Candidates had confused the description of an atom with that of an ion. They also thought molecules are charged.

Question 15

- Option **B** was a popular choice and option **D** was more popular than the key.
- Candidates thought that the elements hydrogen and oxygen were compounds and that water is a mixture rather than a compound.

Question 16

- Options **A** and **C** were common incorrect answers.
- Candidates were not familiar with the bonding in ammonia.

Question 17

- Options **B** and **C** were more popular than the key.
- Candidates thought that the formula for oxygen is O rather than O_2 and the formula for A*l* is Al_2.

Question 18

- Option **B** was more popular than the key.

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- They knew that chlorine is produced at the anode during the electrolysis of aqueous sodium chloride and incorrectly thought sodium is formed at the cathode.

Question 19

- Option **B** was a common incorrect answer.
- Candidates thought that chlorine is produced when calcium reacts with dilute hydrochloric acid, rather than hydrogen.

Question 22

- Option **A** was more popular than the key.
- Measuring a boiling point is a physical test and not a chemical test for the presence of water.

Question 32

- Option **A** was a common incorrect answer and option **B** was more popular than the key.
- Candidates were limited in identifying how energy is transferred thermally from the surface of the Moon into space.

Question 33

- All of the options were equally popular, indicating guessing with thermal insulators and their role in reducing the transfer of thermal energy.

Question 36

- This question attracted a range of responses. Option **A** was more popular than the key.
- Candidates were able to determine the speed of sound in some cases.

Question 37

- Option **C** was a common incorrect answer.
- Candidates were able to determine the current using voltage and resistance in some cases.

Question 38

- Option **A** was a common incorrect answer.
- Candidates could not interpret the role of the switches in the circuit diagram shown.

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Paper 0653/12
Multiple choice Core

Key messages

Candidates performed well on **Question 2**.

Candidates performed less well on **Questions 4**, **8**,1**2**, **15**, **16**, **19**, **20**, **21**, **22**, **26**, **27**, **28**, **29**, **31**, **35**, **38** and **39**.

Candidates found **Question 20** the hardest on the paper and there was evidence of guessing on **Question 27**.

Comments on specific questions

Question 4

- Option **B** was more popular than the key.
- Candidates knew the effect of size of food pieces during physical digestion and thought that a chemical change occurs during this process.

Question 8

- Option **B** was more popular than the key.
- Candidates knew that rate of breathing increases when a person starts to exercise and thought that depth of breathing decreases.

Question 12

- Option **A** was as popular as the key.
- These candidates were not able to identify the structures in the diagram of the male reproductive system and then link them to their correct function.

Question 15

- Option **C** was as popular as the key.
- The number of electrons shells do not increase across a period. Candidates may have confused the terms period and group.

Question 16

- Option **A** was more popular than the key and option **B** was as popular.
- Some candidates were not able to interpret the information about each particle and the number of protons, neutrons or electrons they contain.

Question 19

- Option **D** was as popular as the key.
- A decrease in temperature indicates an endothermic reaction rather than an exothermic one.

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Question 20

- Candidates found this the hardest question on the paper. Options **B** and **C** were more commonly chosen than the key.
- Only carbon dioxide will turn the universal indicator orange or red.

Question 21

- Options **A** and **B** were as popular as the key.
- Candidates did not know that chlorides of transition elements are coloured and that transition elements have a high electrical conductivity and have catalytic properties.

Question 22

- Option **B** was a common incorrect answer.
- The amount of carbon dioxide would not increase as the iron nail rusts.

Question 26

- Option **B** was as popular as the key and option **C** was more commonly chosen.
- Candidates were not familiar with the terms filtrate, residue and solute.

Question 27

- All options were popular, indicating guessing with recognising the acidified aqueous barium nitrate is used to test for the sulfate ion.

Question 28

- Option **C** was a common incorrect answer.
- The mass of the matter of an object is not the weight.

Question 29

- Options **B** and **C** were as popular as the key.
- Candidates were less secure in calculating density from mass and volume.

Question 31

- Option **A** was a common incorrect answer.
- Candidates knew that liquids flow and thought they are easy to compress.

Question 35

- Option **B** was more popular than the key and option **C** was as popular.
- Candidates did not know the relative speeds of radio waves, visible light and X-rays in a vacuum.

Question 38

- Options **B** and **C** were common incorrect answers.
- Candidates were less secure in recalling what is meant by a kilowatt-hour.

Question 39

- Options **A** and **D** were more popular than the key.
- Candidates did not know how to determine the combine resistance in series and in parallel.

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Paper 0653/13
Multiple choice Core

Key messages

Candidates performed well on **Question 2**.

Candidates performed less well on **Questions 4**, **8**,1**2**, **15**, **16**, **19**, **20**, **21**, **22**, **26**, **27**, **28**, **29**, **31**, **35**, **38** and **39**.

Candidates found **Question 20** the hardest on the paper and there was evidence of guessing on **Question 27**.

Comments on specific questions

Question 4

- Option **B** was more popular than the key.
- Candidates knew the effect of size of food pieces during physical digestion and thought that a chemical change occurs during this process.

Question 8

- Option **B** was more popular than the key.
- Candidates knew that rate of breathing increases when a person starts to exercise and thought that depth of breathing decreases.

Question 12

- Option **A** was as popular as the key.
- These candidates were not able to identify the structures in the diagram of the male reproductive system and then link them to their correct function.

Question 15

- Option **C** was as popular as the key.
- The number of electrons shells do not increase across a period. Candidates may have confused the terms period and group.

Question 16

- Option **A** was more popular than the key and option **B** was as popular.
- Some candidates were not able to interpret the information about each particle and the number of protons, neutrons or electrons they contain.

Question 19

- Option **D** was as popular as the key.
- A decrease in temperature indicates an endothermic reaction rather than an exothermic one.

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Question 20

- Candidates found this the hardest question on the paper. Options **B** and **C** were more commonly chosen than the key.
- Only carbon dioxide will turn the universal indicator orange or red.

Question 21

- Options **A** and **B** were as popular as the key.
- Candidates did not know that chlorides of transition elements are coloured and that transition elements have a high electrical conductivity and have catalytic properties.

Question 22

- Option **B** was a common incorrect answer.
- The amount of carbon dioxide would not increase as the iron nail rusts.

Question 26

- Option **B** was as popular as the key and option **C** was more commonly chosen.
- Candidates were not familiar with the terms filtrate, residue and solute.

Question 27

- All options were popular, indicating guessing with recognising the acidified aqueous barium nitrate is used to test for the sulfate ion.

Question 28

- Option **C** was a common incorrect answer.
- The mass of the matter of an object is not the weight.

Question 29

- Options **B** and **C** were as popular as the key.
- Candidates were less secure in calculating density from mass and volume.

Question 31

- Option **A** was a common incorrect answer.
- Candidates knew that liquids flow and thought they are easy to compress.

Question 35

- Option **B** was more popular than the key and option **C** was as popular.
- Candidates did not know the relative speeds of radio waves, visible light and X-rays in a vacuum.

Question 38

- Options **B** and **C** were common incorrect answers.
- Candidates were less secure in recalling what is meant by a kilowatt-hour.

Question 39

- Options **A** and **D** were more popular than the key.
- Candidates did not know how to determine the combine resistance in series and in parallel.

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Paper 0653/21
Multiple choice Extended

Key messages

Candidates performed well on **Questions 1**, **2**, **3**, **4**, **5**, **6**, **7**, **8**, **9**, **10**, **14**, **15**, **16**, **17**, **22**, **26**, **33**, **34**, **37**, **38**, and **39**.

Candidates performed less well on **Questions 11**, **12**, **13**, **18**, **19**, **20**, **21**, **23**, **24**, **28**, **31** and **36**.

Overall, candidates performed well on this paper. They found **Questions 2** and **14** the easiest on the paper and performed well on most biology questions. They found **Questions 11** and **20** the hardest.

Comments on specific questions

Question 11

- Option **C** was more popular than the key.
- Candidates knew that overuse of antibiotics may lead to antibiotic resistance and incorrectly thought that increasing use of antibiotics increases the chance of bacteria developing immunity.

Question 12

- Option **A** was a common incorrect answer.
- Candidates thought that an egg is fertilised in the ovaries.

Question 13

- Option **B** was a common incorrect answer.
- Candidates did not realise that loss of soil is an undesirable effect of deforestation.

Question 18

- Option **D** was a common incorrect answer.
- Candidates did not recognise that bonds are broken in Cl2 and therefore thermal energy is taken in from the surroundings, so the reaction is endothermic.

Question 19

- Option **D** was a common incorrect answer.
- The greatest rate of reaction occurs with the magnesium power at 50 °C.

Question 20

- Option **B** was more popular than the key.
- Candidates did not recognise that preparation of an insoluble salt by precipitation requires the reactants to be soluble substances.

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Question 21

- Option **B** was a common incorrect answer.
- Candidates did not identify the three homologous series in the compounds, which are alkane, alkene and alcohol.

Question 23

- Option **A** was a common incorrect answer.
- Methane and carbon dioxide molecules absorbing thermal energy contributes to global warming rather than greenhouse gases emitting thermal energy into space.

Question 24

- Option **C** was a common incorrect answer.
- Carbon monoxide does not remove carbon impurities from hematite during the extraction of iron. It is needed to reduce iron oxide.

Question 28

- Option **D** was more popular than the key.
- Candidates did not recognise that cube Y had the same density as the cube X.

Question 31

- Option **D** was a common incorrect answer.
- Tube X needed to be cooled rather than heated to fit inside tube Y.

Question 36

- Option **B** was a common incorrect answer.
- Candidates recognised that the image would be the same size as the object and incorrectly thought it was real rather than virtual.

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Paper 0653/22
Multiple choice Extended

Key messages

Candidates performed well on **Questions 1**, **5**, **8**, **9**, **10**, **13** and **32**.

Candidates performed less well on **Questions 11**, **12**, **14**, **16**,**18**, **19**, **20**, **22**, **26**, **27**, **28** and **37**.

Candidates found **Question 1** the easiest and **Questions 20** and **28** the hardest on the paper. Chemistry was an area for further development among candidates.

Comments on specific questions

Question 11

- Option **D** was a common incorrect answer.
- Candidates needed further development in interpreting what could be deduced from the graph.
- The steepest increase in resistance to any antibiotic as for antibiotic W from 2000 to 2001.

Question 12

- Option **B** was a common incorrect answer.
- Candidates were not aware that in an insect-pollinated flower, its anthers produce pollen.

Question 14

- Option **C** was a common incorrect answer.
- Candidates thought that oxygen gas dissolved in pure water to form a solution created a mixture of compounds, rather than a mixture an element and a compound.

Question 16

- Option **C** was a common incorrect answer.
- Cations gain electrons at the cathode and not the anode.

Question 18

- Option **B** was as popular as the key.
- Candidates did not appreciate that the steepest curve, option **A**, represented the greatest rate.

Question 19

- Option **D** was a common incorrect answer.
- Candidates knew the impact of increasing temperature on collisions and thought that increasing the concentration meant that more particles have the activation energy.

Question 20

- Options **C** and **D** were more popular than the key.

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- Candidates were not familiar with the first step in the preparation of a variety of salts.

Question 22

- Option **A** was more popular than the key.
- Candidates were not able to recognise that as the atomic number and then nucleon number of element Y are the same and that element Y is in the same period as X, then X must be a monatomic gas.

Question 26

- Option **B** was as popular as the key.
- Candidates thought that alkanes contain a carbon-carbon double bond.

Question 27

- Option **C** was a common incorrect answer.
- Candidates had reversed the distance travelled by the solvent and distance travelled by the substance in the expression.

Question 28

- Options **B** and **C** were more popular than the key.
- Candidates were less secure in describing the resultant force as the raindrop falls.

Question 37

- Option **B** was as popular as the key.
- Candidates knew the image was virtual and thought it formed at position X rather than at Y.

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Paper 0653/23
Multiple choice Extended

Key messages

Candidates performed well on **Questions 4**, **9**, **10**, **12**, **24**, **30**, **33**, **35**, **38** and **39**.

Candidates performed less well on **Questions 3**, **5**, **16**, **17**, **19**, **20**, **21**, **22**, **25**, **27**, **28**, **33**, **36** and **37**.

Candidates found **Question 33** the easiest and **Question 19** the hardest on the question paper. There was evidence of guessing on **Question 16**.

Comments on specific questions

Question 3

- Option **D** was a common incorrect answer.
- Candidates were not familiar with the what the results of Benedict's solution and iodine solution showed.

Question 5

- Options **B** and **D** were more popular than the key.
- Candidates were not able to interpret the structures shown in the lower epidermis of a leaf.

Question 16

- There was evidence of guessing to this question, with all options being chosen.
- Candidates may have found the 'what is not correct' aspect of this question on electrolysis an additional challenge.

Question 17

- Option **C** was a common incorrect answer.
- Candidates were able to interpret the reaction pathway diagram to identify the activation energy and reactants and incorrectly thought it showed an exothermic reaction.

Question 19

- Candidates found this the hardest question on the paper.
- All of the options were more popular than the key, indicating guessing with displacement reactions of the halogens.

Question 20

- Option **B** was more popular than the key.
- Candidates did not know the meaning of the term raw material and thought that iron was the raw material in the blast furnace.

Question 21

- Option **A** was as popular as the key and option **D** was a more popular choice.

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- Candidates were not able to work out that Rb and F would react together in the most vigorous reaction.

Question 25

- Option **B** was equally as popular as the key and option **C** was more popular.
- Candidates did not recognise that the compound was ethene and therefore, formed an addition polymer.

Question 27

- Options **B** and **C** were common incorrect choices.
- Candidates were less secure with interpreting results of tests with acidified silver nitrate, aqueous sodium hydroxide and acidified aqueous barium nitrate.

Question 28

- Option **A** was a common incorrect answer.
- Candidates were not able to interpret the speed-time graph to determine the average speed of the object.

Question 36

- Option **B** was more popular than the key.
- Candidates new the image would be laterally inverted, and incorrectly thought it would be real, rather than virtual.

Question 37

- Option **C** was more popular than the key.
- Determining the value of *t* from the current and charge was an area for improvement.

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Paper 0653/31
Core Theory

Key messages

What candidates did well

- Candidates generally performed well in questions where a choice had to be made from several possible answers. These questions could involve circling a response from a list, completing sentences using given words or matching boxes.
- Candidates did well in most of the ecology questions and questions on the Solar System.
- They interpreted graphical information and other data well.

What candidates needed to improve

- Candidates should make sure they are familiar with the definitions of scientific terms as described in the syllabus.
- Label lines on diagrams should touch the intended structure.
- Candidates should show their working in calculations.
- In calculations, candidates should make sure that the units required for the answer match the units of quantities given in the question and do a conversion if necessary.
- They should learn the structures of a bacterial cell and the composition of clean dry air.

Comments on specific questions

Question 1

(a) (i) Comprehensive responses

- A few candidates successfully identified the DNA and the plasmid in the bacterial cell.

Limited responses

- Other candidates wrote nucleus for **A** and vacuole for **B**. Candidates are reminded that membrane-bound organelles are not found in bacterial cells.

(ii) Comprehensive responses

- A few candidates stated the correct function of **C**.

Limited responses

- Many candidates gave energy release or defence as the function of the ribosome, **C**. They should be aware that protein synthesis takes place at **C**.

(iii) Comprehensive responses

- The most common correct structures quoted were the nucleus and mitochondria.

Limited responses

- Many candidates stated structures that are present in plant cells such as chloroplast and cell wall. Careful reading of the question shows that the structures must be in animal cells.
- Candidates are reminded that a cell membrane and cytoplasm are present in both animal cells and bacterial cells.

(b) Comprehensive responses

- Many candidates completed the sentences successfully.

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Limited responses

- The main incorrect response was the first sentence. Some candidates completed this by stating breakdown instead of modify. Candidates should be aware of the syllabus statement that drugs modify or affect chemical reactions in the body.

(c) Comprehensive responses

- Many candidates successfully answered white blood cells.

Limited responses

- Incorrect responses included red blood cells and plasma. Other incorrect answers were haemoglobin, oxygen and various structures in the circulatory system. Candidates are reminded that the four components of the blood are red blood cells, white blood cells, platelets and plasma, and some of the white blood cells are involved in phagocytosis.

Question 2

(a) Comprehensive responses

- Many candidates matched the boxes correctly.

Limited responses

- The most common incorrect matchings were **F**, an anther which produces pollen and **G** the stigma which catches pollen. Frequently these matches were reversed.

(b) (i) Comprehensive responses

- Most candidates stated sperms correctly.

Limited responses

- Incorrect responses included various parts of the male reproductive system, the most common of which was testes. Candidates are reminded that the sperms are made in the testes.

(ii) Comprehensive responses

- Many candidates successfully circled testes.

Limited responses

- There was no particular pattern to the incorrect answers. Several candidates did not circle any of the possible answers.

(c) (i) Comprehensive responses

- Most candidates gave two correct answers.

Limited responses

- Some candidates confused the term tertiary consumer with the third trophic level. As a result, they gave small bird or mouse as their answers. Candidates are reminded that a tertiary consumer is at the fourth trophic level. Other candidates did not appear to understand the term tertiary at all and wrote one of the other consumers.

(ii) Comprehensive responses

- Most candidates successfully answered this question.

Limited responses

- Some candidates stated that the mouse eats the flowering plant to gain energy from it, omitting the grasshopper. Careful study of the food web shows that energy has to pass through the grasshopper before reaching the mouse.

(d) Comprehensive responses

- Many candidates completed the equation correctly.

Limited responses

- Some candidates confused the products with the second reactant, oxygen. Others wrote starch or glucose in the spaces, confusing the equation with photosynthesis. Candidates are

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reminded that glucose is broken down in the presence of oxygen to produce carbon dioxide and water.

Question 3

(a) (i) Comprehensive responses

- Some candidates labelled the phloem correctly.

Limited responses

- Most of the remainder of the candidates labelled the xylem, and a few labelled other parts of the stem. Candidates are reminded that the phloem is the tissue contained in the vascular bundle towards the outside of the stem. Candidates are also reminded that labelling lines should touch the intended structure. There should not be a space between the end of the label line and the intended structure.

(ii) Comprehensive responses

- Some candidates circled the correct answer.

Limited responses

- The most common incorrect answer was evaporation. Candidates should be aware that transpiration is the correct term for evaporation from leaves.

(b) (i) Comprehensive responses

- A few candidates answered this correctly.

Limited responses

- Most of the remaining responses did not state that an enzyme is a protein. Candidates are advised that an enzyme is a special type of catalyst made of protein.

(ii) Comprehensive responses

- Some candidates successfully answered this question.

Limited responses

- Many candidates only stated that the enzyme activity increases with increasing temperature. They needed to state that as the temperature becomes higher, after 37 °C, the activity decreases. Some candidates stated that the enzyme denatured 37 °C. The term denature is not on the core syllabus so a description that the activity declined was needed.

(c) (i) Comprehensive responses

- Most candidates ticked the correct box.

Limited responses

- The most common incorrect answer was the first one, (an ecosystem) is an area containing different groups of organisms. This definition is of a community. The ecosystem has to include interactions of the organisms with each other and their environment.

(ii) Comprehensive responses

- Some candidates successfully stated two reasons for habitat destruction.

Limited responses

- Many candidates gave deforestation as one of their responses. The syllabus describes the reasons for habitat destruction, which are all due to human activities. Therefore, a bit more explanation about why deforestation was needed in answers to describe the reason the trees are being removed. An example of this is deforestation for building houses.

Question 4

(a) Comprehensive responses

- Some candidates filled in the table successfully.

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Limited responses

- The relative masses were not widely known. Many candidates wrote 0 as the relative mass of an electron, instead of 1/1840. The relative charge of a proton was often stated as 1 instead of +1. Candidates are reminded that they should know the relative mass and relative charges of all the particles in an atom.

(b) Comprehensive responses

- Some candidates gave the correct electronic configuration for silicon.

Limited responses

- Other candidates did not understand the term electronic configuration and instead quoted the number of electrons, 14. Candidates should be aware that the electronic configuration shows the number of electrons in each shell, starting from the shell nearest to the nucleus. A few candidates used the relative atomic mass, 28, and wrote configuration for this. Candidates are reminded that the number of electrons in an atom is the same as the number of protons. In the case of silicon, it is 14.

(c) Comprehensive responses

- A few candidates stated the correct definition.

Limited responses

- Many responses described the idea of sharing electrons between atoms. These responses were not precise enough. Candidates should be aware that a covalent bond is formed when two atoms share a pair of electrons.

(d) Comprehensive responses

- Many candidates stated the correct molecular formula for compound **J**.

Limited responses

- Some candidates wrote superscripts instead of subscripts in their responses. They put $C^4H^{12}Si$ instead of the correct form, $C_4H_{12}Si$. Other candidates needed to know that the atoms had to be grouped and not just listed.

(e) Comprehensive responses

- A few candidates gave a correct definition of a polymer.

Limited responses

- Many candidates stated that a polymer is a type of plastic. Candidates are reminded that the definition of a polymer is in the syllabus, they are large molecules built up from many small molecules called monomers. Poly(ethene), also known as polythene, is a common plastic, and there are many other polymers, for example starch.

(f) Comprehensive responses

- Some candidates stated alloy correctly.

Limited responses

- The most common incorrect response was compound. Candidates are reminded that a compound is formed when two or more different elements combine. In the case of an alloy, there is no chemical reaction between the elements. It remains a mixture.

Question 5

(a) (i) Comprehensive responses

- Some candidates stated the correct two compounds in the boxes provided.

Limited responses

- Other candidates stated the wrong gas with hydrogen and oxygen seen quite frequently. Candidates should be aware that the reaction of a carbonate with an acid gives a salt, water and carbon dioxide. The salt, magnesium chloride, is given in the question.

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(ii) Comprehensive responses

- Many candidates gave a correct meaning of exothermic.

Limited responses

- Although some candidates knew that exothermic means that energy is transferred to the surroundings, they omitted to say that it is thermal energy. Others described an endothermic energy transfer.

(iii) Comprehensive responses

- Some candidates answered this question correctly.

Limited responses

- The remaining candidates responded with a range of different colours, including colourless. There was no particular pattern to the incorrect colours. Candidates are reminded that methyl orange indicator turns red in an acidic environment.

(iv) Comprehensive responses

- Some candidates chose the correct method of separation.

Limited responses

- Incorrect responses included electrolysis, distillation, crystallisation and heating. Candidates should be aware that the term excess solid magnesium chloride means that there will be some solid left over at the end of the reaction.
- The magnesium chloride formed in the reaction is soluble (aqueous). Carbon dioxide is a gas that leaves the reaction. The solid unreacted magnesium carbonate has to be separated from the products.
- Therefore, filtration is the correct method of separation.

(b) Comprehensive responses

- Some candidates circled the correct answer.

Limited responses

- There was no pattern to the incorrect answers. Candidates are reminded that copper (II), iron(ll) and iron (lll) all give coloured precipitates, with only calcium ions giving a white precipitate when sodium hydroxide is added.

(c) (i) Comprehensive responses

- Some candidates labelled the cathode and the electrolyte successfully.

Limited responses

- Other candidates labelled the cathode on the electric wiring between the power supply and the electrode. Candidates should be aware that the electrode dips into the electrolyte.
- Candidates are reminded that the cathode is the electrode that leads to the negative terminal of the power supply.

(ii) Comprehensive responses

- Some candidates correctly stated two of the three available responses.

Limited responses

- Some candidates stated that the electrodes should be a good conductor. They needed to state a good electrical conductor because the same term, conductor, could apply to a heat conductor.
- Other candidates stated the opposite ideas of what was required. Those candidates who stated that the electrode had to be reactive were stating the opposite idea of inert.
- Candidates should be aware that one of the properties of a material suitable for use as an electrode is that it should have a high melting point.

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Question 6

(a) **Comprehensive responses**

- A small number of candidates answered this question correctly.

Limited responses

- Many candidates identified either the nitrogen or oxygen sectors in the pie charts. The smallest segment, both noble gases and carbon dioxide, was only identified by a few candidates.
- Candidates should be aware of the composition of the air as described in the syllabus. Therefore, the largest component is nitrogen, followed by oxygen and lastly carbon dioxide and noble gases.

(b) **Comprehensive responses**

- Many candidates answered this question correctly.

Limited responses

- Whilst many candidates matched the sulfur dioxide box with the correct response, quite often the methane and carbon monoxide matches were reversed.
- Candidates are reminded that carbon monoxide results from combustion of carbon-containing fuels with an insufficient oxygen supply, and methane is produced by decomposition of vegetation.

(c) (i) **Comprehensive responses**

- A small number of candidates completed the equation correctly.

Limited responses

- There were two parts to this question. First of all, the equation had to be balanced. Candidates should be aware that the numbers of each type of atom should be the same on both sides of the equation.
- Secondly, the state symbols had to be correct. Careful reading of the stem shows that methane is reacting with steam. Candidates are reminded that steam is water in the gaseous state so all four state symbols should be (g).

(ii) **Comprehensive responses**

- Many candidates answered this question correctly.

Limited responses

- There was no pattern to the rest of the responses. A few answers stated to balance the equation. A few others stated that a catalyst is used for energy. Candidates should be aware that a catalyst increases the rate of reaction.

(d) **Comprehensive responses**

- A small number of candidates answered this question correctly.

Limited responses

- Many candidates could not distinguish between physical properties and chemical properties. They are reminded that the chemical properties of an element are concerned with how an element reacts.
- Physical properties are more closely related with melting points and boiling points, electrical and thermal conductivity, malleability and ductility.

Question 7

(a) (i) **Comprehensive responses**

- Some candidates calculated the correct weight and wrote the unit successfully.

Limited responses

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- The question involved multiplying the mass by 9.8 N (acceleration of free fall = 9.8 m/s^2). Some candidates wrote 26 (N) for their answer, reflecting the use of 10.0 m/s^2 for acceleration of free fall. Candidates are reminded that the value for acceleration of free fall in this syllabus has recently changed from 10.0 m/s^2 to 9.8 m/s^2.
- Many candidates were unaware that the correct unit for weight is N (newtons). Incorrect units stated were kg, g and N/kg.

(ii) Comprehensive responses

- Some candidates answered both parts of this question successfully.

Limited responses

- Generally, candidates knew that weight is the gravitational force acting on an object.
- Most candidates were not aware that of the definition of mass is a measure of the quantity of matter in an object. Incorrect responses included density, volume and weight.

(b) (i) Comprehensive responses

- Many candidates answered this question correctly.

Limited responses

- The question was a two-stage calculation. The volume of the sphere had to be found first.
- Then the density can be calculated using the mass of the sphere and the volume of the sphere. Candidates are reminded that the volume of the sphere in the experiment is found by calculating how much water is displaced within the measuring cylinder.

(ii) Comprehensive responses

- Most candidates successfully wrote a possible value for the density of sphere **R**.

Limited responses

- Some candidates stated a value that was greater than 1.0 (g/cm^3). Candidates are reminded that an object will sink in water if its density is greater than 1.0 (g/cm^3). Since sphere **R** floats its density must be less than 1.0 (g/cm^3).

Question 8

(a) Comprehensive responses

- A few candidates planned the experiment successfully.

Limited responses

- Most candidates quoted the correct equation, speed = distance ÷ time.
- Some candidates started to stop the stopwatch when it reached the wall. There was no way of finding the time taken to reach the wall. Waiting for the echo of the clap was possible though before stopping the stopwatch.
- Candidates should be aware that the distance travelled by the sound of the clap is 2d, and that should be brought into the calculation.
- The alternative is to divide the time taken by 2 because the time was for the sound going to the wall and back.

(b) Comprehensive responses

- Many candidates successfully ticked the first two boxes.

Limited responses

- Some candidates ticked the last box, the frequency of sound 1 is less than the frequency of sound 2. Candidates are reminded that a sound with a higher pitch has a higher frequency than a sound with a lower pitch.
- Other candidates ticked the fourth box, that the frequency of each sound is measured in ohms (Ω). Candidates should be aware that the ohm is a unit of electrical resistance. Frequency is measured in Hz.

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(c) Comprehensive responses

- Many candidates completed the sentences correctly.

Limited responses

- Some candidates completed the first sentence with reflected instead of refracted. These candidates are reminded that refraction occurs when light passes into a different medium. Refection occurs when light bounces off a shiny surface.
- Other candidates confused the colours of light at **T** and **U**. They should be aware that red light bends the least and violet light bends the most when white light passes through the prism.

Question 9

(a) Comprehensive responses

- A few candidates circled the four correct phrases correctly.

Limited responses

- Some candidates circled either the same as, or greater than, for the first sentence. Candidates should be aware that the current at point **K** is less than the current at point **J** because there is more resistance in circuit **Y** compared with circuit **X**.
- Some candidates circled either less than, or the same as for the second sentence. Candidates are reminded that circuit **Z** is a parallel circuit. The current in the main circuit at point **M** is greater than the current at point **N**. This is because the current is shared between the branches of a parallel circuit and point **N** is in one of the branches, so it has to be less than at **M**.
- Some candidates circled either the same as, or greater than, for the third sentence. Candidates should be aware that arranging two resistors in parallel (circuit **Z**) gives a combined resistance that is less than arranging the same resistors in series (circuit **X**).
- Some candidates circled either less than, or the same as, for the last sentence. Candidates are reminded that the voltage is shared between resistors in a series circuit. Since the resistors are all identical, the 6.0V is shared between fewer resistors in circuit **X** compared with circuit **Y** so each resistor has a higher voltage across it.

(b) (i) Comprehensive responses

- Some candidates answered this question correctly.

Limited responses

- This question required the use of the equation P = I × V. The equation had to be rearranged before carrying out the calculation. Many candidates divided the current by the power, instead of dividing the power by the current.
- There was a conversion needed of the current from mA to A. Candidates are reminded that the equation P = I x V needs the current to be in amps (A). Therefore, the 2500 mA had to be divided by 1000, making the current 2.5 A. Many candidates omitted this conversion.

(ii) Comprehensive responses

- Many candidates answered this question successfully.

Limited responses

- A few candidates chose one of the existing planets in the Solar System as an example of a dwarf planet. These candidates should be aware that the dwarf planets, with Pluto the most well-known example, orbit the Sun but are smaller than the eight planets in the Solar System.

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COMBINED SCIENCE

Paper 0653/32
Core Theory

Key messages

What candidates did well

- Candidates generally performed well in questions where drawing conclusions from a graph was required.
- Candidates performed well at handling data and interpreting graphical information.
- Candidates did well at working out the magnification of an image seen under the microscope.
- They were familiar with the term for the change of state from a solid to a liquid.

What candidates needed to improve

- Candidates should make sure they are familiar with the definitions of scientific terms as described in the syllabus.
- Label lines on diagrams should touch the intended structure.
- Candidates should show their working in calculations.
- In calculations, candidates should make sure that the units required for the answer match the units of quantities given in the question and do a conversion if necessary.

Comments on specific questions

Question 1

(a) **Comprehensive responses**

- Some candidates successfully identified both the penis and the part that produces a fluid for sperm to swim in.

Limited responses

- There were two responses needed in this question. Most candidates identified only the penis correctly, other candidates should be aware that the part that produces a fluid for sperm to swim in is the prostate gland, shown by letter **A**

(b) **Comprehensive responses**

- Some candidates successfully completed all three sentences.

Limited responses

- The second sentence, the site of fertilisation of the egg cell was not widely known. Many candidates stated the ovary as their answer. These candidates are reminded that the egg cell is released from the ovary and it is fertilised in the oviduct as it travels towards the uterus.
- Many candidates stated cells as their response to the third sentence. Candidates should be aware that fertilisation is the fusion of the nuclei from a male gamete and a female gamete.

(c) **Comprehensive responses**

- Most candidates answered this question successfully using the definitions stated on the syllabus.

Limited responses

- Incorrect responses included photosynthesis, ability to feel pain and breathing. Candidates are reminded that only plants carry out photosynthesis and feeling pain and beathing are specific to animals. The characteristics of living organisms apply to both plants and animals.

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(d) **Comprehensive responses**

- Several candidates made two correct observations from the graph.

Limited responses

- The question was intended to allow candidates to draw conclusions from the data. Some candidates gave the graph readings for each age group.
- Others restated the information in the stem, that the graph shows the percentage of a population with one type of sexually transmitted infection.
- Candidates are reminded that their answers must add to the information given by indicating a maximum, a minimum or a trend.

Question 2

(a) (i) **Comprehensive responses**

- Many candidates completed the calculation successfully.

Limited responses

- Some candidates applied the equation incorrectly. These candidates should be aware that the correct equation is magnification = image size ÷ actual size, and not actual size ÷ image size.

(ii) **Comprehensive responses**

- Some candidates completed the three spaces correctly.

Limited responses

- Many candidates knew the differences in concentration of the particles in the two regions.
- Fewer candidates successfully completed the first missing word. These candidates are reminded that diffusion is the net movement of particles due to their random movement. This means that a few particles will move from lower to higher concentration region, and the vast majority will move from higher to lower concentration region because of the random movement of the particles.

(b) **Comprehensive responses**

- Many candidates named two further components of blood successfully.

Limited responses

- Candidates should be aware that there are four components of blood: red blood cells, white blood cells, platelets and plasma. Some candidates identified substances found in the blood, such as haemoglobin and oxygen.

(c) (i) **Comprehensive responses**

- A few candidates labelled a coronary artery correctly.

Limited responses

- Most candidates put their label to indicate one of the large blood vessels entering or leaving the heart. Candidates are reminded that the coronary arteries supply blood to the heart muscle, and they can be seen in the drawing spreading over the surface of the ventricles.

(ii) **Comprehensive responses**

- The correct response was circled by several candidates.

Limited responses

- There was no particular pattern to the incorrect responses. Candidates should be aware of the term lumen to describe the hollow centre of an artery.

(d) (i) **Comprehensive responses**

- Many candidates gave the correct response.

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Limited responses

- Incorrect response included starch and fats and oils. The large molecules made from amino acids are proteins. Starch is a large molecule made from glucose, and fats and oils are made from fatty acids and glycerol.

(ii) Comprehensive responses

- A few candidates listed the elements correctly.

Limited responses

- Incorrect responses included small molecules, for example carbon dioxide, water and oxygen.
- Candidates are reminded that an element is a type of atom, and a molecule of glucose has the formula $C_6H_{12}O_6$, therefore it contains carbon, hydrogen and oxygen.

Question 3

(a) (i) Comprehensive responses

- A few candidates stated two other functions of the part labelled T.

Limited responses

- There were two parts to this answer. Some candidates stated correctly that that one function of the xylem is to transport minerals in the plant. Others did not state that the xylem provides support for the root. Candidates are reminded that the xylem transports water and minerals and also provides support to the root.

(ii) Comprehensive responses

- A few candidates answered this question successfully.

Limited responses

- Many candidates were not familiar with the term cortex cells. More knew the term mesophyll cells in the leaf. Candidates should be aware that after water enters the root hair cells, it has to get to the xylem in the centre of the root. Therefore, the water has to pass through the root cortex cells to reach the xylem. After transport through the xylem, water reaches the mesophyll cells in the leaf.

(b) (i) Comprehensive responses

- Many candidates identified the gas oxygen.

Limited responses

- The most common incorrect response was carbon dioxide. Candidates are reminded that carbon dioxide is one of the raw materials in photosynthesis. It combines with water to produce the gas oxygen and glucose.

(ii) Comprehensive responses

- Many candidates answered both of the responses correctly.

Limited responses

- The question relates to the experiment using a lamp. Candidates are reminded to draw conclusions from the information provided in the experiment. Some responses referred to sunlight, which was not included in the experiment.

(c) Comprehensive responses

- Many candidates answered this question successfully.

Limited responses

- The most common incorrect answer was chloroplast. Candidates should be aware that the green pigment used in photosynthesis is chlorophyll that is found in chloroplasts in plant cells.

Question 4

(a) Comprehensive responses

- Most candidates completed the table successfully.

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Limited responses

- A few candidates added the number of protons to the number of neutrons to calculate the number of electrons. Candidates are reminded that in a neutral atom the number of protons equals the number of electrons. The number of neutrons is calculated using the periodic table by subtracting the atomic number (the number of protons) from the relative atomic mass.

(b) Comprehensive responses

- A few candidates completed the four sentences correctly.

Limited responses

- Several candidates confused the trends of melting point and reactivity going down Group I. These candidates should be aware that the reactivity increases and the melting point decreases down the group.

(c) (i) Comprehensive responses

- Some candidates gave a satisfactory description of an alloy.

Limited responses

- Some candidates indicated that the lithium and aluminium reacted chemically to make the alloy. Candidates are reminded that an alloy is a mixture of a metal with one or more other elements with no chemical reaction taking place.

(ii) Comprehensive responses

- Some candidates suggested a suitable advantage of using an aluminium alloy rather than pure aluminium, usually stating that the alloy is stronger.

Limited responses

- Several candidates suggested that the alloy would not rust. These candidates should be aware that only iron rusts.
- Some candidates did not use the comparative term. They were stating an advantage of the alloy rather than pure aluminium, so they should have stated stronger or harder, instead of strong or hard.

Question 5

(a) Comprehensive responses

- Some candidates completed the dot-and-cross diagram successfully.

Limited responses

- It was clear that some candidates were unfamiliar with a dot-and-cross diagram. Candidates are reminded that knowledge of dot-and-cross diagrams for some molecules, including methane, are stated on the syllabus.

(b) Comprehensive responses

- Some candidates circled the correct answer.

Limited responses

- Many candidates circled an incorrect temperature. These candidates should be aware that a gas at 20 °C will have a boiling point lower than 20 °C. The only possible answer is –162 °C.

(c) Comprehensive responses

- Some candidates answered the question successfully.

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Limited responses

- Candidates were given all of the reactants and products apart from the product water. Many candidates wrote oxygen and CO_2 correctly. These candidates are reminded that complete combustion of a hydrocarbon produces both carbon dioxide and water, not hydrogen.

(d) Comprehensive responses

- A few candidates made two valid points about the effect of methane on the environment.

Limited responses

- Most candidates stated one point, that methane in the atmosphere enhances global warming. These candidates are reminded that more detail about a consequence of global warming would improve their answers. An example of a consequence of global warming is climate change.

(e) Comprehensive responses

- A few candidates answered this question successfully.

Limited responses

- Most candidates were not familiar with the test using aqueous bromine. These candidates are reminded that when aqueous bromine is added to an alkene, a reaction occurs and the solution becomes colourless.
- In the case of the alkane, methane, no reaction occurs because the methane molecule is saturated and relatively unreactive.

Question 6

(a) Comprehensive responses

- Some candidates completed the table successfully.

Limited responses

- The processes of filtration, sedimentation and chlorination were known by many candidates.
- Less well known was the process of adding carbon to remove taste and odour.

(b) Comprehensive responses

- Several candidates answered this question correctly, aware that tap water will contain dissolved chemicals that could interfere with experiments.

Limited responses

- Some candidates stated that tap water contains microbes that could affect the accuracy of experiments. These candidates should be aware that chlorination of water in the water treatment process kills any microbes present.

(c) (i) Comprehensive responses

- A few candidates were familiar with the use of cobalt chloride paper as a test for water

Limited responses

- The majority of candidates responded to this question in terms of pH, using the colours of the cobalt(II) chloride paper in the same way as litmus paper. Candidates are reminded that cobalt(II) chloride paper is used as a test for water. The blue colour indicates that water is not present and the pink colour shows that water is present.

(ii) Comprehensive responses

- Some candidates ticked the correct box.

Limited responses

- Most candidates were unfamiliar with the test for chloride ions with many choosing limewater as their preferred answer. Candidates should be aware that limewater is used as a test for carbon dioxide gas and acidified silver nitrate solution is used as a test for chloride ions.

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(d) (i) Comprehensive responses

- A few candidates answered this question correctly.

Limited responses

- Most candidates were not familiar that sulfur dioxide is a product of combustion of sulfur compounds in petrol. More candidates mentioned acid rain as a pollutant.
- Candidates should be aware that sulfur compounds produce sulfur dioxide when reacted with oxygen and this leads to acid rain in the environment.

(ii) Comprehensive responses

- Most candidates recognised that cobalt is acting as a catalyst in this reaction.

Limited responses

- Some responses stated that cobalt is used to remove sulfur compounds. This was information contained in the introduction to the previous question. Candidates are reminded that this question contains the definition of a catalyst. It increases the rate of reaction and is unchanged at the end of the reaction.

Question 7

(a) (i) Comprehensive responses

- Many candidates successfully answered this question.

Limited responses

- Some candidates stated that between 10 min and 15 min the candidate is moving at a constant speed. These candidates should be aware that on this distance-time graph the candidate is stationary at the stated time. A flat line on a speed-time graph shows a constant speed.

(ii) Comprehensive responses

- Some candidates did all parts of the calculation correctly.

Limited responses

- Most candidates remembered the equation speed = distance ÷ time. Some candidates were less accurate when calculating the distance. Candidates are reminded to take into account the scale of the graph when taking readings from it.
- Some candidates did the calculation using minutes for the time instead of converting the time into seconds to give the units as requested in the question.

(b) (i) Comprehensive responses

- Many candidates answered this question correctly.

Limited responses

- Incorrect responses included weight, gravity and air resistance. Candidates are reminded that the force of friction acts between the surface of the road and the bicycle tyres. This force enables the tyres of the bicycle to grip the road.

(ii) Comprehensive responses

- Many candidates circled the correct two phrases.

Limited responses

- There was no particular pattern to the incorrect responses. Candidates should be aware that a resultant force acting on an object can cause it to accelerate, decelerate or change direction. Since there was no resultant force acting on the bicycle, it must be moving at a constant speed and moving in a straight line.

Question 8

(a) (i) Comprehensive responses

- Most candidates answered this question correctly.

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Limited responses

- A few candidates wrote an incorrect change of state as their response. These candidates are reminded that boiling occurs when a liquid is heated to its boiling point. This causes a change of state from a liquid to a gas.

(ii) Comprehensive responses

- Some candidates answered this question successfully.

Limited responses

- Candidates needed to state that the particles in a solid are regularly arranged. Not many candidates did this.
- More candidates made the point that the particles in a solid are close to each other.

(iii) Comprehensive responses

- Many candidates made a successful comparison between the motion of particles in a solid and the motion of particles in a gas.

Limited responses

- Candidates should be aware that the particles in a solid do not move around. Instead, they vibrate in their fixed positions.
- By contrast, the particles in a gas move at high speed.

(b) (i) Comprehensive responses

- Some candidates answered this question successfully.

Limited responses

- The two gases found in the Sun, were not widely known. Incorrect responses included oxygen, carbon dioxide and carbon monoxide. Candidates should be aware that the Sun is mainly composed of hydrogen and helium.

(ii) Comprehensive responses

- Some candidates named the three regions of the electromagnetic spectrum correctly.

Limited responses

- There was no particular pattern to the incorrect responses. Candidates are reminded that the three regions of the electromagnetic spectrum which radiate most of the Sun's energy are infrared, visible and ultraviolet.

(iii) Comprehensive responses

- A small number of candidates answered this question correctly.

Limited responses

- Most candidates were unfamiliar with the diameter of the Milky Way, 100 000 light-years. The different star in the question is situated near the centre of the Milky Way, so it will take light from this star 50 000 years to reach the outer edge of the Milky Way.

Question 9

(a) (i) Comprehensive responses

- A small number of candidates labelled the ray diagram correctly.

Limited responses

- Most candidates were unfamiliar with the terms needed to label the ray diagram. Candidates should be aware of the terms principal axis, principal focus (focal point) and focal length and be able to use them to label the diagram in the question.

(ii) Comprehensive responses

- Many candidates successfully did the calculation.

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Limited responses

- Some candidates multiplied the cost of the electricity by the cost of 1 kWh. Others divided the cost of 1 kWh by the cost of the energy used. To do the calculation, the fraction of a kWh had to be determined. Therefore, the cost of the electricity is divided by the cost of 1 kWh of energy. Candidates should be aware that the cost of the energy used was less than the cost of 1 kWh.

(iii) Comprehensive responses

- Many candidates did the calculation successfully.

Limited responses

- Some candidates used the equation for finding resistance, dividing the voltage by the current and obtaining an answer of 6.25. Candidates are reminded that the current and voltage are multiplied together to give the power.

(b) Comprehensive responses

- Many candidates ticked the correct two boxes.

Limited responses

- Whilst many candidates ticked the box to show that the image is inverted, fewer candidates knew the term diminished. Candidates should be aware that the term diminished describes an image that is smaller than the object, as shown in the diagram.

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COMBINED SCIENCE

Paper 0653/33
Core Theory

Key messages

What candidates did well

- Candidates generally performed well in questions where drawing conclusions from a graph was required.
- Candidates performed well at handling data and interpreting graphical information.
- Candidates did well at working out the magnification of an image seen under the microscope.
- They were familiar with the term for the change of state from a solid to a liquid.

What candidates needed to improve

- Candidates should make sure they are familiar with the definitions of scientific terms as described in the syllabus.
- Label lines on diagrams should touch the intended structure.
- Candidates should show their working in calculations.
- In calculations, candidates should make sure that the units required for the answer match the units of quantities given in the question and do a conversion if necessary.

Comments on specific questions

Question 1

(a) **Comprehensive responses**

- Some candidates successfully identified both the penis and the part that produces a fluid for sperm to swim in.

Limited responses

- There were two responses needed in this question. Most candidates identified only the penis correctly, other candidates should be aware that the part that produces a fluid for sperm to swim in is the prostate gland, shown by letter **A**

(b) **Comprehensive responses**

- Some candidates successfully completed all three sentences.

Limited responses

- The second sentence, the site of fertilisation of the egg cell was not widely known. Many candidates stated the ovary as their answer. These candidates are reminded that the egg cell is released from the ovary and it is fertilised in the oviduct as it travels towards the uterus.
- Many candidates stated cells as their response to the third sentence. Candidates should be aware that fertilisation is the fusion of the nuclei from a male gamete and a female gamete.

(c) **Comprehensive responses**

- Most candidates answered this question successfully using the definitions stated on the syllabus.

Limited responses

- Incorrect responses included photosynthesis, ability to feel pain and breathing. Candidates are reminded that only plants carry out photosynthesis and feeling pain and beathing are specific to animals. The characteristics of living organisms apply to both plants and animals.

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(d) **Comprehensive responses**

- Several candidates made two correct observations from the graph.

Limited responses

- The question was intended to allow candidates to draw conclusions from the data. Some candidates gave the graph readings for each age group.
- Others restated the information in the stem, that the graph shows the percentage of a population with one type of sexually transmitted infection.
- Candidates are reminded that their answers must add to the information given by indicating a maximum, a minimum or a trend.

Question 2

(a) (i) **Comprehensive responses**

- Many candidates completed the calculation successfully.

Limited responses

- Some candidates applied the equation incorrectly. These candidates should be aware that the correct equation is magnification = image size ÷ actual size, and not actual size ÷ image size.

(ii) **Comprehensive responses**

- Some candidates completed the three spaces correctly.

Limited responses

- Many candidates knew the differences in concentration of the particles in the two regions.
- Fewer candidates successfully completed the first missing word. These candidates are reminded that diffusion is the net movement of particles due to their random movement. This means that a few particles will move from lower to higher concentration region, and the vast majority will move from higher to lower concentration region because of the random movement of the particles.

(b) **Comprehensive responses**

- Many candidates named two further components of blood successfully.

Limited responses

- Candidates should be aware that there are four components of blood: red blood cells, white blood cells, platelets and plasma. Some candidates identified substances found in the blood, such as haemoglobin and oxygen.

(c) (i) **Comprehensive responses**

- A few candidates labelled a coronary artery correctly.

Limited responses

- Most candidates put their label to indicate one of the large blood vessels entering or leaving the heart. Candidates are reminded that the coronary arteries supply blood to the heart muscle, and they can be seen in the drawing spreading over the surface of the ventricles.

(ii) **Comprehensive responses**

- The correct response was circled by several candidates.

Limited responses

- There was no particular pattern to the incorrect responses. Candidates should be aware of the term lumen to describe the hollow centre of an artery.

(d) (i) **Comprehensive responses**

- Many candidates gave the correct response.

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Limited responses

- Incorrect response included starch and fats and oils. The large molecules made from amino acids are proteins. Starch is a large molecule made from glucose, and fats and oils are made from fatty acids and glycerol.

(ii) Comprehensive responses

- A few candidates listed the elements correctly.

Limited responses

- Incorrect responses included small molecules, for example carbon dioxide, water and oxygen.
- Candidates are reminded that an element is a type of atom, and a molecule of glucose has the formula $C_6H_{12}O_6$, therefore it contains carbon, hydrogen and oxygen.

Question 3

(a) (i) Comprehensive responses

- A few candidates stated two other functions of the part labelled T.

Limited responses

- There were two parts to this answer. Some candidates stated correctly that that one function of the xylem is to transport minerals in the plant. Others did not state that the xylem provides support for the root. Candidates are reminded that the xylem transports water and minerals and also provides support to the root.

(ii) Comprehensive responses

- A few candidates answered this question successfully.

Limited responses

- Many candidates were not familiar with the term cortex cells. More knew the term mesophyll cells in the leaf. Candidates should be aware that after water enters the root hair cells, it has to get to the xylem in the centre of the root. Therefore, the water has to pass through the root cortex cells to reach the xylem. After transport through the xylem, water reaches the mesophyll cells in the leaf.

(b) (i) Comprehensive responses

- Many candidates identified the gas oxygen.

Limited responses

- The most common incorrect response was carbon dioxide. Candidates are reminded that carbon dioxide is one of the raw materials in photosynthesis. It combines with water to produce the gas oxygen and glucose.

(ii) Comprehensive responses

- Many candidates answered both of the responses correctly.

Limited responses

- The question relates to the experiment using a lamp. Candidates are reminded to draw conclusions from the information provided in the experiment. Some responses referred to sunlight, which was not included in the experiment.

(c) Comprehensive responses

- Many candidates answered this question successfully.

Limited responses

- The most common incorrect answer was chloroplast. Candidates should be aware that the green pigment used in photosynthesis is chlorophyll that is found in chloroplasts in plant cells.

Question 4

(a) Comprehensive responses

- Most candidates completed the table successfully.

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Limited responses

- A few candidates added the number of protons to the number of neutrons to calculate the number of electrons. Candidates are reminded that in a neutral atom the number of protons equals the number of electrons. The number of neutrons is calculated using the periodic table by subtracting the atomic number (the number of protons) from the relative atomic mass.

(b) Comprehensive responses

- A few candidates completed the four sentences correctly.

Limited responses

- Several candidates confused the trends of melting point and reactivity going down Group I. These candidates should be aware that the reactivity increases and the melting point decreases down the group.

(c) (i) Comprehensive responses

- Some candidates gave a satisfactory description of an alloy.

Limited responses

- Some candidates indicated that the lithium and aluminium reacted chemically to make the alloy. Candidates are reminded that an alloy is a mixture of a metal with one or more other elements with no chemical reaction taking place.

(ii) Comprehensive responses

- Some candidates suggested a suitable advantage of using an aluminium alloy rather than pure aluminium, usually stating that the alloy is stronger.

Limited responses

- Several candidates suggested that the alloy would not rust. These candidates should be aware that only iron rusts.
- Some candidates did not use the comparative term. They were stating an advantage of the alloy rather than pure aluminium, so they should have stated stronger or harder, instead of strong or hard.

Question 5

(a) Comprehensive responses

- Some candidates completed the dot-and-cross diagram successfully.

Limited responses

- It was clear that some candidates were unfamiliar with a dot-and-cross diagram. Candidates are reminded that knowledge of dot-and-cross diagrams for some molecules, including methane, are stated on the syllabus.

(b) Comprehensive responses

- Some candidates circled the correct answer.

Limited responses

- Many candidates circled an incorrect temperature. These candidates should be aware that a gas at 20 °C will have a boiling point lower than 20 °C. The only possible answer is –162 °C.

(c) Comprehensive responses

- Some candidates answered the question successfully.

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Limited responses

- Candidates were given all of the reactants and products apart from the product water. Many candidates wrote oxygen and CO_2 correctly. These candidates are reminded that complete combustion of a hydrocarbon produces both carbon dioxide and water, not hydrogen.

(d) Comprehensive responses

- A few candidates made two valid points about the effect of methane on the environment.

Limited responses

- Most candidates stated one point, that methane in the atmosphere enhances global warming. These candidates are reminded that more detail about a consequence of global warming would improve their answers. An example of a consequence of global warming is climate change.

(e) Comprehensive responses

- A few candidates answered this question successfully.

Limited responses

- Most candidates were not familiar with the test using aqueous bromine. These candidates are reminded that when aqueous bromine is added to an alkene, a reaction occurs and the solution becomes colourless.
- In the case of the alkane, methane, no reaction occurs because the methane molecule is saturated and relatively unreactive.

Question 6

(a) Comprehensive responses

- Some candidates completed the table successfully.

Limited responses

- The processes of filtration, sedimentation and chlorination were known by many candidates.
- Less well known was the process of adding carbon to remove taste and odour.

(b) Comprehensive responses

- Several candidates answered this question correctly, aware that tap water will contain dissolved chemicals that could interfere with experiments.

Limited responses

- Some candidates stated that tap water contains microbes that could affect the accuracy of experiments. These candidates should be aware that chlorination of water in the water treatment process kills any microbes present.

(c) (i) Comprehensive responses

- A few candidates were familiar with the use of cobalt chloride paper as a test for water

Limited responses

- The majority of candidates responded to this question in terms of pH, using the colours of the cobalt(II) chloride paper in the same way as litmus paper. Candidates are reminded that cobalt(II) chloride paper is used as a test for water. The blue colour indicates that water is not present and the pink colour shows that water is present.

(ii) Comprehensive responses

- Some candidates ticked the correct box.

Limited responses

- Most candidates were unfamiliar with the test for chloride ions with many choosing limewater as their preferred answer. Candidates should be aware that limewater is used as a test for carbon dioxide gas and acidified silver nitrate solution is used as a test for chloride ions.

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(d) (i) Comprehensive responses

- A few candidates answered this question correctly.

Limited responses

- Most candidates were not familiar that sulfur dioxide is a product of combustion of sulfur compounds in petrol. More candidates mentioned acid rain as a pollutant.
- Candidates should be aware that sulfur compounds produce sulfur dioxide when reacted with oxygen and this leads to acid rain in the environment.

(ii) Comprehensive responses

- Most candidates recognised that cobalt is acting as a catalyst in this reaction.

Limited responses

- Some responses stated that cobalt is used to remove sulfur compounds. This was information contained in the introduction to the previous question. Candidates are reminded that this question contains the definition of a catalyst. It increases the rate of reaction and is unchanged at the end of the reaction.

Question 7

(a) (i) Comprehensive responses

- Many candidates successfully answered this question.

Limited responses

- Some candidates stated that between 10 min and 15 min the candidate is moving at a constant speed. These candidates should be aware that on this distance-time graph the candidate is stationary at the stated time. A flat line on a speed-time graph shows a constant speed.

(ii) Comprehensive responses

- Some candidates did all parts of the calculation correctly.

Limited responses

- Most candidates remembered the equation speed = distance ÷ time. Some candidates were less accurate when calculating the distance. Candidates are reminded to take into account the scale of the graph when taking readings from it.
- Some candidates did the calculation using minutes for the time instead of converting the time into seconds to give the units as requested in the question.

(b) (i) Comprehensive responses

- Many candidates answered this question correctly.

Limited responses

- Incorrect responses included weight, gravity and air resistance. Candidates are reminded that the force of friction acts between the surface of the road and the bicycle tyres. This force enables the tyres of the bicycle to grip the road.

(ii) Comprehensive responses

- Many candidates circled the correct two phrases.

Limited responses

- There was no particular pattern to the incorrect responses. Candidates should be aware that a resultant force acting on an object can cause it to accelerate, decelerate or change direction. Since there was no resultant force acting on the bicycle, it must be moving at a constant speed and moving in a straight line.

Question 8

(a) (i) Comprehensive responses

- Most candidates answered this question correctly.

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Limited responses

- A few candidates wrote an incorrect change of state as their response. These candidates are reminded that boiling occurs when a liquid is heated to its boiling point. This causes a change of state from a liquid to a gas.

(ii) Comprehensive responses

- Some candidates answered this question successfully.

Limited responses

- Candidates needed to state that the particles in a solid are regularly arranged. Not many candidates did this.
- More candidates made the point that the particles in a solid are close to each other.

(iii) Comprehensive responses

- Many candidates made a successful comparison between the motion of particles in a solid and the motion of particles in a gas.

Limited responses

- Candidates should be aware that the particles in a solid do not move around. Instead, they vibrate in their fixed positions.
- By contrast, the particles in a gas move at high speed.

(b) (i) Comprehensive responses

- Some candidates answered this question successfully.

Limited responses

- The two gases found in the Sun, were not widely known. Incorrect responses included oxygen, carbon dioxide and carbon monoxide. Candidates should be aware that the Sun is mainly composed of hydrogen and helium.

(ii) Comprehensive responses

- Some candidates named the three regions of the electromagnetic spectrum correctly.

Limited responses

- There was no particular pattern to the incorrect responses. Candidates are reminded that the three regions of the electromagnetic spectrum which radiate most of the Sun's energy are infrared, visible and ultraviolet.

(iii) Comprehensive responses

- A small number of candidates answered this question correctly.

Limited responses

- Most candidates were unfamiliar with the diameter of the Milky Way, 100 000 light-years. The different star in the question is situated near the centre of the Milky Way, so it will take light from this star 50 000 years to reach the outer edge of the Milky Way.

Question 9

(a) (i) Comprehensive responses

- A small number of candidates labelled the ray diagram correctly.

Limited responses

- Most candidates were unfamiliar with the terms needed to label the ray diagram. Candidates should be aware of the terms principal axis, principal focus (focal point) and focal length and be able to use them to label the diagram in the question.

(ii) Comprehensive responses

- Many candidates successfully did the calculation.

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Limited responses

- Some candidates multiplied the cost of the electricity by the cost of 1 kWh. Others divided the cost of 1 kWh by the cost of the energy used. To do the calculation, the fraction of a kWh had to be determined. Therefore, the cost of the electricity is divided by the cost of 1 kWh of energy. Candidates should be aware that the cost of the energy used was less than the cost of 1 kWh.

(iii) Comprehensive responses

- Many candidates did the calculation successfully.

Limited responses

- Some candidates used the equation for finding resistance, dividing the voltage by the current and obtaining an answer of 6.25. Candidates are reminded that the current and voltage are multiplied together to give the power.

(b) Comprehensive responses

- Many candidates ticked the correct two boxes.

Limited responses

- Whilst many candidates ticked the box to show that the image is inverted, fewer candidates knew the term diminished. Candidates should be aware that the term diminished describes an image that is smaller than the object, as shown in the diagram.

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COMBINED SCIENCE

Paper 0653/41
Extended Theory

Key messages

What candidates did well

- Candidates recalled syllabus facts and used appropriate scientific terms to express their answers.
- Candidates used the wording shown in the syllabus for definitions and processes.
- Candidates read and used data from graphs accurately.
- In calculations, candidates used relevant relationships between variables and processed data accurately. They set out working clearly and stated final numerical answers to an appropriate number of significant figures.

What candidates needed to improve

- Candidates should learn scientific definitions as they appear in the syllabus.
- Candidates should include details that are relevant to the context of the question and avoid answers that are too general. For example, if the answer should be 'kinetic energy' then candidates should avoid stating simply 'energy' or 'motion'.
- Candidates should aim to be selective in the information they are giving and keep their answers focused on what is being asked.
- Reaction profile diagrams in Chemistry should be drawn carefully, with arrows showing activation energy and reaction energy change located with precision.
- Candidates should make sure that chemical symbols of elements are expressed as shown on the Periodic Table. and that subscripts and stoichiometry are expressed using digits that are the correct relative sizes and positioned accurately.
- Candidates should always include working in calculations. This should state the relevant relationships between variables and clearly set out the steps which lead to the final answer. Candidates should make sure the data they are processing has the correct units. This means that they need to recall the units of variables that should be used in any formula. They should then check whether the units given in the question need to be converted.

Comments on specific questions

Question 1

(a) (i) Comprehensive responses

- Most candidates identified the three parts of the digestive system correctly.

Limited responses

- Incorrect suggestions for part **C**, the large intestine, were common.

(ii) Comprehensive responses

- Many candidates identified both starch and simple or reducing sugars including glucose and maltose.

Limited responses

- Carbohydrate was often suggested instead of starch. Other common mistakes included stating the unqualified term 'sugar' or reversing the answers starch and, for example, glucose. References to protein digestion and its products were made by some candidates.

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(b) (i) Comprehensive responses

- Most candidates read the optimum temperature for amylase from the graph with responses typically close to the value shown.

Limited responses

- Of the small number of incorrect suggestions, 40 °C was most common.

(ii) Comprehensive responses

- Some candidates included at least three of the key ideas. Clear connections were made between the increase in enzyme activity caused by increased particle collision frequency which in turn arises from increased particle kinetic energy.

Limited responses

- Many candidates stated that the enzyme activity increases. Some answers could be developed further by referring to 'energy' rather than 'kinetic energy' or suggested 'more collisions' rather than increased frequency of collisions. In some cases, candidates described processes such enzyme – substate complex formation or denaturation, often in some detail, rather than explaining the increased activity over the stated temperature range.

Question 2

(a) (i) Comprehensive responses

- Many candidates correctly calculated the rate of water loss and showed their working.

Limited responses

- Some candidates correctly calculated the mass of water lost. A variety of approaches were then seen when these candidates attempted to calculate the rate of water loss. Some answers were affected by rounding, for example 0.21 g per minute.

(ii) Comprehensive responses

- Many candidates referred to increased temperature. Some candidates referred to decreased humidity. Candidates generally avoided suggesting the term 'heat'.

Limited responses

- Many candidates stated unqualified answers such as 'temperature' or 'humidity'. Some candidates suggested environmental factors such as global warming or consequences of climate change. Two other common mistakes were references to light and surface area.

(b) Comprehensive responses

- Many candidates completed all three sentences correctly. Responses included the terms 'root hair' and 'palisade mesophyll'.

Limited responses

- Many candidates stated hair cell and some also stated xylem. Some of the more common incorrect suggestions included phloem for both xylem and mesophyll and palisade for mesophyll.

(c) (i) Comprehensive responses

- Many candidates stated the balanced equation for photosynthesis. Chemical formulae were written correctly with chemical symbols that were clearly upper case. Digits showing subscripts and stoichiometry were the correct sizes and positioned correctly.

Limited responses

- Some candidates wrote chemical formulae such as Co2, h_2O, $_6O2$. Some candidates wrote the balanced equation for respiration.

(ii) Comprehensive responses

- Most candidates stated palisade or palisade mesophyll.

Limited responses

- The three most common mistakes were chloroplast, chlorophyll and unqualified mesophyll.

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Question 3

(a) Comprehensive responses

- Some candidates described what the graph showed and compared the antibody concentrations following vaccination and later infection. Many of these candidates stated that both vaccination and infection caused antibody concentration to increase and some noted the greater increase following infection compared to vaccination. These candidates also described how the rate of increase in concentration was higher after infection compared to vaccination. A small number of candidates stated that the concentration of antibodies following infection remained at a relatively high level compared to the quicker decline following vaccination.

Limited responses

- Many candidates stated that antibody concentration increased following both vaccination and infection. Many of these candidates went on to describe details of how vaccinations work, or how memory cells are involved following infection, rather than using the graph to compare the effects on antibody concentration.

(b) Comprehensive responses

- Some candidates identified the drug type as antibiotics to which bacteria might become resistant with overuse. These candidates then referred to the link between resistant bacteria and reduced effectiveness of the antibiotics.

Limited responses

- Common mistakes included references to bacteria becoming immune or the body becoming resistant to the antibiotic and confusing the terms antibody and antibiotic. Some answers made unqualified references to the risks to health. Some candidates described the risk of drug addiction or gave details of the mechanisms by which antibiotics work to destroy bacteria.

(c) (i) Comprehensive responses

- Almost all the candidates recalled one way of reducing the risk of coronary heart disease.

Limited responses

- A small number of candidates stated the unqualified answer ‘smoking’ or gave answers referring to diet.

(ii) Comprehensive responses

- Almost all the candidates referred to vitamins (or named vitamins), minerals (or a correct named mineral) and fibre (or roughage). Some candidates also referred to health conditions alleviated by one of these three.

Limited responses

- Some candidates used the general term ‘nutrients’.

Question 4

(a) (i) Comprehensive responses

- Many candidates stated the properties of graphite that are important in the context of electrolysis. Some candidates also referred to its high melting point.

Limited responses

- Correct properties of graphite which were not specific to its function as an electrode were suggested. Examples included solid, insoluble, hard. Some candidates referred to ‘conductor’ rather than ‘good electrical conductor’.

(ii) Comprehensive responses

- Many candidates stated magnesium.

Limited responses

- The two most common types of incorrect suggestions were magnesium ions and answers involving chlorine. Some candidates suggested the answers ‘a grey solid’ or ‘a grey metal’.

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(iii) **Comprehensive responses**

- Some candidates understood that electrical conductivity in electrolysis requires mobile ions and that these are not present in solid sodium chloride.

Limited responses

- A common mistake was reference to the absence of delocalised electrons. Some candidates suggested the idea that because magnesium chloride is not a pure metal it is unable to conduct electricity.

(b) **Comprehensive responses**

- Many candidates stated that energy is needed to break chemical bonds between particles. Some of these candidates also referred to increased particle kinetic energy which would exist in the molten state. A small number of candidates emphasised that the bond between positive and negative ions is particularly strong.

Limited responses

- Candidates often repeated the question and made statements such as ‘energy is always needed to melt substances’. Some candidates referred to particle collisions and other ideas drawn from reaction rate theory.

(c) **Comprehensive responses**

- Many candidates completed the dot-and-cross diagrams correctly and stated the correct ionic charges.

Limited responses

- The outer electron shell was often omitted from one or both ions, and incorrect ionic charges were frequently suggested. One of the more common incorrect ionic charges was 2- for chloride.

Question 5

(a) **Comprehensive responses**

- A small number of candidates was familiar with the methyl orange colour change.

Limited responses

- Many incorrect variations of the colour change were suggested. One of the more common ones was red to orange.

(b) **Comprehensive responses**

- Many candidates stated the balanced equation correctly. Chemical formulae were written accurately using upper- and lower-case letters for the chemical symbols. Digits showing subscripts and stoichiometry were the correct sizes and positioned correctly.

Limited responses

- Some equations remained unbalanced and some chemical formulae were inaccurately expressed, for example H2O, caO and cacL2.

(c) **Comprehensive responses**

- Some answers included both ideas that increased acid concentration means that there are more acid particles in each volume, and this causes an increased frequency of particle collisions.

Limited responses

- Many candidates stated that there would be more acid present although they omitted to connect this to the idea that collision frequency between acid particles and calcium oxide would be increased. Some candidates referred to ‘more collisions’ rather than increased frequency of collision’. Many candidates suggested that increased concentration meant that the energy of the particles would be increased which would then cause the rate to increase.

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(d) **Comprehensive responses**

- Many candidates constructed correct energy profile diagrams. These showed reactant and product energy levels correctly positioned with respect to each other and connected by the activation energy maximum. Arrows labelling the activation energy and overall reaction energy were drawn carefully and unambiguously.

Limited responses

- Some candidates constructed energy diagrams for an endothermic reaction. The arrow used to label the reaction energy was often double headed or pointed from the product level towards the reactant level. In some diagrams the arrows used to label the activation energy were positioned unclearly.

Question 6

(a) **Comprehensive responses**

- Many candidates stated that members of a homologous series have a general formula and similar chemical properties. Some candidates also referred to the same functional group or an increment of $–CH_2–$ between successive members.

Limited responses

- Common responses included suggesting that members had the same chemical properties, had the same or similar physical properties, contained the same elements or had the same chemical or structural formula.

(b) **Comprehensive responses**

- Addition was recognised by many candidates.

Limited responses

- Of the variety of incorrect suggestions, two of the more common ones were cracking and displacement.

(c) (i) **Comprehensive responses**

- Many candidates stated nickel.

Limited responses

- Some candidates suggested hydrogen, acid, phosphoric acid and iron. Some candidates also referred to a transition metal.

(ii) **Comprehensive responses**

- Many candidates stated ethane.

Limited responses

- A variety of incorrect suggestions were made. These included ethene hydroxide, carbon dioxide and water, polyethene and methane.

(d) **Comprehensive responses**

- Many candidates named two air pollutants and their effects. The most popular examples were carbon dioxide and carbon monoxide. Carbon dioxide was then associated with climate change, or an enhanced greenhouse effect and carbon monoxide was identified as being toxic to humans. The small number of candidates that identified particulates usually knew that these would increase the risk of respiratory issues or even lung cancer.

Limited responses

- Some suggestions referred to pollutants that would not be produced by the combustion of diesel fuel, such as methane. Other responses included sulfuric acid, sulfur and nitrogen. Some candidates stated that carbon monoxide causes breathing difficulty. Candidates sometimes referred to carbon dioxide causing the greenhouse effect rather than an enhanced or run-away greenhouse effect.

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Question 7

(a) (i) Comprehensive responses

- Most candidates stated 'constant speed' or 'constant velocity'. Other responses included 'uniform speed', 'steady speed' and 'constant 40 m / s'.

Limited responses

- Other responses included 'constant motion' and 'not changing'. Some candidates suggested that the train would be stationary.

(ii) Comprehensive responses

- Many candidates converted the duration of the deceleration from 5 minutes to 300 seconds and then substituted into the expression change in speed = acceleration x time.

Limited responses

- Some candidates used the values 40 m/s and 10 m/s from the graph to obtain a value of 30 m/s. Some candidates stated the correct expression to use and then made mistakes when attempting to substitute values into it.

(iii) Comprehensive responses

- Some candidates converted the time data from minutes to seconds and then calculated both relevant areas on the graph namely, the triangular area between 40 and 10 m / s and the rectangular area below it. These candidates then found the sum of these areas. A small number of candidates treated the combined areas as a trapezium and used the formula for the area of a trapezium.

Limited responses

- Many candidates limited their calculation of area to either the triangular section or the rectangle. The only mistake made by some candidates was to leave the time in minutes rather than converting it. Some candidates substituted into the expression distance = speed × time.

(b) (i) Comprehensive responses

- Many candidates calculated the resultant force acting on the rocket and then substituted values into the expression force = mass × acceleration to determine the mass.

Limited responses

- The common mistakes included using either the value of thrust or the value of weight rather than the resultant and using the value of g, 9.8, rather than the given acceleration of 1.25 m / s^2. Some candidates did not calculate the resultant force and suggested using mass = weight ÷ 9.8.

(ii) Comprehensive responses

- Many candidates stated the correct expression for orbital speed, expressed either in symbols or words, for example orbital speed = (2 × pi x radius of orbit) ÷ orbital period.

Limited responses

- The incorrect attempts at the formula included stating speed = distance ÷ time, suggesting speed = $2 \times \pi \times r^2$ / time and stating the speed of light, 3×10^8 (m / s).

Question 8

(a) Comprehensive responses

- Most candidates stated that the pressure increases, and many explained this in terms of increased kinetic energy or speed of particles which collide with the container walls more frequently or with greater force.

Limited responses

- Some answers could be developed further, for example referring to energy or motion rather than kinetic energy or particle speed. Many candidates referred to particle collisions omitting the key idea of collision with the container walls. Some candidates referred to 'more collisions'

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rather than increased collision frequency. Some candidates suggested answers that were more relevant to chemical reaction rate theory.

(b)(i) Comprehensive responses

- Most candidates correctly labelled a region of compression and one of rarefaction on the sound wave diagram.

Limited responses

- Of the few incorrect answers, the most common mistake was to label the two regions of compression on the diagram both as either compression or rarefaction.

(ii) Comprehensive responses

- Most candidates correctly stated longitudinal.

Limited responses

- The most common mistake was transverse. Other mistakes included types of transverse waves and a variety of electromagnetic waves.

(c) Comprehensive responses

- Many candidates substituted values into the expression wave speed = frequency x wavelength and processed the data correctly. Many of these candidates correctly explained that the value for wave speed that emerged was much lower than that for the liquids in the table and so substance **Y** was likely to be a gas.

Limited responses

- Some candidates evaluated 9000 ÷ 0.11. A common misconception was that sound travels faster through a gas and so substance **Y** was incorrectly labelled as a solid.

Question 9

(a) Comprehensive responses

- Many candidates correctly stated ‘charge’.

Limited responses

- The incorrect responses included electron, amps, current, volts, force, energy.

(b)(i) Comprehensive responses

- Most of the candidates showed in their working that they had correctly applied Ohm’s Law.

Limited responses

- Candidates who did not make use of Ohm’s Law looked for any way to use the data that evaluated to 4.8 V. An example of this is (4.00 + 2.00 – 1.2) = 4.8 V.

(ii) Comprehensive responses

- Many candidates knew that the same potential difference exists across both arms of the parallel circuit and so correctly stated 4.8 V.

Limited responses

- The most common mistake was the assumption that the current through the 3Ω resistor would also be 1.2 A and that the potential difference across it could also be found by applying Ohm’s Law, which gave the value 3.6 V

(iii) Comprehensive responses

- Some candidates substituted values into Ohm’s Law to calculate the current through the 3Ω resistor using the potential difference from **(b)(ii)**. Next, they calculated the potential difference across the 2Ω resistor, having calculated the current through it by adding the currents in both arms of the parallel part of the circuit. These candidates then found the total emf in the circuit by adding the two calculated values of potential difference. Candidates who used this approach almost always set out each step of the calculation clearly. Some candidates used alternative methods.

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Limited responses

- Many candidates made some progress, and applied Ohm's Law to some parts of the circuit. Some candidates used the expression to calculate the combined resistance of two resistors in parallel and then calculated the total resistance in the circuit. Determining the overall current flowing through the combined resistance was a common problem.

(c) Comprehensive responses

- Many candidates were familiar with the expression used to calculate the combined resistance of two parallel resistors and processed the question data correctly.

Limited responses

- Candidates sometimes recalled the parallel resistance expression incorrectly stating $R_{total} = 1 / R_A + 1 / R_B$. One other common mistake was to calculate $R_T = 1 / 15 + 1 / 20$. Some candidates recalled the correct expression and substituted values into it without going on to process the data to produce the final answer.

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COMBINED SCIENCE

Paper 0653/42
Extended Theory

Key messages

What candidates did well

- Demonstrated knowledge and understanding across Biology, Chemistry and Physics by recalling scientific facts, terminology and equations in a wide range of familiar contexts.
- Interpreted information presented in diagrams, graphs and tables and used this information appropriately in explanations and calculations.
- Recalled and applied equations successfully in straightforward calculations.
- Identified relevant scientific ideas and combined these to explain familiar biological, chemical and physical processes.
- Used information provided in question stems to support explanations, complete calculations and justify conclusions.

What candidates needed to improve

- Develop explanations by linking scientific ideas into complete scientific explanations rather than identifying individual scientific facts.
- Use precise scientific terminology to distinguish between closely related structures, substances, processes and scientific quantities.
- Compare biological, chemical and physical processes by identifying both similarities and differences where required.
- Complete multi-step calculations by selecting and applying appropriate equations in sequence, carrying forward intermediate results and using appropriate unit conversions where required.
- Develop responses by including sufficient scientific detail to explain observations and justify conclusions.

Comments on specific questions

Question 1

(a) (i) Comprehensive responses

- Most candidates identified the diaphragm and the bronchiole.

Limited responses

- A common response was to identify the bronchiole as the bronchus or bronchi.
- Some candidates identified both structure and needed to match them to the correct to labels.

(ii) Comprehensive responses

- Many candidates identified the larynx.

Limited responses

- A common response was to identify the trachea.

(b) (i) Comprehensive responses

- Most candidates identified at least one other feature of a gas exchange surface.

Limited responses

- A common response was to refer to thin cell walls or thin cell membranes rather than recognising that gas exchange surface is one cell thick or has a thin membrane.

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(ii) Comprehensive responses

- Many candidates described at least one factor affecting the rate of diffusion through a gas exchange surface.

Limited responses

- Common insufficient responses referred to concentration rather than concentration gradient or pressure rather than pressure difference.

(c) (i) Comprehensive responses

- Many candidates identified the vein and gave at least one appropriate explanation.

Limited responses

- Some responses identified the larger lumen and needed to refer to the thinner wall.
- Some responses identified the thinner wall and needed to refer to the larger lumen.

(ii) Comprehensive responses

- Comprehensive responses described the role of white blood cells and platelets in defending the body from pathogens.

Limited responses

- Some responses referred to antibodies and needed to refer to the white blood cells that produce them.
- A common misconception was to refer to antibiotics rather than antibodies.
- Some candidates described antibody production or phagocytosis and needed to include the role of platelets.

Question 2

(a) (i) Comprehensive responses

- Most responses identified one other enzyme produced by the pancreas.

(ii) Comprehensive responses

- Most responses identified the large molecule digested by lipase and the products of its digestion.

Limited responses

- A common insufficient response was to refer to fatty acids only.
- A common insufficient response was to refer to glycerol only.
- A common response was to refer to proteins and amino acids.

(b) Comprehensive responses

- Most responses identified pH 7 as the optimum pH for lipase.
- Comprehensive responses explained that, at the optimum pH 7 the active site retains its complementary shape, allowing more successful collisions to form more enzyme-substrate complexes.

Limited responses

- Some responses referred to the complementary shape of the enzyme and needed explain that this results in more successful collisions forming enzyme-substrate complexes.
- Some responses referred only to the increased frequency of collisions or identified the optimum pH without explaining the effect on enzyme activity.

(c) (i) Comprehensive responses

- Most candidates calculated the number of bubbles correctly.

Limited responses

- A common response was to round 7.33 to 8.

(ii) Comprehensive responses

- Most candidates described the relationship between the concentration of carbon dioxide and the rate of photosynthesis.

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Question 3

(a) (i) Comprehensive responses

- Most candidates identified the anther.

(ii) Comprehensive responses

- Most responses described pollination as the transfer of pollen the wind to the stigma.

(b) Comprehensive responses

- Most responses recognised that fertilisation involves male and female gametes.
- Comprehensive responses identified the similarity as the fusion of the nuclei of the gametes and explained that fertilisation occurs in the ovary of humans and in the ovary in flowering plants.

Limited responses

- Many responses recognised the need for male and female gametes and needed to explain that fertilisation involves the fusion of their nuclei.
- Some responses identified sperm, egg and ovule and needed to distinguish between the sites of fertilisation in humans and flowering plants.
- A common insufficient response was to refer only to the oviduct or the ovary.

Question 4

(a) Comprehensive responses

- Comprehensive responses correctly identified the number of protons, neutrons and electrons where required and determined the formula of the fluorine ion.
- Most responses identified the proton number of the lithium ion and the number of neutrons in the sodium ion.

Limited responses

- A common response was to identify fluorine as Fl rather than F, or F^+ rather than F^-.

(b) (i) Comprehensive responses

- Most responses identified chlorine as the least dense of the three elements.

(ii) Comprehensive responses

- Most responses identified iodine as the least reactive of the three elements.

(c) (i) Comprehensive responses

- Most responses identified the reaction between aqueous sodium bromide and aqueous chlorine as a displacement or redox reaction.

(ii) Comprehensive responses

- Most responses identified colourless, orange, brown or yellow.
- Many candidates recognised that the solution is colourless before the reaction.
- Many candidates recognised that the solution changes to orange, brown or yellow during the reaction.

Limited responses

- A common response was to identify the initial colour of the solution as yellow or brown.

Question 5

(a) Comprehensive responses

- Most candidates explained that methanol is not a hydrocarbon because it contains oxygen.

Limited responses

- Some misconceptions included references to the hydroxyl group (OH), saturation, double bonds and the absence of water.

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(b) Comprehensive responses

- Comprehensive responses completed the dot-and-cross diagram by showing the correct bonding electrons and the correct number of unbonded electrons on the oxygen atom.

Limited responses

- A common response was four electrons in the bond between carbon and oxygen.
- A common response was to show one or more unbonded electrons on hydrogen atoms.

(c) (i) Limited responses

- Some responses defined activation energy as the minimum energy needed to start a reaction and needed to relate this to the energy of colliding particles.
- A common misconception is that activation energy is the energy required for particles to collide.

(ii) Comprehensive responses

- Most candidates identified the name and symbol of the reactant and the symbol of the product.
- Many candidates also balanced the symbol equation correctly.

(iii) Comprehensive responses

- Most candidates identified the test and observation.

Question 6

(a) (i) Comprehensive responses

- Most responses identified at least one pollutant formed by incomplete combustion of hydrocarbon.

Limited responses

- Common response included sulfur dioxide and oxides of nitrogen.

(ii) Comprehensive responses

- Comprehensive responses identified city K by considering the combined concentrations of the the two pollutants responsible for causing acid rain.

Limited responses

- A common response was to identify city J.

(iii) Comprehensive responses

- Most candidates calculated the total mass of gaseous pollutants (271 μg) correctly.

Limited responses

- A common response was adding the mass of the particulates also to give 317 μg.

(b) Comprehensive responses

- Most responses explained how at least one of the suggested strategies reduces the effects of climate change.
- Many candidates explained that planting trees removes carbon dioxide from the atmosphere.
- Some candidates explained that reducing livestock farming reduces the amount of methane released into the atmosphere.

Limited responses

- A common misconception was that reducing the numbers of livestock reduces the amount of carbon dioxide released by respiration.

Question 7

(a) (i) Comprehensive responses

- Most candidates calculated the power of the lamp correctly.

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(ii) Comprehensive responses

- Many candidates indicated the direction electron flow correctly and gave an appropriate reason.

(iii) Comprehensive responses

- Many responses stated the correct equation relating the current in different parts of the circuit.

(b) Comprehensive responses

- Many responses recognised that an alternating current changes direction.

Limited responses

- A common insufficient response was to state that an alternating current *can* change direction.

(c) Comprehensive responses

- Comprehensive responses first determined the total charge before using the time taken to calculate the current.

Limited responses

- Some candidates calculated the total charge and needed to use the equation $Q = It$ to determine the current.
- Common responses occurred when values in standard form were transcribed for example 1.6×10^{19} C rather than 1.6×10^{-19} C.

Question 8

(a) (i) Comprehensive responses

- Most responses identified an appropriate example of a transverse wave.

(ii) Comprehensive responses

- Most responses distinguished correctly between the pressure and particle spacing in compressions and rarefactions.

(b) Limited responses

- Some candidates recognised that the distance between particles in a gas is much greater than in a solid.
- Some candidates recognised that the forces between particles in a gas are much weaker than those between particles in a solid.
- Many candidates needed to explain that solids expand less than gases because the particles are closer together and the stronger forces between them restrict their movement.

(c) Limited responses

- Some responses referred to vibrations passing from one particle to the next.
- Some response recognised the role of free or delocalised electrons.
- Few responses explained that free electrons transfer thermal energy by moving through the metal from hotter to cooler regions and transferring energy by collisions with particles.

Question 9

(a) Comprehensive responses

- Many responses identified at least one energy resource that does not have the Sun as its main source of energy.

Limited responses

- Common responses included hydroelectricity and wind energy.

(b) Comprehensive responses

- Comprehensive responses explained that energy in the Sun is released by the fusion of hydrogen to form helium.

Limited responses

- Many responses identified the correct process and needed to identify the elements involved.

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- Many responses identified the correct elements and needed to identify the process.
- A common response was to refer to the fusion of hydrogen and helium.
- A common response was to describe the radiation emitted by the Sun without referring to the nuclear fusion reaction that produces it.

(c) (i) Comprehensive responses

- Comprehensive responses applied the kinetic energy equation twice: first to determine the mass of the car and then to calculate its kinetic energy of the car at its final speed.

Limited responses

- Some candidates recalled the kinetic energy equation and needed to substitute the given values correctly.
- A common response was to include the value of the acceleration in the calculation.

(ii) Limited responses

- Few candidates calculated the distance that the car travels while it is accelerating.
- Some candidates recognised the need to calculate the time taken to accelerate from the initial to the final speed and needed to use the average of these speeds to complete the calculation of distance.
- Some candidates calculated the time for the acceleration and multiplied by the change in speed rather than the average speed.
- Some candidates recognised the need to calculate the force exerted on the car due to its mass and acceleration and needed to use the change in kinetic energy and the equation for work done to determine the distance travelled.

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COMBINED SCIENCE

Paper 0653/43
Extended Theory

Key messages

What candidates did well

- Demonstrated knowledge and understanding across Biology, Chemistry and Physics by recalling scientific facts, terminology and equations in a wide range of contexts.
- Interpreted information presented in diagrams, graphs and tables and used this information appropriately in explanations and calculations.
- Completed straightforward calculations by selecting appropriate equations and showing clear working.
- Linked scientific ideas to explain biological, chemical and physical processes.
- Used information provided in question stems to support explanations and justify conclusions.

What candidates needed to improve

- Develop explanations by linking scientific ideas into complete chains of reasoning rather than identifying individual scientific facts or processes.
- Apply scientific knowledge in unfamiliar contexts, particularly when explanations required several linked steps or calculations required several stages.
- Use precise scientific terminology to distinguish between closely related structures, substances, processes and scientific quantities.
- Complete multi-step calculations by selecting and applying more than one equation where required and applying them in sequence, carrying forward intermediate results, using appropriate unit conversions.
- Develop explanations by including sufficient scientific detail to justify conclusions and explain observations.

Comments on specific questions

Question 1

(a) **Comprehensive responses**

- Many responses identified P as the stigma.
- Many responses described the filament as supporting the anther.
- Many responses identified T as the petal and explained that petals attract pollinators.

Limited responses

- A common response was to identify the function of the filament as fertilisation, reproduction or for the transport of nutrients.

(b) **Comprehensive responses**

- Most responses describe pollination as the transfer of pollen grains.
- Comprehensive responses distinguished fertilisation from pollination by referring to the fusion of the nuclei of the male and female gametes.

Limited responses

- Many responses described pollination without explaining that fertilisation involves the fusion of gamete nuclei.

(c) **Comprehensive responses**

- Some responses explained that active transport moved mineral ions from a lower concentration in the soil to a hair concentration in the root hair cells.

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- Comprehensive responses also referred to movement against the concentration gradient and the need for energy from respiration.

Limited responses
- A common misconception was that water enters root hair cells by active transport.
- Some responses referred generally to nutrients or minerals rather than mineral ions.
- Some responses described the movement across a concentration gradient without stating that the movement was against the concentration gradient.
- Other responses described the large surface area of root hair cells without explaining the role of active transport.

Question 2

(a) (i) Comprehensive responses
- Most responses identified the right ventricle and the septum.

(ii) Comprehensive responses
- Some responses explained that structure X (the valve) allows blood to flow in one direction through the heart.
- Comprehensive response also explained that structure Y (muscle) in contracting to pump blood through the heart.

Limited responses
- Some responses referred to pumping rather than the contraction of the heart muscle.
- Some responses described the movement of the blood from the atrium to the ventricle without explaining the function of the valve.
- Some responses referred to the contraction of structure X rather than its role in controlling the direction of the flow of blood.

(b) (i) Comprehensive responses
- Many candidates calculated the increase in the heart rate.
- Comprehensive responses calculated the increase in heart rate before dividing by the initial heart rate to determine the percentage increase.

Limited responses
- Some candidates divided the highest heart rate by the initial heart rate.
- A common response was to misread the y-axis scale giving, for example, 64 beats per minute for the initial heart rate rather than 68 beats per minute.
- Some candidates divided the increase in the heart rate by the time taken (10 minutes).

(ii) Limited responses
- Some responses recognised that less energy or less oxygen was required and needed to link these to the reduced rate of respiration.
- Few responses explained that the reduced oxygen demand resulted from less frequent muscle contraction.

Question 3

(a) (i) Comprehensive responses
- Many responses recognised that proteins contain nitrogen whereas carbohydrates do not.

Limited responses
- Some responses referred to amino acids rather than identifying the element nitrogen.

(ii) Comprehensive responses
- Many candidates recognised that lipase digest fats.
- Comprehensive responses explained that protein molecules cannot bind to the active site because their shape is not complementary to that of lipase.
- Some responses recognised that lipase does not digest proteins and needed to explain this in terms of protein specificity.

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(b) (i) Comprehensive responses

- Almost all candidates identified the rabbit as an herbivore.

(ii) Comprehensive responses

- Most candidates identified the transfer of chemical energy from the plant to the inchworm.
- Many candidates identified chlorophyll as the green pigment in plants.

Limited responses

- A common response was to identify plants, rather than the Sun as the principal source of energy entering biological systems.
- A common misconception was to refer to ATP rather than chemical energy.

Question 4

(a) (i) Limited responses

- Few candidates completed the balanced symbol equation for the reaction between sodium and chlorine.
- A common response was to record chlorine as C*l* rather than Cl_2.
- Some candidates represented sodium and chorine as ions rather than atoms.

(ii) Limited responses

- Few candidates recognised that chlorine gas is pale green.

(iii) Comprehensive responses

- Most candidates identified at least one true or false statement about chlorine gas.

(b) Comprehensive responses

- Most candidates completed the dot-and-cross diagram to show the outer shell electrons and charges of the sodium and chloride ions.

Limited responses

- Some responses transferred the outer electron from the sodium atom to the chloride ion without showing that the second electron shell becomes the outer shell of the sodium ion.
- Candidates need to recognise that the second electron shell becomes the outer shell after the outer electron is transferred.

Question 5

(a) (i) Comprehensive responses

- Most candidates determined the number of atoms of each element in ammonium hydroxide.
- Most candidates determined the formula of sodium hydrogen carbonate.

(ii) Limited responses

- Few candidates recognised that some bases are not alkalis because they are insoluble in water.

(b) (i) Comprehensive responses

- Many candidates recognised that the reaction of a base with an acid produces a salt and water.

(ii) Comprehensive responses

- Many candidates recognised that increasing temperature increases the kinetic energy of the reacting particles.
- Comprehensive responses explained that the increase in kinetic energy results in more frequent successful collisions between particles.

Limited responses

- Many responses recognised that particles collide more frequently and needed to explain that a greater proportion of collisions have sufficient activation energy for reaction.

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Question 6

(a) Comprehensive responses

- Most candidates identified refinery gas as having the shortest chain length and bitumen as having the longest chain length.

Limited responses

- A common response was to identify diesel oil as having a shorter chain length than naphtha.

(b) (i) Comprehensive responses

- Most candidates deduced the correct molecular formula of the hydrocarbon.

(ii) Comprehensive responses

- Many candidates identified the hydrocarbon as an alkane.

(iii) Comprehensive responses

- Many candidates identified the correct number of hydrogen atoms in the smaller hydrocarbon produced by cracking.
- Some candidates recognised the presence of a carbon-carbon double bond in the cracked hydrocarbon.

Limited responses

- Many candidates identified high temperature or pressure as conditions for cracking and needed to include to the use of a catalyst.

(c) (i) Limited responses

- Few candidates linked the sulfur present in diesel fuel to the formation of sulfur dioxide during combustion.

(ii) Comprehensive responses

- Most candidates described at least one strategy to reduce the concentration of carbon dioxide in the atmosphere.

Question 7

(a) (i) Limited responses

- Few candidates identified microwaves as the region of the electromagnetic spectrum used for mobile phone communication.
- A common response was to identify radio waves.

(ii) Comprehensive responses

- Most candidates gave an appropriate example of a transverse wave.
- Most candidates gave an appropriate example of a longitudinal wave.

(b) (i) Limited responses

- Few candidates identified the correct equation for calculating orbital speed.
- Some candidates identified the equation and needed to convert the orbital period from days to hours before completing the calculation.

(ii) Limited responses

- Few candidates calculated the time taken for light to reflect from the Earth to the Moon and back.
- Some responses identified the correct speed of light and needed to convert the Earth-Moon distance from kilometres to metres and account for the return journey.
- Some responses converted the distance and needed to use the correct value for the speed of light.

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Question 8

(a) (i) Comprehensive responses

- Most candidates showed that the weight of the dinosaur is 64 000 N.

(ii) Comprehensive responses

- Many candidates calculated the pressure exerted on the ground by the dinosaur.

Limited responses

- Some responses identified the correct equation for pressure and needed to use the combined area of both feet in the calculation.
- Some responses gave incorrect units e.g. P, N, J.

(b) Limited responses

- Few candidates calculated the acceleration of the dinosaur.
- Some candidates recalled the kinetic energy equation and used it to calculate the final speed.
- Few candidates determined the final speed correctly and needed to determine the change in speed before determining the acceleration.

Question 9

(a) Limited responses

- Few candidates explained how thermal energy is transferred from the heating element to the water.
- Some candidates referred to the increased vibration or increased kinetic energy of the particles in the heating element and needed to explain how collisions between particles transfer thermal energy to the water.

(b) (i) Limited responses

- Few candidates calculated the efficiency of the kettle.
- Some candidates used the equation $E = Pt$ and needed to convert the time from minutes to seconds before completing calculating the energy supplied.
- Some candidates identified the efficiency equation and needed to substitute the calculated energy supplied before determining the efficiency.

(ii) Comprehensive responses

- Many responses identified one advantage of connecting heaters in parallel.

(iii) Limited responses

- Few candidates calculated the resistance of heater B.
- Some responses used $P = V^{1}$ to calculate the current in the circuit.
- Some responses used the circuit current to determine the current in heater B.
- Some responses used $R = V/I$ to calculate the resistance of heater B.

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Paper 0653/51
Practical Test

Key messages

Guidance for the requirements for the practical component can be found at the back of the syllabus. Teachers are referred to Section 4.

Candidates need to ensure that they are familiar with the Notes for Qualitative Analysis, given in the syllabus and on the last page of the question paper. Many candidates attempted to answer **Question 2** without reference to this information.

What candidates did well

- Candidates engage with the practical component of the test. They complete the experiments and record their data and observations.
- Values for their measurements are usually within the expected range and in agreement with those of the Supervisor Report.
- Candidates typically do mathematical calculations well. They substitute numbers and compute answers correctly.
- Some candidates produce appropriate graphs, with lines of best fit in line with the guidance in Section 4 of the syllabus.
- Most candidates were able to identify apparatus for the planning question, **Question 4** and were able to describe a brief method and what to measure.

What candidates needed to improve

- There was a high omit rate across the candidates. Many questions were left unattempted, particularly the planning question, **Question 3**.
- Candidates need to follow instructions carefully, for example, in step 4 of **Question 1,** candidates are asked to record their values of temperature to the nearest 0.5 °C. Few candidates did so when completing their results table.
- When asked to record to a specific number of decimal places, they need to include zero as a measured decimal place if their value is a whole number, for example 24.0 rather than 24.
- They need to ensure that when asked for any relationship they answer in terms of the variables in the question, for example ensuring they discuss percentage concentration of hydrogen peroxide and rate of reaction in **Question 1 (a)(v)**.
- When asked to refer to a particular step in a procedure (for example in **Question 1 (a)(iv)**, candidates do so and ensure that their answers are specific to the question. In questions such as this it is important to avoid generic responses and instead refer to the procedure in that step.
- Candidates need to look at the guidance for constructing graphs given in the syllabus. Many candidates do not label axes appropriately; they omit units or choose appropriate scales. Some candidates plotted points using ‘blobs’ rather than crosses or dots in circles. Some candidates did not draw appropriate lines of best fit. Candidates are encouraged to refer to the Mathematical Requirements in Section 4 of the syllabus.
- Drawing familiar apparatus (for filtration) was an area for further development in **Question2 (b)**. This is an area for improvement.
- Candidates need to ensure, when answering the planning question, that their procedure relates to the two variables in the question and that they answer all bullet points.
- The symbols required for electrical components are given in the Electrical Symbols page of Section 4 of the syllabus. Candidates need to know these symbols. **Question 4(a)** revealed that many do not know the symbol for a resistor.
- Sometimes, questions rely on candidates giving their answers to a specified number of decimal places or significant figures. In calculations where this is expected, candidates are always clearly instructed to do so. It is very common for candidates to miss this instruction. For example, **Question 4 (c)(v)**,

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candidates were asked to give their answer to three significant figures. This instruction was not always followed.

Comments on specific questions

Question 1

(a) (i) Comprehensive responses

- Candidates recorded all initial and highest temperatures.
- They followed instructions correctly. This was evident when the trend in temperature changes was correct, with the greatest change seen in test-tube A.
- Step 4 of the procedure in the question asks candidates to record their temperature measurements 'to the nearest 0.5 °C'. Where a temperature is exactly an integer, a zero after the decimal point needs to be included, for example 24.0. Comprehensive answers gave all values to one decimal place.

Limited responses

- Most candidates did not obey the instruction in step 4 to record temperature to the nearest 0.5 °C.

(ii) Comprehensive responses

- Almost all candidates correctly completed the subtraction.

Limited responses

- Very few candidates did not subtract their values correctly.

(iii) Comprehensive responses

- Many candidates correctly identified the percentage concentration of hydrogen peroxide as the independent variable.

Limited responses

- Confusion between independent and dependent variables is common. Some stated either 'temperature' or 'change in temperature', both of which are incorrect.

(iv) Comprehensive responses

Notice that this question specifically guides candidates to step 2 and step 5 of the procedure. When questions of this nature are asked, it is essential that candidates are specific in their responses and show that they have referred to the correct step of the procedure.

- Some candidates identified that the foil is used to prevent the loss of thermal energy to the surroundings. Some candidates used the term 'heat' for thermal energy.
- Some candidates were specific in their answers, referring to step 5 of the procedure and stating that the yeast was settled at the bottom and so needed to be stirred to evenly distribute the yeast.

Limited responses

- Vague responses referring to 'preventing energy loss' alone are insufficient. The question required reference to thermal energy or heat.
- Another vague response that was frequently seen was that the reaction was stirred 'to mix it up'.
- Some stated that the mixture was stirred to evenly distribute the temperature. The temperature of the yeast mixture before adding it to the hydrogen peroxide is not the temperature that is measured in the procedure. The temperature is only measured after mixing, so this is an incorrect idea.

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(b) (i) Comprehensive responses

- Candidates who answered this well followed the guidance in the Mathematical Requirements, Section 4 of the syllabus), which describes the conventions for drawing graphs correctly.
- They labelled the graph axes with the labels given in the question and shown in the headings of the table, with the dependent variable on the vertical axis (change in temperature) and the dependent variable on the horizontal axis (percentage composition of hydrogen peroxide).
- For axis labels, it is essential that units are provided, in this case '°C' for temperature and 'percentage' for concentration.
- They chose simple, linear scales such that the points occupy more than half the grid. This means that typically the horizontal axis scale usually increased by 1 per cent on each major grid line.
- They plotted their points correctly using either small crosses or dots in circles.

Limited responses

- Some candidates omitted the units from the vertical axis or abbreviated the label for the horizontal axis to 'concentration' which is insufficient because 'percentage' is the unit for this axis.
- Some scales chosen were too small so that the points did not occupy half the grid in a horizontal direction.
- Some candidates drew large 'blobs', making it difficult to judge the accuracy of the plotting.

(ii) Comprehensive responses

- Candidates recognised that the relationship is a straight line that, in the case of the data in this question, goes through the origin. They drew their line with a ruler such that points not exactly on the line were evenly distributed on either side.
- The guidance for drawing lines of best fit is in the Mathematical Requirements in Section 4 of the syllabus.
- It should be noted that values carried forward were applied to the construction of the graph and the choice of the line of best fit. Some candidate results suggested a curve and a curved line was drawn.

Limited responses

- Some candidates did not use a ruler.
- Some candidates drew a line which had several points on one side and none on the other so that the points were not evenly distributed.
- Some candidates assumed that the line goes from the origin to the last point. This did not represent the line of best fit.
- Some candidates drew dot to dot lines.

(iii) Comprehensive responses

- Most candidates correctly stated that as the percentage concentration of hydrogen peroxide increases, the rate of reaction increases.
- In the case of this data, the line is straight and does go through the origin, so 'directly proportional' was a correct answer. Candidates should be careful about using this phrase in general for relationships that do not follow these two indicators of a proportional relationship.

Limited responses

- The question asked for the relationship between the percentage concentration of hydrogen peroxide and the rate of reaction. A very common response was to instead describe the relationship between the percentage concentration and the change in temperature.

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Question 2

It should be noted that the Notes for Qualitative Analysis are provided on the last page of the question paper. It was essential that candidates refer to these notes to answer **Question 2**.

(a) **Comprehensive responses**

- The expected observations from a reaction between an acid and a carbonate are included in the Notes of Qualitative Analysis. The question reinforced the correct observation by stating that 'the reaction fizzes'. Some responses referred to the provided notes to identify the anion as a carbonate ion.

Limited responses

- Most candidates answered this question incorrectly. The most common answer was to identify the gas given off (carbon dioxide), rather than the anion.

(b) **Comprehensive responses**

- Some clear diagrams were seen, drawing and labelling clearly a filter funnel and filter paper with a collecting vessel to collect the filtrate.

Limited responses

- Most answers clearly recognised that the procedure was filtration, with further development needed in representing the apparatus clearly. Common responses were to draw a funnel either without the tube at the bottom, to omit the filter paper or to draw the filter paper with an open area at the bottom so that any residue would fall through.
- The two key labels were filter funnel and filter paper. Some gave either partial or incorrect labels such as 'filter' alone or 'filtrate funnel'.

(c) **Comprehensive responses**

- Some candidates stated their observations by including both a state and a colour for the filtrate and residue, leading to the correct answer of a blue solution for a filtrate and a green solid residue.

Limited responses

- Some candidates correctly identified the colours, with further development needed in describing the state of the substances. 'Sludge' or 'wet lumps' were often stated rather than solid, and 'solution' was usually omitted.

(d) (i) **Comprehensive responses**

- When carrying out a flame test, candidates should refer to the Notes for Qualitative Analysis given in the paper to identify both the relevant colour and the cation in the sample. Many candidates correctly stated the colour (blue green) and identified the ion (copper).
- Some supervisors reported that the flame colour seen was yellow. In such cases, some candidates identified the colour as yellow and the element as sodium.

Limited responses

- Some candidates stated the correct observation of a blue-green flame and did not continue to correctly identify the ion. This implies that they were not referring to the Notes for Qualitative Analysis when they were answering.

(ii) **Comprehensive responses**

- Some candidates recognised that a yellow flame obscures the colours produced in the flame test.
- Some candidates knew that a yellow flame gives a false positive test for sodium.

Limited responses

- Some candidates would benefit from expressing their ideas clearly. Some stated vaguely 'you can't see the flame'.
- A relatively high proportion of incorrect answers stated that the blue flame is hotter. Although this is true, it is stated in the question so in this case in an incorrect answer.

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Question 3

Comprehensive responses

- Candidates who answer this question fully typically ensure that they engage with the question asked, in this case the relationship between the mass of salt dissolved in water and the volume of foam made when the detergent is shaken with the water.
- A second common feature of comprehensive responses is candidates who ensure that they have addressed all five bullet points.
- For this question, there was a significant amount of information in the question. The question specified the apparatus provided and gave an outline that the salt should be dissolved in the water, detergent added and the volume of foam measured. Candidates who answered well, began with this core experiment and adapted it to investigate the impact of changing the mass of salt dissolved.
- Stated essential additional apparatus, such as a balance and an additional measuring cylinder.
- Described a clear method, logically sequenced such that another student could follow to achieve results.
- Took care to state clearly that the detergent, water and foam are measured by volume and that the salt is measured by mass.
- Included stating the necessary measurements essential to the procedure.
- Included a statement about how results would be processed, for example by stating the graph axes to use to construct a graph to show the relationship investigated in the question or by sketching the axes of the graph (they do not need to show the relationship).

Limited responses

- There was an exceptionally high omit rate for this question. Many candidates did not attempt to answer.
- A common reason for a limited response is that some candidates did not take care to ensure that their plan addressed the variables given. It was relatively common for candidates to vary the amount of detergent or the temperature of the water.
- The method needs to be logical and sequenced. Some candidates omitted to add either water or detergent before shaking.
- A further reason for limited responses was that many candidates do not address all five bullet points. It was relatively common for answers to omit measurements or to omit to describe how to process results to reach a conclusion.
- It should be noted that vague generic statements about ‘doing repeats’ are insufficiently applied to the context. The procedure needs to be a detailed description of an experiment that another student could follow and specific to this context.
- It is essential that all solutions are measured or controlled by volume and solids are measured by mass. Some candidates used general statements such as ‘measure the amount of salt’.

Question 4

(a) **Comprehensive responses**

- Some candidates correctly circled P on the diagram and drew the correct symbol for a resistor in the provided box.

Limited responses

- Many candidates omitted to indicate the position in the circuit where the resistor should be placed.
- Incorrect symbols for the resistor were often seen. A fuse or a variable resistor were common incorrect answers.

(b)(i)(ii) **Comprehensive responses**

- Many candidates gave voltmeter and ammeter values that were in close agreement with the supervisor report for the centre.

Limited responses

- Some candidates gave readings that were unlikely to be accurate. Some ammeter values were high and, in some cases, exceeded the voltmeter readings. It was not clear why this issue arose. In some cases, it appeared that candidates were confusing their voltmeters and ammeters.

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(iii) Comprehensive responses

- Almost all candidates correctly the resistance based on their own values. This question was well answered.

(c) (i) Comprehensive responses

- Almost all candidates who attempted this question suggested positions that gave a difference of 50.0 cm.

(ii) Comprehensive responses

- The question asked candidates to 'suggest a change to the apparatus'. Some responses suggested an alternative, such as using a pin or a nail to make the connection rather than the wide crocodile clip.

Limited responses

- Many candidates gave responses that were close to repeating the question. The question stated that the end of the crocodile clip was wide. A common answer that was insufficient was to 'use a narrow crocodile clip' rather than to suggest an alternative piece of apparatus.

(iii) Comprehensive responses

- In common with **(b)**, many candidates gave voltmeter and ammeter readings close to the expected results and in line with their supervisor values.

Limited responses

- Again, some incorrect readings were reported, with ammeter readings sometimes exceeding voltmeter readings.

(iv) Comprehensive responses

- Many candidates were able to give a reason for opening the switch relating to either the issue of the circuit heating causing an increase in resistance or to preserve the charge on the battery.

Limited responses

- Some incorrectly referred to avoidance of electric shock, which is not correct at the voltages used in the question.

(v) Comprehensive responses

- Some candidates substituted and computed the value correctly and considered the instruction to 'Give your answer to three significant figures'.

Limited responses

- Although most candidates substituted correctly, the instruction to provide an answer correct to three significant figures was not always followed.

(d) (i) Comprehensive responses

- Many candidates correctly substituted their value for R_1 into the provided expression and computed the answer correctly.

Limited responses

- A common incorrect answer was to substitute the value for R_2 rather than R_1 into the expression.

(ii) Comprehensive responses

- There are a wide range of correct approaches to this question. The most common correct approach is to calculate the percentage difference between the two values and compare this to 10 per cent.
- Other corrected approaches included calculating a 10 per cent increase in the lower value or a 10 per cent decrease in the higher value.
- Many candidates used a viable method and stated a correct conclusion.

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Limited responses

- Some candidates were unable to devise a suitable method for identifying whether the two values were 10 per cent apart.
- Some gave a statement 'the two values are close together' without justifying their answer with a calculation. A supporting calculation would have strengthened these responses.

(e) **Comprehensive responses**

- Some candidates stated that the readings would exceed those of the available scale on the voltmeter and/or ammeter. Some candidates made this point clearly.

Limited responses

- Some candidates only talked about either the readings or the voltmeter/ammeter and did not make a logical connection between the two. Answers such as 'the readings would be high' or 'the voltmeter or ammeter have a small scale' were insufficient.

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COMBINED SCIENCE

Paper 0653/52
Practical Test

Key messages

Teachers can find guidance on the requirements for the practical component in ***Section 4*** at the back of the syllabus.

Candidates need to be familiar with the Notes for Quantitative Analysis that can be found in the syllabus and are also printed on the final page of the question paper, as these are often needed to answer some of the chemistry questions – in this case, **3(e)**.

What candidates did well

- Candidates engaged with the completion of the experiments and candidates completed their experiments and recorded their observations and results.
- Values recorded by candidates tended to be in the range expected by examiners or were close to those in the Supervisor Report.
- Some candidates made very good use of the data, information and instructions given within the questions. They engaged with the contexts, and extracted necessary information from experimental procedures and results.
- Some candidates took care to follow instructions carefully, for example to 'record to the nearest 0.1 seconds' or 'give your answer to two significant figures'.
- Candidates typically did mathematical calculations well. They substituted numbers and calculated answers correctly.

What candidates needed to improve

- Some candidates left many questions blank.
- Candidates needed to follow all instructions given in the questions. For example, if asked to record a value to the nearest mm, as in **Question 1(a)(ii)**, then recording it to the nearest centimetre is not going to be sufficient. In **Question 4(b)(i)**, candidates were asked to record a value to the nearest 0.1 seconds. The .0 needs to be included if the value is a whole number of seconds. 11.0 s would be the correct answer whereas just 11 s alone would not be.
- Some candidates would benefit from looking at the guidance in the syllabus about constructing graphs. Many candidates did not label the axes appropriately. For example, they did not use the words from the column headings of the table, or they missed out the units.

Comments on specific questions

Question 1

(a) (i) Comprehensive responses

- Candidates drew a clear pencil drawing that filled more than half of the box in both directions. The diagram did not touch the lines that formed the box.
- The outer outline was a single, freehand pencil line with no breaks or joints.
- They included sufficient detail for it to be an accurate biological diagram, in this case the detail included the seeds and the crescent shaped structures in which the seeds can be found.

Limited responses

- Candidates drew a generic or 3D diagram of a slice of tomato.
- Some candidates shaded or coloured in their diagram, which is not correct as a biological line diagram needs to be clear. The details such as the seeds would be missing in a limited response example and the outer edge of the tomato would be not drawn using a continuous line. Some candidates drew around a protractor rather than producing a freehand diagram.

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(ii) Comprehensive responses

- A correct value measured to the nearest whole millimetre and not centimetre.

Limited responses

- A value given in centimetres or a fractional number of millimetres, such as 11.2 mm.

(iii) Comprehensive responses

- A value recorded to the nearest whole millimetre and a line or other indication showing the start and end points of their measurement.

Limited responses

- Many candidates did not include a line or double headed arrow or other indication on their diagram and so it was not possible for examiners to confirm the candidate's measurement as they did not know where the candidate's measurement started and ended.

(iv) Comprehensive responses

- A correctly calculated magnification with a minimum of two significant figures calculated using the formula given in the question.

Limited responses

- Some candidates calculated the magnification incorrectly by dividing d by D instead of the other way round.

(b) Comprehensive responses

- Many candidates were able to describe the appearance of DCPIP as being colourless for the positive test or used the word decolorise or stated 'no colour'.

Limited responses

- Some candidates referred to other colours or used the word 'clear'. Candidates are reminded that 'clear' means that something can be seen through. A substance can be both coloured and clear at the same time, as shown by copper sulfate solution.

Question 2

Comprehensive responses

- Candidates who answered this question fully ensured that they included details that addressed all five of the bullet points given in the question.
- They gave the correct scientific name of suitable apparatus and explained what it would be used for.
- In the method section they gave sufficient detail that another candidate could use it to obtain results. In this question it was necessary to mention how the juice would be extracted from the tomato such as by cutting, mashing, or juicing it. It was then essential for the Benedict's solution and tomato juice to be heated to initiate the reaction that may cause the colour change.
- In the measurement section candidates explicitly told the examiner that they would look at the initial colour of the Benedicts and the final colour of it after heating. They used specific scientific terminology such as volume or mass rather than amount.
- Candidates gave a suitable range of factors that must be kept constant to ensure the experiment was valid.
- Unusually in this question it was not necessary to describe a graph and more comprehensive responses explained what the colour of the Benedict's solution would be for both a positive and negative test for reducing sugars.

Limited responses

- It was common for examiners to see missing details such as no means of heating the Benedict's solution or no detail given as to how the juice of the tomato may be extracted.
- In more limited responses candidates did not explain that the juice would need to be extracted from the tomato, instead thinking that you could just heat a whole tomato or just add Benedict's to a tomato without any heating.

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- In other limited responses, candidates said that they would look for a colour change without saying that this involved looking at the initial and the final colour of the Benedict's solution. Vague terminologies such as amount rather than technical terms such as volume and mass were used.
- Irrelevant control variables would be mentioned such as the same size of beaker.
- The processing results section was commonly missing in the limited answers.
- Another reason for a limited response was one that did not address all five of the bullet points given in the question.

Question 3

(a) Comprehensive responses

- A comprehensive response included all measurements of mass correctly rounded to one decimal place.

Limited responses

- Some candidates only wrote down the numbers from the balances in Figure 3.1 without either rounding or truncating the answer. This did not follow the instruction to record the readings to 2 decimal places. Some candidates truncated all the answers rather than correctly rounding up where this was necessary.

(b) Comprehensive responses

- A comprehensive response included all observations of colour. White at the start, turning to yellow and then back to white.

Limited responses

- Some candidates only wrote the initial colour change from white to yellow and did not follow the instruction about leaving the solid to cool and so they missed the second colour change back to white.

(c) Comprehensive responses

- Candidates said that the zinc carbonate should be heated and the mass re-measured and this process repeated until the mass did not change.
- Some candidates gave answers about adding acid and looking for effervescence and, whilst this was not the answer that was anticipated by the author of the paper, it showed a good understanding of the underlying science.

Limited responses

- It was common for candidates just to reheat the zinc carbonate without mentioning to check that the mass was remaining constant. Some candidates mentioned looking for a gas to be produced instead of effervescence. A gas usually cannot be seen and so was not a valid observation whereas bubbles of gas would be able to be observed.

(d) (i) Comprehensive responses

- Candidates needed to subtract M_1 from M_3 and most candidates were able to do this.

Limited responses

- Some candidates added the values of M_1 and M_3 together rather than subtracting and others attempted to find an average of some combination of the three values in Table 3.1.

(ii) Comprehensive responses

- Candidates needed to subtract M_1 from M_6 and most candidates were able to do this.

Limited responses

- It was common for candidates to add the values together.

(iii) Comprehensive responses

- Candidates correctly used their two values from the previous questions, showed the full working out including the multiplication by 100, gave their final answer to this calculation (64.8) and then correctly rounded it to the two significant figures (65) required by the question.

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Limited responses

- More limited responses only included a final answer that was incorrect or not given to two significant figures. Showing working out would have helped to demonstrate the method used.

(e) Comprehensive responses

- Candidates understood that a yellow flame would add a black coating of soot to the test tube and affect the mass. Others realised that the blue flame was hotter or that yellow was not hot enough to start the decomposition of the carbonate.

Limited responses

- Limited responses tended to include wording such as a blue flame being 'stronger' rather than hotter or getting it the wrong way around and telling the examiner that a yellow flame was hotter than a blue one.

(f) (i) Comprehensive responses

- For the two tests a comprehensive answer describing the formation of a white precipitate or solid that then dissolves to form a colourless solution was seen.

Limited responses

- Many candidates did not say that the white precipitate would then dissolve or that the solution would become colourless.

(ii) Comprehensive responses

- The ion zinc, or Zn^{2+} was identified. Some candidates identified calcium, or Ca^{2+} where a white precipitate had been observed in both tests in the previous questions.

Limited responses

- Some candidates gave other incorrect ions or metals.

Question 4

(a) (i) Comprehensive responses

- Candidates correctly measured the distance d and gave the correct value of 4.0 cm. A tolerance of 2 centimetres was applied to their measurement.

Limited responses

- Many candidates measured a distance that was not accurate and so was out of the tolerance allowed or did not come close to the Supervisor's value.

(ii) Comprehensive responses

- Candidates gave a reasonable suggestion as to why it would be difficult to measure the distance D. Typically this was the idea that the ruler is shorter than the gap size or that the centre of the rods is circular and so there is uncertainty as to where the centre of these would be.

Limited responses

- A more limited response did not include sufficient detail such as 'it was difficult to keep the ruler steady' without explaining why or that it was just difficult to measure the distance D without explaining that their ruler was too short. Comments along the lines of 'it would not be accurate' without giving any information as to why this would be the case were relatively common.

(iii) Comprehensive responses

- Most candidates correctly gave the correct answer to this question and wrote the correct value in the table.

Limited responses

- It was rare to see an incorrect answer to this question. Those who did not answer correctly usually left the table blank.

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(b) (i)(ii) Comprehensive responses

- Most candidates gave suitable values and wrote these in the correct places in the table.

Limited responses

- It was uncommon to see incorrect values.

(iii) Comprehensive responses

- Most candidates correctly calculated the average time for 10 oscillations and recorded this to the same level of precision as the other numbers in the table, to the nearest one decimal place or 0.1 s.

Limited responses

- Some candidates were not able to calculate the average time and others gave this to a larger number of decimal places than the values already printed in the table, so the value was not given to the same level of precision as the other values in the table.

(iv) Comprehensive responses

- Both values were correctly given such that the values were given to the same number of decimal places within each column, with 2 decimal places in the T column and 1 decimal place in the T^4 column.

Limited responses

- Some candidates gave the period to either an insufficient or too large number of decimal places and some candidates were unable to calculate the correct value of T^4.

(v) Comprehensive responses

- Candidates gave correct answers in terms of human reaction time or that the time would be too short to measure for just one swing.

Limited responses

- Some candidates gave vague answers about 'it not being accurate' without explaining why this would be the case. Others gave answers about calculating an average.

(c) (i) Comprehensive responses

- Candidates who answered this question well followed the guidance in the mathematical requirements section of the syllabus (***Section 4***) and followed the conventions used for correctly drawing a graph.
- Graphs included axis labels that matched those from the table (T^4/s^4 on the vertical and D^2/cm^2 on the horizontal) and included the units. The scales increased by equal increments and produced plots that were easy to plot without needing a calculator to check the position. The plots were either small crosses or small dots and were accurately plotted.

Limited responses

- Where candidates gave more limited responses it was usually because they had omitted the units on the axes, used scales that did not use most of the graph paper or had scales that increased by unequal increments. Limited responses usually had incorrect plots (often caused by trying to use the unsuitable scale) or used blobs rather than crosses and so it was not possible for examiners to accurately locate the centre of their plot accurately.

(ii) Comprehensive responses

- Candidates recognised that the line of best fit was a straight line and drew a thin continuous line using a ruler, such that there was an even distribution of points on either side of the line.

Limited responses

- Some candidates did not use a ruler or drew a line that joined the dots in a dot-to-dot fashion. Some candidates who did use a ruler did not ensure there was an equal balance of points on either side of the line. Some candidates just joined the first and last point with a straight line and this also did not ensure an even spread of points on either side of the line.

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(d) **Comprehensive responses**

- Candidates generally mentioned the base of the clamp being heavy or adding masses to the base of the clamp to weigh it down.

Limited responses

- Many candidates were unable to give a correct answer and were unfamiliar with a G clamp. Teachers are reminded of the apparatus list in the syllabus and questions may be asked involving any of this standard apparatus.

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Paper 0653/61
Alternative to Practical

Key messages

Although the alternative to practical is a paper-based assessment, it is intended that candidates do a substantial amount of practical work integrated into their course. The assessment may be designed around written questions, and it is not intended that the candidates only practise using written questions. Some candidates would benefit from further practical experience.

Guidance for the requirements for the practical component can be found at the back of the syllabus. Teachers are referred to Section 4.

Candidates need to ensure that they are familiar with the Notes for Qualitative Analysis, given in the syllabus and on the last page of the question paper. Many candidates attempted to answer **Question 2** without reference to this information.

What candidates did well

- They engage fully with the questions and there are few questions left unattempted.
- Some candidates make very good use of the data, information and instructions given within the questions. They engage with the contexts, extract necessary information from experimental procedures and results.
- Some candidates take care to follow instructions carefully, for example to 'record to the nearest 0.5 °C' or to 'give your answer to three significant figures'.
- Candidates typically do mathematical calculations well. They substitute numbers and compute answers correctly.

What candidates needed to improve

- When asked to record to a specific number of decimal places, they need to include zero as a measured decimal place when asked. For example, in **Question 1 (a)(i)**, 24.0 is the correct answer to the nearest 0.5 °C. 24 is incorrect as it is given to a whole degree.
- They need to ensure that when asked for any relationship they answer in terms of the variables in the question, for example ensuring they discuss percentage concentration of hydrogen peroxide and rate of reaction in **Question 1 (a)(v)**.
- When asked to refer to a particular step in a procedure (for example in **Questions 1 (a)(vii), 2 (a)** and **2(b)**, candidates do so and ensure that their answers are specific to the question. In questions such as this vague, generic answers that do not clearly refer to the reagents or reaction in that step will not earn
- Candidates need to look at the guidance for constructing graphs given in the syllabus. Many candidates do not label axes appropriately; they omit units or choose appropriate scales. Some plot points using 'blobs' rather than crosses or dots in circles. Some candidates did not draw appropriate lines of best fit. Candidates are encouraged to refer to the Mathematical Requirements in Section 4 of the syllabus.
- Drawing familiar apparatus (for filtration) was an area for further development in **Question 2 (c)**. This is an area for improvement.
- Candidates need to ensure, when answering the planning question, that their procedure relates to the two variables in the question and that they answer all bullet points.
- The symbols required for electrical components are given in the Electrical Symbols page of Section 4 of the syllabus. Candidates need to know these symbols. **Question 4(a)** revealed that many do not know the symbol for a resistor.
- Sometimes, questions rely on candidates giving their answers to a specified number of decimal places or significant figures. In calculations where this is expected, candidates are always clearly instructed to do so. It is very common for candidates to miss this instruction. For example, **Question 4 (d)(ii)**, candidates were asked to give their answer to three significant figures. This instruction was not always followed.

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Comments on specific questions

Question 1

(a) (i) Comprehensive responses

- The question asks candidates to record their temperature measurements 'to the nearest 0.5 °C'. Where a temperature is exactly an integer, this needs to be indicated, in this case it is 24.0. Comprehensive answers gave both readings to one decimal place, 21.5 and 24.0.

Limited responses

- 24 is incorrect, because it is a reading to a whole number.

(ii) Comprehensive responses

- Almost all candidates correctly completed the subtraction.

Limited responses

- Very few candidates did not subtract their values correctly.

(iii) Comprehensive responses

- Candidates who answered this well followed the guidance in the Mathematical Requirements, Section 4 of the syllabus), which describes the conventions for drawing graphs correctly.
- They labelled the graph axes with the labels given in the question and shown in the headings of the table, with the dependent variable on the vertical axis (change in temperature) and the dependent variable on the horizontal axis (percentage composition of hydrogen peroxide).
- For axis labels, it is essential that units are provided with the labels, in this case '°C' for temperature and 'percentage' for concentration.
- They chose simple, linear scales such that the points occupy more than half the grid. This means that typically the horizontal axis scale usually increased by 1 per cent on each major grid line.
- They plotted their points correctly using either small crosses or dots in circles.

Limited responses

- Some candidates omitted the units from the vertical axis or abbreviated the label for the horizontal axis to 'concentration' which is insufficient because 'percentage' is the unit for this axis.
- Some scales chosen were too small so that the points did not occupy half the grid in a horizontal direction.
- Some candidates drew large 'blobs', making it difficult to judge the accuracy of the plotting.

(iv) Comprehensive responses

- Candidates recognised that the relationship is a straight line that, in the case of the data in this question, goes through the origin. They drew their line with a ruler such that points not exactly on the line were evenly distributed on either side.
- The guidance for drawing lines of best fit is in the Mathematical Requirements in Section 4 of the syllabus.

Limited responses

- Some candidates did not use a ruler.
- Some candidates drew a line which had several points on one side and none on the other so that the points were not evenly distributed.
- Some candidates assumed that the line goes from the origin to the last point. This did not represent the line of best fit.

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(v) Comprehensive responses

- Most candidates correctly stated that as the percentage concentration of hydrogen peroxide increases, the rate of reaction increases.
- In the case of this data, the line is straight and does go through the origin, so 'directly proportional' was a correct answer. Candidates should be careful about using this phrase in general for relationships that do not follow these two indicators of a proportional relationship.

Limited responses

- The question asked for the relationship between the percentage concentration of hydrogen peroxide and the rate of reaction. A very common response was to instead describe the trend in the table by stating the relationship between the percentage concentration and the change in temperature.

(vi) Comprehensive responses

- Many candidates correctly identified the percentage concentration of hydrogen peroxide as the independent variable.

Limited responses

- Confusion between independent and dependent variables is common. Some stated either 'temperature' or 'change in temperature', both of which are incorrect.

(vii) Comprehensive responses

Notice that this question specifically guides candidates to step 2 and step 7 of the procedure. When questions of this nature are asked, it is essential that candidates are specific in their responses and show that they have referred to the correct step of the procedure.

- Some candidates identified that the foil is used to prevent the loss of thermal energy to the surroundings. Some candidates used the term 'heat' for thermal energy.
- Some candidates were specific in their answers, referring to step 7 of the procedure and identifying the actual reagents that are being removed by washing. Some responses stated that washing the thermometer removes left over yeast or enzyme or hydrogen peroxide.

Limited responses

- Vague responses referring to 'preventing energy loss' alone are insufficient. The question required reference to thermal energy or heat.
- Vague responses stating that washing 'avoids contamination' are insufficient because they do not clearly show that candidates have engaged with the detail of the procedure in steps 2 and 7, as the question asks.

(b) Comprehensive responses

- Some candidates answered well by stating the biuret is used to test for protein and stated the positive result colour change to purple.

Limited responses

- Some candidates knew that the final colour of the protein test is purple, and further development was needed in recalling the correct reagent. Iodine and Benedict's were common responses.
- Some knew that the reagent is biuret and additional attention was needed in recalling the final colour. Brick red was a common response, implying some confusion between testing for protein and testing for reducing sugars.

Question 2

It should be noted that the Notes for Qualitative Analysis are provided on the last page of the question paper. It was essential that candidates refer to these notes to answer **Question 2**.

(a) Comprehensive responses

- The expected observations from a reaction between an acid and a carbonate are included in the Notes of Qualitative Analysis. Many candidates either recalled that the reaction produces a fizz, bubbles or effervescence, or referred to the notes to answer this correctly.

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Limited responses

- Some candidates stated that a gas or carbon dioxide is formed rather than recording an observation.

(b) Comprehensive responses

- The question refers candidates specifically to step 4. Some candidates engaged with the reagents and reactions taking place and stated that the excess copper carbonate is added to ensure that all the acid has reacted.

Limited responses

- Commonly, candidates gave generic responses such as 'to make sure the reaction has finished'. This would happen regardless of whether all the acid was used up or whether excess carbonate was added and so was not correct.

(c) Comprehensive responses

- Some very clear diagrams were seen, drawing and labelling clearly a filter funnel and filter paper with a collecting vessel to collect the filtrate.

Limited responses

- Many answers clearly recognised that the procedure was filtration, with further development needed in representing the apparatus clearly. Common responses were to draw a funnel either without the tube at the bottom, to omit the filter paper or to draw the filter paper with an open area at the bottom so that any residue would fall through.
- The two key labels were filter funnel and filter paper. Some gave either partial or incorrect labels such as 'filter' alone or 'filtrate funnel'.

(d) Comprehensive responses

- Candidates who considered the information given at the top of the question knew that copper carbonate is a green solid and that copper sulfate is a blue solution. These candidates often identified the filtrate as a blue solution and the residue as a green solid.

Limited responses

- There was some evidence that candidates were guessing about the appearance of the substances, rather than identifying the information in the question. Various colours and states were seen for both the filtrate and the residue.

(e) (i) Comprehensive responses

- Many candidates correctly stated that the colour for the flame test is blue green.

Limited responses

- Some gave incorrect responses that are not colours related to any of the metal ions tested in the syllabus. This implies that these candidates are not referring to the Notes for Qualitative Analysis on the last page of the paper, where all the flame test colours are given.

(ii) Comprehensive responses

- Some candidates recognised that a yellow flame obscures the colours produced in the flame test.
- Some candidates knew that a yellow flame gives a false positive test for sodium.

Limited responses

- Some candidates would benefit from expressing their ideas clearly. Some stated vaguely 'you can't see the flame'.
- A relatively high proportion of incorrect answers stated that the blue flame is hotter. Although this is true, it is stated in the question so in this case in an incorrect answer.

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Question 3

Comprehensive responses

- Candidates who answer this question fully typically ensure that they engage with the question asked, in this case the relationship between the mass of salt dissolved in water and the volume of foam made when the detergent is shaken with the water.
- A second common feature of comprehensive responses is candidates who ensure that they have addressed all five bullet points.
- For this question, there was a significant amount of information in the question. The question specified the apparatus provided and gave an outline that the salt should be dissolved in the water, detergent added and the volume of foam measured. Candidates who answered well, began with this core experiment and adapted it to investigate the impact of changing the mass of salt dissolved.
- Stated essential additional apparatus, such as a balance and an additional measuring cylinder.
- Described a clear method, logically sequenced such that another student could follow to achieve results.
- Took care to state clearly that the detergent, water and foam are measured by volume and that the salt is measured by mass.
- Included stating the necessary measurements essential to the procedure.
- Included a statement about how results would be processed, for example by stating the graph axes to use to construct a graph to show the relationship investigated in the question or by sketching the axes of the graph (they do not need to show the relationship).

Limited responses

- A common reason for a limited response is that some candidates did not take care to ensure that their plan addressed the variables given. It was relatively common for candidates to vary the amount of detergent or the temperature of the water.
- The method needs to be logical and sequenced. Some candidates omitted to add either water or detergent before shaking.
- A further reason for limited responses was that many candidates do not address all five bullet points. It was relatively common for answers to omit measurements or to omit to describe how to process results to reach a conclusion.
- It should be noted that vague generic statements about ‘doing repeats’ are insufficiently applied to the context. The procedure needs to be a detailed description of an experiment that another student could follow and specific to this context.
- It is essential that all solutions are measured or controlled by volume and solids are measured by mass. Some candidates used general statements such as ‘measure the amount of salt’.

Question 4

(a) Comprehensive responses

- Some candidates correctly circled P on the diagram and drew the correct symbol for a resistor in the provided box.

Limited responses

- Many candidates omitted to indicate the position in the circuit where the resistor should be placed.
- Incorrect symbols for the resistor were often seen. A fuse or a variable resistor were common incorrect answers.

(b) (i) Comprehensive responses

- Candidates considered the scales carefully and worked out what each minor resolution line represented to give the correct answers 1.35 (V) and 0.30 (A).

Limited responses

- Some candidates assumed that the minor resolution lines each represented 0.1, leading to incorrect answers such as 1.7 V and 0.6 A.

(ii) Comprehensive responses

- Almost all candidates correctly calculated the resistance. Values carried forward was allowed from incorrect readings of voltage and/or current earlier in the question.

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(c) (i) Comprehensive responses

- The question asked for the position to be recorded to the nearest 0.1 cm. This instruction was usually obeyed, with the correct answer, 70.7 being the most seen answer,

(ii) Comprehensive responses

- Some candidates used specific language to describe the difficulty, such as stating that the measurement or scale were hidden by the wide clip.

Limited responses

- Many candidates gave vague responses such as 'you can't see the ruler' (the whole ruler is not obscured) or the clip is too wide' which does not describe the difficulty in determining the position.

(iii) Comprehensive responses

- Many answers correctly identified that the clips are less than 50.0 cm apart.

Limited responses

- Some incorrect responses stated that 'the clips are in the wrong place' which does not give any additional information to that in the question.

(d) (i) Comprehensive responses

- In common with **4 (b)(i)**, some candidates took care to consider the scale and the values for the minor lines before taking a reading.

Limited responses

- In common with **4 (b)(i)** some candidates did not consider that the minor lines do not automatically represent 0.1.

(ii) Comprehensive responses

- Some candidates substituted and computed the value correctly and considered the instruction to 'Give your answer to three significant figures'.
- It should be noted that values carried forward was allowed from incorrect values given in **4 (d)(i).**

Limited responses

- Although most candidates substituted correctly, the instruction to provide an answer correct to three significant figures was not always followed.

(e) (i) Comprehensive responses

- Many candidates correctly substituted their value for R_1 into the provided expression and computed the answer correctly.

Limited responses

- A common incorrect answer was to substitute the value for R_2 rather than R_1 into the expression.

(ii) Comprehensive responses

- There are a wide range of correct approaches to this question. The most common correct approach is to calculate the percentage difference between the two values and compare this to 10 per cent.
- Other corrected approaches included calculating a 10 per cent increase in the lower value or a 10 per cent decrease in the higher value.
- Many candidates used a viable method and stated a correct conclusion.

Limited responses

- Some candidates were unable to devise a suitable method for identifying whether the two values were 10 per cent apart.
- Some gave a statement 'the two values are close together' without justifying their answer with a calculation. A supporting calculation would have strengthened these responses.

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(f) **Comprehensive responses**

- Some candidates stated that the readings would exceed those of the available scale on the voltmeter and/or ammeter. Some candidates made this point clearly.

Limited responses

- Some candidates only talked about either the readings or the voltmeter/ammeter and did not make a logical connection between the two. Answers such as ‘the readings would be high’ or ‘the voltmeter or ammeter have a small scale’ were insufficient.

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COMBINED SCIENCE

Paper 0653/62
Alternative to Practical

Key messages

Teachers are reminded that practical work is a key part of the Combined Science IGCSE course and it is not intended that practical skills are taught solely through the use of past paper questions. It was clear from some responses that some candidates had limited experience of practical work. Teachers can find guidance on the requirements for the practical component in ***Section 4*** at the back of the syllabus.

Candidates need to be familiar with the Notes for Quantitative Analysis that can be found in the syllabus and are also printed on the final page of the question paper, as these are often needed to answer some of the chemistry questions – in this case, **3(e)**.

What candidates did well

- Candidates engaged fully with the questions and there were few questions left unattempted.
- Some candidates made very good use of the data, information and instructions given within the questions. They engaged with the contexts, and extracted necessary information from experimental procedures and results.
- Some candidates took care to follow instructions carefully, for example to 'record to the nearest 0.1 seconds' or 'give your answer to two significant figures'.
- Candidates typically did mathematical calculations well. They substituted numbers and calculated answers correctly.

What candidates needed to improve

- Candidates needed to follow all instructions given in the questions. For example, if asked to record a value to the nearest mm, as in **Question 1(a)(ii)**, then recording it to the nearest centimetre is not going to be sufficient. In **Question 4(c)(i)**, candidates were asked to record a value to the nearest 0.1 seconds. The .0 needs to be included if the value is a whole number of seconds. 11.0 s would be the correct answer whereas just 11 s alone would not be.
- Some candidates would benefit from looking at the guidance in the syllabus about constructing graphs. Many candidates did not label the axes appropriately. For example, they did not use the words from the column headings of the table or they missed out the units.

Comments on specific questions

Question 1

(a) (i) Comprehensive responses

- Candidates drew a clear pencil drawing that filled more than half of the box in both directions. The diagram did not touch the lines that formed the box and was approximately the same shape as the tomato shown in Figure 1.1.
- The outer outline was a single, freehand pencil line with no breaks or joints.
- They included sufficient detail for it to be an accurate biological diagram, in this case the detail included the seeds and the crescent shaped structures in which the seeds can be found.

Limited responses

- Candidates drew a generic or 3D diagram of a slice of tomato that did not look like the one in Figure 1.1. Some candidates shaded or coloured in their diagram, which is not correct as a biological line diagram needs to be clear. The details such as the seeds would be missing in a limited response example and the outer edge of the tomato would be not drawn using a continuous line. Some candidates drew around a protractor, resulting in a diagram that was not freehand.

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(ii) Comprehensive responses

- A correct value measured to the nearest whole millimetre and not centimetre.

Limited responses

- A value given in centimetres or a fractional number of millimetres e.g. 11.2 mm.

(iii) Comprehensive responses

- A value recorded to the nearest whole millimetre and a line or other indication showing the start and end points of their measurement.

Limited responses

- Many candidates did not include a line or double headed arrow or other indication on their diagram and so it was not possible for examiners to confirm the candidate's measurement as they did not know where the candidate's measurement started and ended.

(iv) Comprehensive responses

- A correctly calculated magnification with a minimum of two significant figures calculated using the formula given in the question.

Limited responses

- Some candidates calculated the magnification incorrectly by dividing d by D instead of the other way round.

(b) Comprehensive responses

- Many candidates were able to describe the appearance of DCPIP as being colourless for the positive test or used the word decolorise or stated 'no colour'.

Limited responses

- Some candidates referred to other colours or used the word 'clear', which means that something can be seen through. It is possible for something to be both, for example, blue and clear at the same time e.g. copper sulfate solution.

Question 2

Comprehensive responses

- Candidates who answered this question fully ensured that they included details that addressed all five of the bullet points given in the question.
- They gave the correct scientific name of suitable apparatus and explained what it would be used for.
- In the method section they gave sufficient detail that another candidate could use it to obtain results. In this question it was necessary to mention how the juice would be extracted from the tomato e.g. cutting it with a knife or mashing it or even just juicing it. It was then essential for the Benedict's solution and tomato juice to be heated to initiate the reaction that may cause the colour change.
- In the measurement section candidates explicitly told the examiner that they would look at the initial colour of the Benedicts and the final colour of it after heating. They used specific scientific terminology such as volume or mass rather than amount.
- Candidates gave a suitable range of factors that must be kept constant to ensure the experiment was valid.
- Unusually in this question it was not necessary to describe a graph and more comprehensive responses explained what the colour of the Benedict's solution would be for both a positive and negative test for reducing sugars.

Limited responses

- It was common for examiners to see missing details such as no means of heating the Benedict's solution or no detail given as to how the juice of the tomato may be extracted.
- In more limited responses candidates did not explain that the juice would need to be extracted from the tomato, instead thinking that you could just heat a whole tomato or just add Benedict's to a tomato without any heating.
- In other limited responses, candidates said that they would look for a colour change without saying that this involved looking at the initial and the final colour of the Benedict's solution. Vague terminologies such as amount rather than technical terms such as volume and mass were used.

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- Irrelevant control variables would be mentioned such as the same size of beaker.
- The processing results section was commonly missing in the limited answers.
- Another reason for a limited response was one that did not address all five of the bullet points given in the question.

Question 3

(a) Comprehensive responses

- A comprehensive response included all three measurements of mass correctly rounded to 2 decimal places.

Limited responses

- Some candidates only wrote down the numbers from the balances in Figure 3.1 without either rounding or truncating the answer. Greater attention to the instruction to record the readings to 2 decimal places would have strengthened these responses. Some candidates truncated all the answers rather than correctly rounding up where this was necessary.

(b) Comprehensive responses

- Candidates said that the zinc carbonate should be heated and the mass re-measured and this process repeated until the mass did not change.
- Some candidates gave answers about adding acid and looking for effervescence and, whilst this was not the answer that was anticipated by the author of the paper, it showed a good understanding of the process involved.

Limited responses

- It was common for candidates just to reheat the zinc carbonate without mentioning to check that the mass was remaining constant. Some candidates mentioned looking for a gas to be produced instead of effervescence. A gas usually cannot be seen and so was not a valid observation whereas bubbles of gas would be able to be observed.

(c) (i) Comprehensive responses

- Candidates needed to subtract M_1 from M_3 and most candidates were able to do this.

Limited responses

- Some candidates added the values of M_1 and M_3 together rather than subtracting and others attempted to find an average of some combination of the three values in Table 3.1.

(ii) Comprehensive responses

- Candidates needed to subtract M_1 from M_6 and most candidates were able to do this.

Limited responses

- It was common for candidates to add the values together.

(iii) Comprehensive responses

- Candidates correctly used their two values from the previous questions, showed the full working out including the multiplication by 100, gave their final answer to this calculation (64.8) and then correctly rounded it to the two significant figures (65) required by the question.

Limited responses

- More limited responses only included a final answer that was incorrect or not given to two significant figures. Showing working out would have helped to demonstrate the method used.

(d) Comprehensive responses

- Candidates understood that a yellow flame would add a black coating of soot to the test tube and affect the mass. Others realised that the blue flame was hotter or that yellow was not hot enough to start the decomposition of the carbonate.

Limited responses

- Limited responses tended to include wording such as a blue flame being ‘stronger’ rather than hotter or getting it the wrong way around and telling the examiner that a yellow flame was hotter than a blue one.

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(e) Comprehensive responses

- Some candidates were able to draw a table with two columns with one of these columns having a heading that allowed them to write the names of the reactants in the column and the other column having a heading that allowed them to describe what they would see if they were to do the test.
- The observations were phrased in terms of bubbling or fizzing or effervescence rather than a gas being evolved or carbon dioxide being produced (as the production of a gas is not visible whereas bubbling is).
- For the final two tests a comprehensive answer describing the formation of a white precipitate or solid that then dissolves to form a colourless solution was seen.

Limited responses

- Some candidates drew diagrams of apparatus and equipment rather than designing a table that could accommodate the observations.
- Other candidates did not give enough detail about their observations such as describing gases being evolved or not saying that the white precipitate would then dissolve or that the solution would become colourless.

Question 4

(a) (i) Comprehensive responses

- Candidates correctly measured the distance d and gave their answer to the nearest 0.1 centimetre, with responses typically close to 4.0 cm.

Limited responses

- Many candidates measured a distance that was not accurate and so was out of the range allowed or they just recorded the whole number of 4 without putting the .0 on the end.

(ii) Comprehensive responses

- Candidates correctly multiplied their previous answer by 10 and wrote it in the correct cell of the table.

Limited responses

- It was unusual to see an incorrect answer to this question.
- Some candidates who wrote (for example) 4.1 in the previous question (and so should have written 41 in the cell) wrote 40 instead.

(iii) Comprehensive responses

- Candidates applied their experience of similar experiments carried out in lessons to give a reasonable suggestion as to why it would be difficult to measure the distance D. Typically this was the idea that the ruler is shorter than the gap size or that the centre of the rods are circular and so there is uncertainty as to where the centre of these would be.

Limited responses

- A more limited response did not include sufficient detail such as ‘it was difficult to keep the ruler steady’ without explaining why or that it was just difficult to measure the distance D without explaining that their ruler was too short. Comments along the lines of ‘it would not be accurate’ without giving any information as to why this would be the case were relatively common.

(iv) Comprehensive responses

- Most candidates correctly gave the correct answer to this question and wrote the correct value in the table.

Limited responses

- It was rare to see an incorrect answer to this question. The table was often left blank when candidates did not provide the correct response.

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(b) **Comprehensive responses**

- Candidates correctly chose the third option.

Limited responses

- Candidates chose an incorrect option, with the second choice being a common incorrect answer.

(c) (i) **Comprehensive responses**

- Most candidates correctly rounded the values from the stopwatches and wrote these in the correct places in the table.

Limited responses

- In more limited responses, one or other of the values would be incorrect or incorrectly rounded. Other candidates omitted the .0 in the value on the first stopwatch.

(ii) **Comprehensive responses**

- Most candidates correctly calculated the average time for 10 oscillations and recorded this to the same level of precision as the other numbers in the table, to the nearest one decimal place or 0.1 s.

Limited responses

- Some candidates were not able to calculate the average time and others gave this to a larger number of decimal places than the values already printed in the table, so the value was not given to the same level of precision as the other values in the table.

(iii) **Comprehensive responses**

- Both values were correctly given such that the values were given to the same number of decimal places within each column, 2 decimal places in the T column and 1 decimal place in the T^4 column.

Limited responses

- Some candidates gave the period to either an insufficient or too large number of decimal places and some candidates were unable to calculate the correct value of T^4.

(iv) **Comprehensive responses**

- Candidates gave correct answers in terms of human reaction time or that the time would be too short to measure for just one swing.

Limited responses

- Some candidates gave vague answers about ‘it not being accurate’ without explaining why this would be the case. Others gave answers about calculating an average.

(d) (i) **Comprehensive responses**

- Candidates who answered this question well followed the guidance in the mathematical requirements section of the syllabus (***Section 4***) and followed the conventions used for correctly drawing a graph.
- Graphs included axis labels that matched those from the table (T^4/s^4 on the vertical and D^2/cm^2 on the horizontal) and included the units. Their graphs had scales that increased by equal increments and so produced plots that were easy to plot without needing a calculator to check the position. The plots were either small crosses or small dots and were accurately plotted.

Limited responses

- Where candidates gave more limited responses it was usually because they had omitted the units on the axes, used scales that did not use most of the graph paper or had scales that increased by unequal increments. Limited responses usually had incorrect plots (often caused by trying to use the unsuitable scale) or used blobs rather than crosses and so it was not possible for examiners to accurately locate the centre of their plot accurately.

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(ii) Comprehensive responses

- Candidates recognised that the line of best fit was a straight line and drew a thin continuous line using a ruler, such that there was an even distribution of points on either side of the line.

Limited responses

- Some candidates did not use a ruler or drew a line that joined the dots in a dot-to-dot fashion. Some candidates who did use a ruler did not ensure there was an equal balance of points on either side of the line. Some candidates just joined the first and last point with a straight line and this also did not ensure an even spread of points on either side of the line.

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COMBINED SCIENCE

Paper 0653/63
Alternative to Practical

Key messages

What candidates did well
- Candidates identified anomalous results on a graph.
- Candidates read values from a variety of scales.
- Candidates calculated changes in sets of data.
- Candidates planned a valid investigation to determine a relationship, identifying variables.

What candidates needed to improve
- Candidates should make sure they give numerical answers in the form they are asked, e.g. to 2 significant figures, or to the nearest 0.05 A.
- Lines of best fit should exclude anomalous results and spread the graph plots equally on each side of the line.
- Graph axes need to be labelled fully, including any units.

Comments on specific questions

Question 1

(a) (i) Comprehensive responses
- Many candidates were able to measure the diameter and length of the cylinder and gave their answers to the nearest 0.1 cm.

Limited responses
- Some candidates measured incorrectly and needed to give their answer to the nearest 0.1 cm.

(ii) Comprehensive responses
- Candidates were able to use their measurements from **1(a)(i)** to calculate the volume.

Limited responses
- Candidates needed to give their answer to two significant figures.

(b) (i) Comprehensive responses
- Some candidates recorded the final mass in the table.

Limited responses
- Many candidates needed to round the mass reading, so it followed the pattern in the table.

(ii) Comprehensive responses
- Most candidates recorded the change in mass correctly in the table for the two cylinders.

Limited responses
- Some candidates needed to include a + or – sign with their calculation.

(iii) Comprehensive responses
- Many candidates used their results to correctly estimate the concentration of sugar.

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Limited responses

- Some candidates needed to be able to analyse the data from the table to estimate when no change would occur.

(iv) Comprehensive responses

- Some candidates suggested a change that would narrow down concentration to use.

Limited responses

- Most candidates suggested repeating the experiment or using a higher concentration. Candidates need to state that using smaller intervals between the range they identified in **(b)(iii)** would give them a more exact estimate.

(v) Comprehensive responses

- Some candidates correctly stated the pattern in the results. They clearly stated when the mass increased and decreased.

Limited responses

- Some candidates stated the effect on the change in mass as the concentration increased.

(c) (i) Comprehensive responses

- Many candidates suggested the water on the outside of the potato would add extra mass.

Limited responses

- Candidates needed to clearly state why the water was removed.

(ii) Comprehensive responses

- Few candidates realised the same length and diameter were needed to control the surface area.

Limited responses

- Many candidates needed to be more specific than ‘make them the same size’.

Question 2

(a) (i) Comprehensive responses

- Most candidates read the thermometers correctly and recorded their responses as directed in the question.

Limited responses

- Some candidates needed to round their answer to follow the pattern of decimal places in the table.

(ii) Comprehensive responses

- Many candidates recorded the temperature increases correctly in the table.

Limited responses

- Some candidates needed to use the information in the question that gave them the starting temperature.

(b) (i) Comprehensive responses

- Many candidates used sensible, linear scales and plotted the results accurately.

Limited responses

- Some candidates needed to include a label for each axis. This label should contain the unit.

(ii) Comprehensive responses

- Most candidates identified the anomalous result.

Limited responses

- Candidates occasionally missed answering this question.

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(iii) Comprehensive responses

- Well drawn lines of best fit had an even spread of plots around the line. Candidates used a sharp pencil to draw a continuous line.

Limited responses

- Candidates did not draw their line so there was an even distribution of points. Many candidates did not draw a line of best fit and joined their points by drawing a line between each.

(iv) Comprehensive responses

- Some responses demonstrated an understanding that the actions should be specific to the anomalous result.

Limited responses

- Most candidates suggested 'repeating the experiment'. Candidates needed to be more specific and state which volume needed to be repeated.

(v) Comprehensive responses

- Few candidates linked the concept of proportionality to the line they had drawn on their graph.

Limited responses

- Candidates need to recognise what patterns on a graph show in terms of proportionality.

(c) Comprehensive responses

- Some candidates used the Procedure given at the start of the question and identified that a wide range of volumes was used. This meant they went on to explain in terms of accuracy.

Limited responses

- Candidates used terms such as 'reliable' and 'precise'. Candidates need to know the meanings of these words and be able to use them correctly.

(d) Comprehensive responses

- Candidates identified variables to control that would affect the temperature change. They named ways to make sure the chemicals were well mixed or ways to stop heat escaping from the beaker.

Limited responses

- Some candidates needed to say more than 'repeat' and include why it is important to repeat an experiment.

Question 3

(a) Comprehensive responses

- Most candidates read the scale correctly.

Limited responses

- Candidates need to be able to record data to a given number of decimal places.

(b) Comprehensive responses

- Candidates drew the resistor correctly on Figure 3.1.

Limited responses

- Candidates confused where to place components in series and parallel circuits.

(c) Comprehensive responses

- Many candidates read the scale following the instruction in the question.

Limited responses

- Candidates need to include the correct number of decimal places as directed in the question.

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(d) **Comprehensive responses**

- Candidates calculated the percentage difference between the two values and clearly stated if they were within the limits of experimental error. Some candidates calculated a 10 per cent increase or decrease on one of the values.

Limited responses

- Candidates needed to state the two values and carry out a calculation to give evidence for their conclusion.

(e) **Comprehensive responses**

- Most candidates used the equation correctly to calculate the current.

Limited responses

- Few candidates used incorrect values or carried out the wrong calculation.

(f) **Comprehensive responses**

- Candidates understood the Procedure given and were able to use this with their knowledge of circuits, to state why the current would be decreasing.

Limited responses

- Candidates confused what would happen when the switch was open and closed. Candidates need to understand the ammeter is indicating the current flow in the circuit and be able to explain why, in this context, the current would be lower.

Question 4

Comprehensive responses

- Candidates listed equipment that was relevant to the investigation, making it clear what they would use it for.
- Candidates gave their methods in bullet points.
- Methods clearly stated the independent and dependent variables.
- It was clear what candidates were going to measure to get valid results.
- Candidates stated variables that needed to be controlled.
- The processing of results was shown by giving the axes for a graph or by saying how y could be calculated.

Limited responses

- Candidates described a different experiment. A common experiment was to investigate moments by changing the placement of a mass.
- It was not clear how y would be measured.
- Candidates need to identify the variables to control in this experiment.
- Candidates need to follow the bullet points given in the question to make sure they include the key areas.

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