COMBINED SCIENCE

Paper 0653/11
Multiple Choice (Core)

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

General comments

Candidates performed well on **Question 5**, **6**, **12**, **22**, **29** and **39**. **Questions 4**, **7**, **17. 18, 24**, **25**, **26** and **38** proved challenging for candidates.

Comments on specific questions

Question 1

Most candidates correctly identified nutrition although some selected options **C** and **D**, excretion and reproduction, respectively.

Question 3

Many candidates selected the correct answer, **C**. However, option **D** was a common incorrect answer.

Question 4

Many candidates incorrectly selected option **D** (–20 °C). Candidates needed to make the link that at this temperature water would have been frozen and therefore the enzyme and substrate would not be able to move freely around the cell.

Question 5

Most candidates knew the definition for a balanced diet.

Question 6

Where candidates selected an incorrect option, they mostly chose option **C**. With this option, they got the size change of the molecules correct (large → small), but not the solubility of the molecules (they incorrectly chose soluble → insoluble).

Question 7

Many candidates answered this incorrectly. Water vapour exits the stomata by diffusion. Candidates frequently chose evaporation, osmosis and respiration.

Question 8

Most candidates correctly identified limewater as the test for carbon dioxide. Some candidates incorrectly opted for Benedict's solution.

Question 9

Most candidates incorrectly selected option **C** for this question (phototropism). The plant was grown in a light-proof box. The plant could not grow towards or away from the light as there was no available light. In this instance, the plant could only respond to gravity.

Question 10

A significant proportion of candidates incorrectly selected option **D**, they correctly identified sexual reproduction as having more than one parent and the process producing a zygote, but incorrectly thought that the offspring were not genetically identical.

Question 11

A majority of candidates chose the correct answer although some thought that the journey started at the prostate gland.

Question 12

Most candidates correctly identified producers, option **D**.

Question 13

Many candidates selected the correct option, but all options were popular choices.

Question 17

Many candidates selected the incorrect answer, option **C**, rather than the correct answer, option **A**. Candidates are expected to understand that boiling water is endothermic as it takes in thermal energy, whilst freezing water is exothermic as it transfers thermal energy to the surroundings.

Question 18

Candidates frequently chose incorrect option **D** rather than correct option **C**. Candidates are expected to describe the apparatus and methods used when investigating a reaction in which a gas is produced.

Question 22

Most candidates were familiar with the relative positions of metals and non-metals in the Periodic Table.

Question 23

Candidates chose incorrect option **B** more often than correct option **D**. Candidates should know that metals combine with non-metals forming ionic compounds, and that transition metals form coloured compounds. They should also be able to deduce the formulae of simple ionic compounds.

Question 24

Candidates chose incorrect options **A**, **B** and **D** more often than correct option **C**. Candidates should know that carbon is less reactive than aluminium oxide, so it does not react with aluminium oxide. They should also know that steam reacts with zinc to form zinc oxide and hydrogen.

Question 25

Candidates chose incorrect options **A** and **C** more often than correct option **B**. Candidates are expected to know that carbon dioxide is a product of respiration, rather than being used up during respiration.

Question 26

Candidates chose incorrect options **A**, **B** and **C** more often than correct option **D**. Candidates should know that alkanes are saturated, generally unreactive compounds of carbon and hydrogen only. They should also know that water is a product of the combustion of alkanes.

Question 28

Although the correct option, **D**, was the most frequently chosen option, option **A** was also a popular choice. Option **A** is a graph which corresponds to a speed that is constant but not zero rather than an acceleration that is constant and not zero.

Question 32

The correct answer. option **B**, was the most popular, but each of the other three options was chosen by a significant number of candidates.

Question 36

Candidates needed to recall that the angle of reflection is measured between the normal and the reflected ray. There was a small amount of deduction involved as it was necessary to deduce from the arrows on the diagram which ray was the incident ray, and which was the reflected ray. Options **B** and D were chosen by a significant number of candidates.

Question 38

Some candidates were unsure of the position of the meters in the circuit. The correct option, **D**, was selected by a minority of candidates and each of the options were chosen by a significant number of candidates.

Question 40

Option **C** is the correct answer and was chosen by the most candidates, but options **A** and **B** were chosen by a similar number of candidates. Candidates should be able to recall the circuit symbols given in the syllabus.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice (Core)

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

General comments

Candidates performed well on **Questions 7**, **8**, **12**, **18**, **25**, **29**, **30** and **36**. **Questions 11**, **15**, **17**, **24** and **33** proved the most challenging for candidates.

Comments on specific questions

Question 1

While a majority of candidates chose the correct option **D**, a number of candidates incorrectly chose option **C**. In both cases, candidates identified that osmosis involves water, but some thought movement was across the cell wall rather than a partially permeable membrane.

Question 2

Some candidates incorrectly selected option **B** (proteins being composed only of carbon and hydrogen). proteins contain carbon, hydrogen, nitrogen and oxygen.

Question 3

Most candidates chose the correct option (protein), however a significant proportion incorrectly thought that enzymes are made of starch.

Question 4

Most candidates correctly linked the organ to its function. Some candidates selected option **A**, thinking that the functions of the large intestine are absorption and ingestion.

Question 5

Most candidates chose the correct option (ingestion).

Question 6

The correct option was the most chosen answer although some candidates thought that the bubble would not move.

Question 7

Most candidates knew that limewater is used to test for carbon dioxide.

Question 8

Some candidates incorrectly selected option **A**, the equation for photosynthesis, or option **C**, a mixture of the substrates and products of photosynthesis and respiration.

Question 9

Some candidates incorrectly selected option **D**, roots grow towards gravity and towards light. Candidates should be aware that roots grow towards gravity and away from light.

Question 10

Most candidates got this question correct, although a few candidates selected option **B**. This indicated that the candidates had recognised that asexual reproduction had a single parent.

Question 11

Most candidates incorrectly selected option **C**. This option described pollination of flowering plants, not fertilisation.

Question 12

Most candidates correctly identified the prostate in the diagram. Where candidates answered incorrectly, they most often chose the testes.

Question 13

Most candidates realised that decomposers release carbon dioxide and selected the correct option, **A**.

Question 15

This question was often answered incorrectly. Candidates should understand that tap water is a solution containing dissolved substances.

Question 17

Candidates chose the incorrect option **C** more often than the correct option, **B**. Candidates should know that sodium carbonate, a base, is neutralised by acids, and that this reaction is exothermic. They should also know that thermal decomposition reactions only occur with the application of large amounts of thermal energy.

Question 20

Candidates chose the incorrect option **C** more often than the correct option, **A**. Candidates are required to know that metals react with acids to produce a salt and hydrogen gas, whilst metal hydroxides react with acids to produce a salt and water.

Question 23

Candidates chose the incorrect option **B** more often than the correct option, **C**. Candidates are required to know the position of the transition elements in the Periodic Table, and that transition elements and their compounds act as catalysts to increase the rate of some reactions.

Question 24

A small number of candidates chose the correct answer, **A**. Candidates are expected to know that copper is low in the reactivity series and that it does not react with dilute hydrochloric acid.

Question 26

Option **B** was a popular incorrect choice. Candidates should know that alkanes are saturated hydrocarbons, and that their molecules contain only single C–C and C–H bonds.

Question 27

Incorrect options **A**, **B** and **D** were popular choices. Candidates are required to know that cracking is a reaction that produces alkenes.

Question 33

Metals are typically good thermal conductors and plastics are typically poor thermal conductors. Option **B** can be excluded as the objects have been in the freezer for several days and will be at the same temperature. This option however, proved to be the most popular choice.

Question 34

The uses of the different regions of the electromagnetic spectrum are many and varied and the syllabus includes the use of microwaves in transmitting satellite television, option **B**. Option **C** was more commonly selected than the correct option.

Question 35

Candidates had to recall the range that the frequencies of audible sounds are found in and then exclude those options that lie within that range. The majority of candidates were able to do this successfully, but many chose one of the other options.

Question 39

There are two separate skills required to answer this question. One is to recognise the electrical components that the symbols in the options represent whist the other is to understand what the components are used for. It would be possible to imagine a circuit in which any of the components represented have a protective function but only the fuse has no other function.

COMBINED SCIENCE

Paper 0653/13
Multiple Choice (Core)

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

General comments

Candidates performed well on **Questions 5**, **8**, **12**, **14**, **18**, **25**, **29**, **30** and **40**. **Questions 9**, **11**, **15**, **17**, **24**, **27** and **33** proved more challenging for candidates.

Comments on specific questions

Question 1

While a majority of candidates chose the correct option **D**, a number of candidates incorrectly chose option **C**. In both cases, candidates identified that osmosis involves water, but some thought movement was across the cell wall rather than a partially permeable membrane.

Question 2

Some candidates incorrectly selected option **B** (proteins being composed only of carbon and hydrogen). proteins contain carbon, hydrogen, nitrogen and oxygen.

Question 3

Most candidates chose the correct option (protein), however a significant proportion incorrectly thought that enzymes are made of starch.

Question 4

Most candidates correctly linked the organ to its function. Some candidates selected option **A**, thinking that the functions of the large intestine are absorption and ingestion.

Question 5

Most candidates chose the correct option (ingestion).

Question 6

The correct option was the most chosen answer although some candidates thought that the bubble would not move.

Question 8

Some candidates incorrectly selected option **A**, the equation for photosynthesis, or option **C**, a mixture of the substrates and products of photosynthesis and respiration.

Question 9

Some candidates incorrectly selected option **D**, roots grow towards gravity and towards light. Candidates should be aware that roots grow towards gravity and away from light.

Question 11

Most candidates incorrectly selected option **C**. This option described pollination of flowering plants, not fertilisation.

Question 13

Most candidates realised that decomposers release carbon dioxide and selected the correct option, **A**.

Question 15

This question was often answered incorrectly. Candidates should understand that tap water is a solution containing dissolved substances.

Question 17

Candidates chose the incorrect option **C** more often than the correct option, **B**. Candidates should know that sodium carbonate, a base, is neutralised by acids, and that this reaction is exothermic. They should also know that thermal decomposition reactions only occur with the application of large amounts of thermal energy.

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Candidates chose the incorrect option **C** more often than the correct option, **A**. Candidates are required to know that metals react with acids to produce a salt and hydrogen gas, whilst metal hydroxides react with acids to produce a salt and water.

Question 23

A number of candidates chose the incorrect option **B** more often than the correct option, **C**. Candidates are required to know the position of the transition elements in the Periodic Table, and that transition elements and their compounds act as catalysts to increase the rate of some reactions.

Question 24

A small number of candidates chose the correct answer, **A**. Candidates are expected to know that copper is low in the reactivity series and that it does not react with dilute hydrochloric acid.

Question 26

Option **B** was a popular incorrect choice. Candidates should know that alkanes are saturated hydrocarbons, and that their molecules contain only single C–C and C–H bonds.

Question 27

Incorrect options **A**, **B** and **D** were popular choices. Candidates are required to know that cracking is a reaction that produces alkenes.

Question 33

Metals are typically good thermal conductors and plastics are typically poor thermal conductors. Option **B** can be excluded as the objects have been in the freezer for several days and will be at the same temperature. This option however, proved to be the most popular choice.

Question 34

The uses of the different regions of the electromagnetic spectrum are many and varied and the syllabus includes the use of microwaves in transmitting satellite television, option **B**. Option **C** was more commonly selected than the correct option.

Question 35

Candidates had to recall the range that the frequencies of audible sounds are found in and then exclude those options that lie within that range. The majority of candidates were able to do this successfully, but many chose one of the other options.

Question 39

There are two separate skills required to answer this question. One is to recognise the electrical components that the symbols in the options represent whist the other is to understand what the components are used for. It would be possible to imagine a circuit in which any of the components represented have a protective function but only the fuse has no other function.

COMBINED SCIENCE

Paper 0653/21
Multiple Choice (Extended)

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

General comments

Candidates performed well on **Questions 2**, **5**, **6**, **12**, **14**, **15**, **17**, **23**, **29** and **34**. **Questions 7**, **9**, **19**, **24**, **27**, **32** and **33** proved challenging for candidates.

Comments on specific questions

Question 1

Most candidates correctly selected option **B**.

Question 2

Most candidates correctly selected option **B**.

Question 3

Some candidates correctly realised that diffusion is the net movement of molecules down a concentration gradient. However, some incorrectly thought that diffusion is the total movement, rather than the net movement.

Question 4

Most candidates correctly answered this question although option **C** was a popular incorrect choice.

Question 5

Most candidates knew the definition for a balanced diet.

Question 6

Most candidates correctly interpreted the diagram and selected option **C**.

Question 7

Most candidates selected the correct option **A**. Option **B** was a common incorrect answer. This indicates that candidates identified the correct side of the heart but had the incorrect chamber contracting to close the valve.

Question 9

Some candidates incorrectly selected option **C**. If one molecule of glucose is respired, six molecules of carbon dioxide are produced. So, for six molecules of glucose, it is: 6 6 molecules of carbon dioxide = 36.

Question 10

Some candidates correctly selected option **D**. Where candidates chose an incorrect answer, option **C** was preferred.

Question 11

Most candidates identified that sexual reproduction needs more than one parent. Some incorrectly thought that genetically identical offspring are produced.

Question 12

Where candidates got this question wrong, most incorrectly thought that the stigma is inside the flower of wind-pollinated flowers.

Question 13

The correct answer was the most chosen option. Some candidates thought that X was oxygen and that it produced carbon dioxide. These candidates tried to link X and Y via combustion. X was fossil fuel; Y was carbon dioxide.

Question 14

Almost all candidates were able to identify the liquid at the given temperature from the melting point and boiling point data.

Question 15

Most candidates correctly identified that a solution is formed when a solute is dissolved in a solvent.

Question 16

Most candidates correctly identified the dot-and-cross diagram for a nitrogen molecule, including non-bonding outer-shell electrons.

Question 17

Most candidates deduced the formula of iron(III) sulfate from the charges of the ions.

Question 21

Most candidates knew that calcium oxide is a base and that aqueous solutions of bases have high pH values.

Question 23

Most candidates correctly deduced the identity of the salt formed by displacement in the reaction of fluorine with potassium iodide.

Question 26

Most candidates knew that carbon dioxide and methane are greenhouse gases that cause the enhanced greenhouse effect.

Question 27

Candidates chose the incorrect option **C** more often than the correct option, **D**. Candidates are required to know that alkanes are compounds in which only carbon and hydrogen atoms are bonded together, rather than mixed. They are also expected to know that alkanes produce water when they burn.

Question 31

This question was answered well by candidates who realised that the increase in kinetic energy was equal to the work done by the resultant force. There were candidates who calculated the work done but did not then add this value on to the original kinetic energy of the car. Option **D** was also chosen by some. This answer is obtained by multiplying the numerical values in the question together and is likely to have been the result of candidates choosing the biggest value rather than as a result of any misunderstanding that would lead to this value.

Question 32

The correct option was the most popular but each of the other three options were chosen by a significant number of candidates.

Question 33

Tides occur at predictable times and hence the energy output of a tidal power station is predictable. Some candidates incorrectly selected option **B**.

Question 36

The description of the manner in which the wave shakes the earth is essentially a definition of a transverse wave. The majority of candidates used this understanding to correctly select option **C**.

Question 37

The ray diagram shows the lens being used as a magnifying glass and the question required candidates to recognise this use from the diagram. A magnifying glass produces an image that is larger than the object and almost all candidates selected one of the two options consistent with this. Some of these candidates gave an option that indicated that the image is upside down.

COMBINED SCIENCE

Paper 0653/22
Multiple Choice (Extended)

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

General comments

Candidates performed well on **Questions 1**, **2**, **8**, **14**, **19**, **21**, **28**, **29** and **40**. **Questions 6**, **13**, **15**, **17**, **24, 31** and **39** proved challenging for candidates.

Comments on specific questions

Question 1

Most candidates answered this question correctly. Where candidates selected an incorrect option, they mostly selected option **A** or option **D**, indicating that they thought that egg cells contained chlorophyll or that root hair cells contained haemoglobin.

Question 2

Most candidates answered correctly. Some candidates incorrectly selected option **C**, indicating that they knew osmosis involved water but did not link it to a partially permeable membrane.

Question 3

Most candidates correctly selected option **C**. Some candidates incorrectly selected option **A**. Candidates should recall that the increase in enzyme activity before the optimum is due to increased kinetic energy of the substrates and enzyme.

Question 5

Most candidates correctly selected option **C**. Where candidates picked another option, this was mostly between options **B** and **D**.

Question 6

The majority of candidates answered this question correctly. Some candidates selected option **B**, indicating that they had identified that cool temperatures resulted in low transpiration, but incorrectly understood the effect of humidity on the process.

Question 7

Most candidates correctly identified that carbon monoxide combines with haemoglobin. Some candidates incorrectly thought that nicotine was the cause of lung cancer.

Question 8

Most candidates knew that limewater is used to test for carbon dioxide.

Question 9

Most candidates linked the colour of limewater to respiration occurring. Amongst candidates that did not make this link, there was a slight preference for option **A**.

Question 10

The correct option was chosen by most candidates, but options **B** and **D** were also chosen.

Question 12

The majority of candidates correctly identified the definition of fertilisation in a flowering plant. Some candidates incorrectly selected the definition of pollination.

Question 13

Most candidates selected the correct option. Some candidates incorrectly selected option **B**, but this did not include respiration in plants.

Question 14

Most candidates were able to identify the gaseous diatomic element from the diagrammatic representations.

Question 15

Candidates chose the incorrect option **B** more often than the correct answer, option **D**. Candidates should know that tap water is a solution containing dissolved substances.

Question 17

Some candidates selected the incorrect option **C** rather than the correct option, **B**. Candidates are expected to deduce the formula of a compound using the charges on the ions present.

Question 19

Most candidates understood that a reducing agent removes oxygen from metal oxides.

Question 21

Most candidates knew the effect that ammonia, a base, has on damp litmus paper.

Question 22

Some candidates selected the incorrect option **A** rather than the correct option, **C**. Candidates should understand that the position of an element in the Periodic Table is related to its electronic configuration and that this can be used to predict its relative reactivity.

Question 31

Although this question was primarily one that required the recalling of learnt facts, it was set in a context that required some application of understanding. The correct option was chosen by a minority of candidates and options **A** and **C** were both more frequently selected. Neither of these depend on energy from the Sun.

Question 34

The correct option, **A**, was chosen by more candidates than any other option. The next most commonly chosen option was **B** which is obtained by calculating the speed correctly but by supplying the reciprocal of the frequency value.

Question 38

Most candidates selected either the correct option **B** or option **D**. Both show an understanding of the equation $Q = It$ and that it needs to be rearranged correctly in order to be applied in this case. The candidates who gave answer **D**, however, had not taken into consideration the fact that the unit of the charge given in the question is mC rather than C. This led to an error of a factor of one thousand.

Question 39

Most candidates found this question demanding. The correct option is **B** but only option **A** was less popular than this choice. Candidates who selected option **C** recognised the inverse relationship with the diameter but the need to square the diameter when determining the cross-sectional area was overlooked. The candidates who were attracted by option **D** spotted the repeated word ‘double’ in the question and selected the option that was double the original value.

COMBINED SCIENCE

Paper 0653/23
Multiple Choice (Extended)

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

General comments

Candidates performed well on **Questions 1**, **2**, **11**, **14**, **15**, **23**, **33**, **34** and **35**. **Questions 5**, **7**, **12**, **16**, **20**, **25**, **38** and **39** proved more challenging for candidates.

Comments on specific questions

Question 1

Most candidates correctly selected option **A**. A small number of candidates incorrectly chose small surface area or xylem present.

Question 2

Most candidates correctly selected option **D** realising that diffusion occurs down a concentration gradient.

Question 3

Some candidates incorrectly selected option **B**, that fats are composed of carbon, hydrogen and nitrogen, but not oxygen. Fats do not contain nitrogen.

Question 4

A small proportion of candidates incorrectly selected option **C**, which was the optimum temperature for the enzyme, not the point where the enzyme was denatured.

Question 5

The majority of candidates interpreted the information correctly to determine that the correct answer was option **A**. Options **B**, **C** and **D** were nearly equally selected by incorrect candidates.

Question 6

Most candidates answered this question correctly although some candidates incorrectly selected the definition of chemical digestion.

Question 7

Candidates found this question demanding. Many candidates thought that water evaporates through the stomata. Candidates should be aware that water evaporates from mesophyll cells and diffuses through the stomata.

Question 8

Most candidates worked through the information and realised that statements 1 and 3 are required for efficient diffusion of gases.

Question 9

Whilst most candidates linked the respiration of the snail to a lack of oxygen, some did not realise that plants in the dark would not replenish this oxygen.

Question 10

Some candidates incorrectly thought that asexual reproduction produces offspring that are different to the parent whilst others incorrectly thought that asexual reproduction produces offspring that are genetically different and that a zygote is produced.

Question 12

Many candidates correctly selected option **D**. Whilst all the options in the first column use oxygen there is only one in the second column that produces it, photosynthesis.

Question 14

Most candidates identified the correct molecule from the diagrammatic representations.

Question 15

Almost all candidates knew that malleability is a general property of metals.

Question 20

Candidates chose the incorrect option **B** more often than the correct answer, option **D**. Candidates should recall that copper does not react with dilute sulfuric acid and that zinc does react because it is more reactive.

Question 23

Most candidates identified the representation of an alloy from the diagrams.

Question 24

Candidates generally knew the order of reactivity of the named metals and selected option **C**.

Question 25

Candidates chose the incorrect option **C** more often than the correct answer, option **B**. Candidates are required to identify oxidation and reduction in symbol equations.

Question 26

Candidates generally knew that both the blast furnace and that the reaction of a metal carbonate with an acid produce carbon dioxide, and that this gas contributes to the enhanced greenhouse effect.

Question 31

Most candidates knew that the energy being transferred to thermal energy was nuclear energy, but a small number did incorrectly select option **A**. Very few candidates chose incorrect options **B** or **C**.

Question 37

Most candidates selected the correct option, **D**. The reading on the meter was correctly taken and used in the equation $I = Q/t$. In this case, it was necessary to rearrange the equation before substituting the values from the question into it. The two most commonly selected incorrect answers involved the numbers from the question being substituted into an incorrectly rearranged version of this equation.

Question 38

The most straightforward way of approaching this question is to determine the effect on the resistance of the change in cross-sectional area and then to determine by how much the length must change to produce the required resistance.

Question 39

The correct option, **C**, was also the most popular choice. The most common incorrect answer was option **B**. This answer was calculated using only one of the headlamps.

Question 40

This question was correctly answered by most candidates. A common error was not to take the reciprocal of the sum of the reciprocals of the two resistances.

COMBINED SCIENCE

Paper 0653/31
Theory (Core)

Key messages

Candidates who did well in this paper were familiar with the contents of the syllabus. They read the questions carefully and were able to express their answers in a clear and legible way.

Candidates who showed correct working in their numerical answers could gain some credit even if the rest of the calculation contained an arithmetical error.

Some candidates did not understand the meaning of the term trend. The trend is the general direction in which something is changing.

General comments

There were some good responses from candidates who demonstrated a thorough knowledge of all three sciences in the syllabus. They were able to answer questions in both familiar and unfamiliar contexts.

Candidates are advised to attempt every question, especially those questions where they choose their answers from responses that are already given on the paper.

Comments on specific questions

Question 1

(a) (i) Many candidates scored well on this question. The most common error was stating that fertilisation takes place in the uterus instead of the oviducts, **A**.

(b) (i) Only a few candidates correctly stated nuclei. The majority wrote sperm. Candidates should be aware that fertilisation is the fusion of the genetic material found in the nuclei of the sperm and ovum.

(ii) Candidates found this question demanding. The question was asking candidates to describe the development of the zygote after it had formed during fertilisation. Instead, many described how the zygote was formed.

(c) (i) Most candidates used the graph appropriately to identify the correct year.

(ii) There were many correct responses from candidates who identified the overall decreasing trend. Incorrect responses did not describe the trend but instead made statements like ‘the number of cases was high in 1997 and low in 2013’. Others made incorrect statements, for example, ‘the number of cases decreased uniformly’.

(iii) Many candidates correctly stated two valid methods of transmission. There were several responses that referred to sharing sharp objects as a way of transmission of HIV. Credit was not awarded in these cases unless further explanation was supplied, for example, a knife that cut an infected person then cut a healthy person.

Question 2

(a) (i) Very few candidates knew a chemical test for water. There was no pattern to the incorrect responses which ranged from the physical appearance of water to a range of incorrect chemical analysis tests.

(ii) Many candidates drew the dot-and-cross diagram correctly. Common errors included writing an incorrect number of electrons in the covalent bonds or placing extra electrons in the orbits of both the oxygen and hydrogen atoms.

(b) (i) Most candidates correctly named a thermometer.

(ii) The most important difference between a physical change and a chemical change is that there is no new substance made in the case of a physical change. Many candidates gained credit for stating this fact. Answers which were not acceptable included descriptions of the change of state, and any explanations stating that it must be a physical change because it can be seen happening.

(iii) Generally, this question was well answered by stronger candidates. Incorrect responses included evaporation, combustion and convection.

(c) Some candidates gained full marks for this question. Among the incorrect sodium products stated were sodium hydroxide, sodium chlorine and the element sodium. Hydrogen and chlorine were often wrongly stated for the gas produced.

Question 3

(a) (i) Some candidates did the calculation $W = mg$ correctly. Others divided the mass by 10 to give 19 000 N instead of 1 900 000 N, the correct answer.

(ii) A small number of candidates identified air resistance as being a form of friction. Incorrect responses included energy, kinetic energy and gravity.

(iii) There were many correct responses to this question. The equation had to be rearranged to calculate the volume by dividing the mass by the density, i.e., 120 000 ÷ 2 800. The most common mistakes were made by those candidates who rearranged the equation incorrectly, and therefore their calculations were based on either 2 800 ÷ 120 000 or 2 800 × 120 000.

(b) Very few candidates scored full marks for this question. Kinetic energy was frequently given for either answer. Some candidates wrote gravitational for the second response instead of the complete term, gravitational potential (energy).

(c) Some of the stronger candidates answered this question correctly. The 4 h 15 min had to be converted to 4.25 h to do the calculation. Many candidates changed the time to minutes to get 255 minutes. Full credit was not given to these calculations unless the final answer was multiplied by 60 to give the correct unit for the answer.

Question 4

(a) (i) Many candidates stated the correct relationship between increased temperature and transpiration. Others stated that temperature affects transpiration without describing what happens when the temperature is increased or decreased.

(ii) Photosynthesis was correctly stated by many candidates. Other valid points included the transport of minerals, the support (of cells) and to cool the plant.

(b) (i) Many candidates identified one of the xylem vessels correctly. When adding labels to diagrams candidates should take care to make their label lines and letters clear so that their responses can be seen unambiguously.

(ii) Many candidates knew the root hair cell. Fewer knew the root cortex cells. There were several responses which stated plant cell and animal cell.

(c) (i) Most candidates gave an appropriate response to this question. A common error stated that fibre strengthens bones and muscles. Candidates are reminded that fibre passes through the digestive system unchanged, so its components do not get absorbed into the blood stream. Protein and calcium are required to build muscles and bones.

(ii) The correct answer, potatoes, was chosen by most candidates. Since fibre is only found in food that comes from plants, the other three alternative answers are animal in origin and can therefore be excluded.

(iii) Stronger candidates stated glucose to gain credit. Other responses included amylase and sucrose.

Question 5

(a) This question was generally answered well by most candidates. Some incorrectly described chemical properties. An example of this is the use of metals as catalysts.

(b) (i) Many correctly stated that a high temperature is needed. Others stated that oxygen is needed. If oxygen is present the carbon will form carbon dioxide and leave the reaction, instead of reacting with the copper oxide.

(ii) The correct statement that aluminium is more reactive than carbon was made by the stronger candidates. There were several incorrect answers. These included comparisons of boiling point, statements referring to aluminium being stronger than carbon, carbon being a non-metal and carbon being more reactive than aluminium. Although carbon is a non-metal, it is placed in the reactivity series because it can displace less reactive metals from their oxides, but not aluminium.

(iii) Very few candidates stated that bauxite is the main ore that contains aluminium. Many candidates stated aluminium oxide, the chemical contained in the ore, but not the ore itself.

(iv) Few candidates answered this correctly by stating that metals are a finite resource. The majority of responses repeated information already given in the question.

(c) (i) Some candidates gave the correct definition of an alloy which is a mixture of a metal with other elements. Others implied that the elements involved had combined chemically.

(ii) This question was generally answered well. Most candidates realised that aluminium alloys are stronger or less dense than pure aluminium.

(d) Candidates found this question demanding. Many candidates successfully identified aluminium as the substance being oxidised, but by far the most common response for the substance that is being reduced was iron. Since both correct answers were needed for this question, few candidates scored the mark. In terms of oxygen gained or lost, the aluminium gains oxygen and is therefore oxidised. The Fe_2O_3 loses oxygen and is therefore reduced.

Question 6

(a) (i) The term quantity did not appear to be widely known. In this case, the quantity is the current. It is measured by the ammeter, and the unit of measurement is the amp. There were many incorrect electrical terms given, for example, volts and ohms.

(ii) Many diagrams showed the correct symbol for the voltmeter, but relatively few candidates placed the voltmeter in the correct place. Common errors included putting the voltmeter in series or placing it in parallel across the ammeter.

(iii) Many candidates carried out the calculation correctly to give the answer 15 Ω. Among those who calculated 15 correctly, some gave the wrong unit. Common errors included using the resistance equation incorrectly, stating $0.24 \div 3.6$, 0.24×3.6, and occasionally $0.24 + 3.6$.

(b) (i) Candidates found this question demanding. The circuit shown in Fig. 6.1. has now changed to include a second identical resistor in series in the circuit. The total resistance of the circuit has now increased. Using the formula $R_T = R_1 + R_2$ the total resistance has now become twice as big as earlier, 30 Ω. Therefore, the new current is $3.6 \div 30 = 0.12$ A. Many candidates stated that the

current would be the same as before. They did not appreciate that the resistance of the circuit had increased.

(ii) This question was challenging to most candidates. The total resistance of the circuit is reduced when a second resistor is placed in parallel in the circuit. As a result, the current increases. Some candidates stated that the current would be different without giving a meaningful explanation.

Question 7

(a) (i) Most candidates drew their arrows correctly to show the feeding relationships from the carp to the heron and from the heron to the alligator. Some candidates placed their arrow heads at the wrong end of the line. Candidates should be aware that the arrows show the direction of transfer of energy.

(ii) Most candidates correctly identified a producer.

(iii) Most candidates identified the consumers correctly. Some wrote first and/or third as their responses. These were not awarded credit because the terms for these feeding relationships are clearly shown as primary and tertiary (consumers) in the syllabus.

(b) Stronger candidates quoted the word equation accurately. Others either gave the equation for photosynthesis or an equation containing the right components but in a random order.

(c) (i) Many candidates scored full credit here. The most common mistake occurred when candidates wrote throat or trachea instead of oesophagus.

(ii) Most candidates correctly circled egestion.

Question 8

(a) (i) Many candidates gained the mark for this question. The most common error seen was by candidates who drew 8 electrons in the outer shell.

(ii) Most candidates correctly deduced that the atom has 18 neutrons.

(b) (i) Most candidates correctly stated electrolysis.

(ii) Candidates found this demanding. Generally, candidates were unfamiliar with the products of the electrolysis of concentrated sodium chloride.

(c) (i) Some candidates gave a correct explanation of the term diatomic, a molecule containing two atoms. Incorrect responses stated two molecules, two electrons or two elements. Some responses described diatomic in terms of reactivity.

(ii) Either physical or chemical properties were accepted in this question. Many candidates gained at least one mark. A common error occurred when candidates described the trend in the wrong direction, for example, the elements become more reactive going down the group.

(d) Most candidates correctly completed the sentences about water treatment.

Question 9

(a) (i) Most candidates successfully completed the electromagnetic spectrum.

(ii) Many candidates gained at least partial credit. The most common error stated that visible light is used to scan baggage. Visible light would not be able to penetrate the luggage case to see what is inside.

(b) Very few candidates answered this correctly. The lower pitch is shown by wave **A** since the waves have a lower frequency. The larger amplitude in wave **A** also makes this the louder sound.

(c) (i) Very few candidates answered this question correctly. Many appeared unfamiliar with the term focal length, in this case the distance from the centre of the lens to one of the focal points.

(ii) Candidates found this question demanding. Some gained credit by continuing the rays that passed through the centre of the lens to the ends of the pencil. Most responses did not show the refracted rays correctly.

COMBINED SCIENCE

Paper 0653/32
Theory (Core)

Key messages

Candidates who did well in this paper were familiar with the contents of the syllabus. They read the questions carefully and were able to express their answers in a clear and legible way.

Candidates who showed correct working in their numerical answers could gain some credit even if the rest of the calculation contained an arithmetical error.

Many candidates would have scored higher credit by being more familiar with the chemistry part of the syllabus, particularly **8(a)** and **2(b)(iv)**.

General comments

There were some good responses from candidates who demonstrated a thorough knowledge of all three sciences in the syllabus. They were able to answer questions in both familiar and unfamiliar contexts.

Candidates are advised to attempt every question, especially those questions where they choose their answers from responses that are already given on the paper.

Comments on specific questions

Question 1

(a)(i) Most candidates identified a bronchus and the trachea correctly. The main error occurred when candidates stated **D**, the alveoli, instead of the bronchus.

(ii) Many candidates successfully selected the pulmonary vein. The most frequent error was to select the pulmonary artery. Candidates are reminded that veins transport blood towards the heart, including the pulmonary vein which transports oxygenated blood.

(b) (i) The correct response, carbon dioxide, was stated by most candidates. Incorrect responses included hydrogen and argon.

(ii) Most candidates correctly calculated the difference between the percentage of oxygen in inspired and expired air.

(iii) This question was answered correctly by stronger candidates. Incorrect responses included breathing and lungs.

(c) (i) Few candidates gained full marks in this question. It was rarely known that the evaporation takes place from the surface of the mesophyll cells inside the leaf. Incorrect answers that were frequently seen were plant cells and guard cells. Many candidates stated that the water vapour exits the leaf by evaporation through the stomata instead of the correct answer, diffusion. Some candidates stated the correct answer, transpiration. The most common incorrect answer was evaporation. Although this does occur, the correct biological term needed to gain credit was transpiration.

(ii) Most candidates appreciated the need for plants to conserve water by closing their stomata on hot, dry days.

Question 2

(a) (i) There were several gases suggested by candidates for this question. Hydrogen, the correct answer, was chosen by many of the stronger candidates. Other responses included carbon dioxide and chlorine.

(ii) Many candidates successfully named zinc chloride. Incorrect responses included zinc chlorine and aqueous zinc salt. Candidates are reminded to study the reactants before predicting the products. Consequently, products containing, for example sodium and sulfate, could not be products in this reaction.

(iii) The aim of this question was to compare the reactivities of zinc and copper. Fig. 2.1 shows that no bubbles of gas are produced when copper is added to the acid, but bubbles are produced when zinc is added. Many candidates successfully explained the results by comparing the reactivities of the two metals. Others just stated that copper is unreactive or that zinc is reactive. These responses did not give a comparison of the reactivities.

(iv) Some candidates stated that the least reactive metal in the list is iron, metal **Y**. The remaining candidates chose one of the other metals as the least reactive. These responses were not awarded credit because all three metals would give a faster rate of reaction than iron.

(b) (i) Many candidates successfully identified the measuring cylinder. The most common incorrect answers were test-tube or just cylinder.

(ii) The experiment is a rate of reaction one in which the volume of gas given out is measured for a certain length of time. Therefore, a stop-watch is necessary, and this response was given by many candidates. Incorrect responses included thermometer and test-tube.

(iii) This question was generally answered well. Most candidates correctly described an increase in temperature, an increase in the acid concentration or the addition of a catalyst.

(iv) Candidates found this question demanding. Only a few were familiar with the analytical test for zinc ions.

Question 3

(a) (i) Some candidates did the calculation $W = mg$ correctly to get 25 000 N. Others divided the mass by 10 to give 250 N.

(ii) The arrow showing the weight had to touch the load and point vertically downwards. Candidates should be aware that the arrow must touch the load, and not the lorry nor the air near the load.

(iii) Most candidates found this question demanding. To gain full marks, the unit for volume had to be converted from cm^3 to m^3 by dividing the given volume by 10^6. Although some effort of unit conversion was attempted by most candidates, the correct value was not used, so only partial credit was awarded to these candidates.

(b) (i) Many candidates used the graph to correctly state the maximum speed of the truck.

(ii) Many candidates correctly stated the time taken by the truck to reach the maximum speed.

(iii) The majority of candidates successfully described the motion of the truck as decreasing its speed or decelerating. Those candidates who wrote decreasing on its own, or that the deceleration was constant were not awarded credit.

(c) Candidates found this question challenging. The most important concept is that the constant speed is maintained by the driving force being equal and opposite to the frictional forces acting on the truck. If these forces are not balanced, the truck's speed will change. Many responses stated that the speed of the truck does not change because the truck is moving on a flat surface with a constant driving force with no mention of the opposing frictional forces.

Question 4

(a) (i) Most candidates correctly identified the herbivore in the food web.

(ii) Most candidates interpreted the food web correctly, naming one of the hawk's two prey animals. Fewer correct responses were given for the second line of the question. Incorrect answers included primary and herbivore (consumer).

(iii) The majority of candidates gained full marks for this question. Others drew the arrows pointing in the wrong direction. These candidates are reminded that the arrows show the direction of transfer of energy between the organisms.

(b) (i) A few candidates gained full marks for this question. Some candidates successfully described the first part of the answer, the transfer of pollen, but the rest of the definition proved challenging. Candidates needed to give detail of the transfer of pollen from the anther to the stigma.

(ii) Some candidates stated the correct function of petals in pollination, to attract insects by their colour. Incorrect answers included protection, storing or producing pollen, and providing nutrition.

(c) Some candidates scored full marks for this question. The most common error occurred when candidates gave uterus as the place where fertilisation takes place.

Question 5

(a) The equation for the complete combustion of methane was known by many candidates. The main error was writing hydrogen instead of water as one of the products. Some candidates omitted to place oxygen in the box for the missing reactant. Candidates are reminded that for the complete combustion of fossil fuels there must be a plentiful supply of oxygen.

(b) (i) Many candidates knew the term fractional distillation. Credit was not awarded to those candidates who wrote just distillation.

(ii) Some candidates knew that the fraction used for bottled gas is refinery gas. Others stated natural gas, methane and propane. These responses did not gain credit because refinery gas may contain these gases but as part of a mixture of the lightest hydrocarbons produced in the column, not the individual gases.

(c) (i) A minority of candidates gave the correct answer, cracking. Some responses stated heating. These responses did not get the mark because the reaction also requires a catalyst and the exclusion of oxygen.

(ii) Some candidates answered this correctly. Incorrect responses included those stating that the colour produced was clear instead of colourless. A clear solution may be coloured, and in the test for an alkene the bromine produces a colourless solution. Some candidates appeared to confuse bromine with iodine and the starch test because they wrote blue-black as one of the colours.

(iii) Stronger candidates successfully stated poly(ethene) as the addition polymer for ethene. It was clear that the remaining candidates found this question challenging.

Question 6

(a) Most candidates scored some marks for this question. The most common errors were wind (energy) written for the first response, and electronic / electricity given for the last answer. Candidates should be aware that the kinetic energy of the moving wind is needed to rotate the blades of the turbine.

(b) (i) This question was generally answered well by most candidates who stated either copper or aluminium.

(ii) Only the strongest candidates gained credit for this question, stating electrons. Incorrect responses included electricity and energy.

(iii) Many candidates performed a successful calculation using the resistance equation. Errors included multiplying 230 (V) by 9.2 (A) or having an incorrect or missing unit.

(c) This question was generally answered well by most candidates. Incorrect responses included descriptions of the wires being covered with rubber and the effect of heat on them, and changes in height of the poles.

Question 7

(a) (i) Most candidates gained credit for stating that the maximum activity of the enzyme occurs at pH 8. To gain full marks candidates had to describe both the increase in activity before pH 8 and the decrease in activity after pH 8. Some candidates did not state both.

(ii) Generally, candidates found this question demanding. All three chemical elements had to be stated. Incorrect responses included water, other compounds and some metals. Candidates are reminded that chemical elements are found on the periodic table, and compounds form when different elements combine.

(iii) This question was well answered by some candidates, who explained the importance of carbohydrates for releasing energy in the body. The most common misunderstanding was made by those candidates who described growth and repair, which are the functions of proteins.

(b) Some candidates answered this question correctly, stating that plasma transports the digested food. The most common incorrect response was red blood cells. Candidates should be aware that red blood cells transport oxygen.

(c) Some candidates misunderstood the question and stated how HIV is spread, not controlled. Others described factors that would not have any effect in controlling the spread of HIV, for example, eating a healthy diet, wearing a mask, visiting a doctor and eating alone.

Question 8

(a) (i) Candidates gained full credit when they stated that the atoms in a molecule are combined chemically. Common errors included the use of the word particle instead of atoms, omitting to state that the atoms are combined chemically, and stating that atoms are mixed instead of combined.

(ii) Some candidates gave a correct definition for diatomic. Other candidates were unfamiliar with the term, and many did not attempt a response.

(iii) Few candidates answered this question correctly. Many responses were given in words instead of formulae, so these were not acceptable. Candidates are reminded to read the question carefully before attempting to respond.

(iv) Candidates who gained credit for this question stated that bacteria are killed by the chlorine. Statements that chlorine removes / gets rid of bacteria were not detailed enough to gain the mark.

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

(ii) Careful reading of the question was necessary to answer this question correctly. Many candidates did not appreciate that only the number of outer shell of electrons was needed for the answer. These candidates gave the full quota of electrons, so no mark was awarded.

(c) Some candidates understood that neon has a full outer shell of electrons, and this causes it to be unreactive. Other candidates stated that chlorine and neon do not react, without giving any explanation. This was repeating information given in the question.

Question 9

(a)(i) Many candidates gave a correct ray diagram, showing the diverging rays coming from the lamp. Candidates should be aware that the rays should be drawn with a ruler to give a straight line. The rays should also be continuous and not have parts missing as they pass through the lens. Arrows drawn on the rays should show the correct direction of travel.

(ii) Very few candidates knew that the distance labelled **X** is the focal length, the distance from the centre of the lens to the point from which the rays diverge as shown in Fig. 9.2.

(iii) Many candidates knew the position of visible light on the electromagnetic spectrum.

(b) (i) Some candidates correctly stated that a loud sound has a large amplitude. Others referred to the pitch or frequency of the sound.

(ii) Many candidates found this question demanding. A low frequency value had to be estimated, and an explanation given that a human with healthy ears could hear it. Responses with high values for frequency, for example values above 2000 Hz, were not accepted because these sounds would be pitched too high for a foghorn.

(iii) Many candidates correctly calculated the time taken for the sound to travel to the ship.

COMBINED SCIENCE

Paper 0653/33
Theory (Core)

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(b) (i) Some candidates correctly stated that a loud sound has a large amplitude. Others referred to the pitch or frequency of the sound.

(ii) Many candidates found this question demanding. A low frequency value had to be estimated, and an explanation given that a human with healthy ears could hear it. Responses with high values for frequency, for example values above 2000 Hz, were not accepted because these sounds would be pitched too high for a foghorn.

(iii) Most candidates correctly calculated the time taken for the sound to travel to the ship.

COMBINED SCIENCE

Paper 0653/41
Theory (Extended)

Key messages

Candidates who did well on this paper:

- read the questions carefully
- used the number of marks for each question as a guide to the level of detail required in their answers
- wrote answers clearly and took care to write chemical formulae and physical units correctly
- ensured that in questions involving calculations, they included well-organised working and clearly showed the relationship between physical quantities.

General comments

Large numbers of candidates showed excellent knowledge and understanding of all sections of the syllabus and demonstrated good examination technique.

Many candidates set out answers to the calculations in **Questions 3** and **6** clearly and logically. They started with the relationship between the relevant variables followed by the working and then wrote the result on the answer line provided. This is good practice and may allow partial credit to be awarded even when the final calculation is not completed correctly.

Material that seemed less familiar to some candidates included:

- the dependence on temperature of the number of molecular collisions exceeding the activation energy, **Question 5(c)**
- the location of the carpel in a flowering plant, **Question 7(a)(i)**
- the importance of including the units of numerical quantities where these are not given, for example, when stating the speed of light, **Question 9(b)(ii)**
- ray diagrams involving a convex lens and an object at infinity, **Question 9(c)**.

Comments on specific questions

Question 1

(a) (i) Most candidates were familiar with the alimentary canal and full marks were frequently awarded. Common incorrect answers included suggesting rectum instead of anus and using the term excretion instead of egestion. If candidates stated the function of the anus without using the term egestion, they had to specify removal of solid waste or faeces rather than use the unqualified term waste.

(ii) Errors included describing mechanical digestion in terms of the breakdown of food molecules rather than pieces of food.

(b) (i) Most candidates interpreted the graph correctly.

(ii) Many candidates were familiar with how to describe the denaturing of enzymes in terms of molecular changes. They also understood that denaturation in this case was caused by the conditions of very low pH in the stomach. Candidates needed to state that the conditions in the stomach are very acidic rather than simply acidic, since the graph shows the enzyme still has some activity at pH 4–5. Candidates needed to make it clear that the active site is located on the enzyme molecule and not on the substrate.

Question 2

(a) Most candidates knew that inert meant unreactive and any answer that suggested this idea gained credit. Credit was not awarded for answers such as 'inert means it has a full outer shell'.

(b) (i) Candidates generally understood that this question was based on the need for lead bromide to be molten before electrolysis occurs. Several ways of expressing this idea were possible and all gained credit. Some candidates referred to the need for mobile ions or the high energy needed to separate ions. Reference to the boiling point of lead bromide rather than the melting point was not accepted.

(ii) Candidates needed to explain the observations listed in the table and so had to mention bromine and lead. Some responses gave advanced detail describing ion/electrode attraction and ionic discharge but did not mention the names of the elements. Some candidates referred to mobile ions carrying charge through the electrolyte, completing the circuit and so causing the lamp to light. Any suggestion that electrons flowed in the electrolyte could not be credited. Credit was awarded, however, to candidates who made the valid point that electrons flowed in the external circuit.

(c) (i) Most candidates stated lead and chlorine, but sometimes incorrect presentation of the chemical symbols was observed, e.g. pb, c*l*, Pb_2 or 2C*l*.

(ii) Candidates needed to state that a gas or vapour of a colour other than orange would be observed. It was not enough simply to state that an orange vapour would not be seen. Many were familiar with the colour of chlorine.

Question 3

(a) (i) The question asks candidates to choose one of the forces stated in the diagram, and so the term drag was not accepted. Most candidates were awarded this mark.

(ii) The majority of candidates were awarded this mark.

(b) The majority of candidates were familiar with the relationship between speed, distance and time and successfully worked through to the correct numerical answer. Some incorrectly stated the answer in the form 3:30 or they rounded to 3 or 4 hr.

(c) Most candidates recalled the formula for kinetic energy. Some did not convert the speed from km / hr to m / s and/or did not find the square of the speed when substituting into the formula.

Question 4

(a) Many candidates were awarded this mark. The most common mistakes were ribs, rib cage and diaphragm.

(b) The majority of candidates were familiar with the features of gas exchange surfaces in alveoli. The most common alternative valid point was to refer to the surface needing to be moist. Some candidates described gas exchange or its importance rather than discussing the features of the surface.

(c) Many candidates identified respiration, although the mark was not awarded if candidates suggested anaerobic respiration. Fewer candidates identified water (vapour). Some incorrect responses suggested instead of water included carbon dioxide, carbon monoxide, nitrogen and oxygen.

(d) Most candidates correctly recognised cilia and knew the function of the cilia in moving mucus. The most common mistakes included suggesting that cell **Y** was a goblet cell and that it produced mucus or that the cilia were villi.

(e) Almost all candidates were awarded this mark.

Question 5

(a) Most candidates successfully used the data in the table to produce acceptable suggestions for the temperature and concentration of the acid. Any values within the ranges 0 to 20 °C and 0 to 1.0 mol / dm^3 were accepted.

(b) Any way of expressing that the rate difference arose from the difference in the acid concentration was accepted. Many candidates were familiar with the explanation of the difference in rate in terms of collision frequency.

(c) Many candidates realised that the number of collisions with energy exceeding the activation energy is dependent on temperature and so correctly identified experiment 3. The most common mistake was to suggest experiment 2 which had the highest acid concentration. It was important, in this case, that candidates noticed that the question contains the phrase 'most colliding particles'. Their answer needed to refer to the highest temperature or the most gas produced, rather than higher temperature or more gas produced. Acceptable alternative answers included the ideas of particles having the highest kinetic energy or the greatest speed.

(d) (i) Many candidates were awarded one mark for stating the idea that metals have different reactivities. The second mark was for linking higher reactivity to higher rate of reaction and was not awarded as frequently. Many candidates opted for stating that higher reactivity meant that more gas is produced but this answer simply repeats the information given in the table.

(ii) Candidates had to state or imply that copper does not react or that no gas is produced. The suggestions that the gas volume would be lower or that there is no observation were not accepted. Candidates who knew that copper produces no gas with dilute acid invariably gave a good reason. The best answers discussed the relative reactivities of copper and hydrogen.

Question 6

(a) (i) Many candidates answered this question correctly. Almost all knew the electrical circuit symbol for a switch. The position of switch **2** was shown correctly more often than that of switch **1**. Some candidates did not label either switch.

(ii) This calculation was completed by many candidates who set out clear working and arrived at the correct numerical answer. Partial credit was awarded to candidates who stated the correct total resistance in each branch of the circuit, even if they could not proceed further with the calculation. Some candidates incorrectly rounded the final answer either to 4.6 Ω or 5 Ω. Candidates should use the same number of significant figures in their final answer as in the data given in the question.

(b) (i) The majority of candidates were familiar with the relationship $Q = I \times t$ and worked through to the correct numerical answer. The most common mistake was to evaluate $I \div t$.

(ii) The strongest responses stated that a thicker cable would have a higher cross-sectional area and that resistance was inversely proportional to the area. Candidates also needed to recognise from the question that the cables were required to carry a very high current and so the resistance needed to be as low as possible. Many candidates suggested that when the resistance is lower the current will increase, which is not the same as needing to carry a current which is already high. Some candidates were awarded credit for stating the idea that lower resistance reduces overheating in the cables.

Question 7

(a) (i) Candidates often correctly identified the carpel, although many incorrect parts of the plant were suggested. Some candidates did not attempt to label the photograph.

(ii) Candidates generally were familiar with the features of an insect-pollinated flower. Candidates had to refer specifically to the anther and stigma being located inside the flower. Other suggestions such as reproductive organs, stamens or filament did not gain credit. Weaker responses referred to descriptions of pollen, colour and scent.

(b) Most candidates answered this question well. Candidates needed to avoid suggesting answers such as 'the Sun' or 'Sun's energy' instead of light. Any term having the same meaning as synthesis was accepted.

(c) (i) The majority of candidates answered this correctly. Xylem was a common error.

(ii) The majority of candidates answered this correctly. Glucose and glycogen were common errors.

(d) Most candidates were able to identify osmosis and the movement of water through a partially permeable membrane. Many candidates were familiar with plasmolysis. If candidates discussed the movement of water down a concentration gradient, it was important that they made it clear that they were referring to the idea of concentration of water.

Question 8

(a) (i) Almost all candidates answered this correctly.

(ii) Most candidates were familiar with the composition of the Earth's atmosphere. Many candidates stated the percentage in the Earth's atmosphere of the gases listed in the table. This implied the differences between Mars and the Earth, and this approach was accepted.

(b) (i) Most candidates correctly stated or implied that six electrons are shared in a nitrogen molecule. The most common incorrect suggestion was three, although the answer 'three pairs' was accepted.

(ii) Most candidates knew the correct form of the dot-and-cross bonding diagram of a carbon dioxide molecule. Some candidates gained one mark either for correct bonding electrons or for correct non-bonding electrons on both oxygen atoms.

(iii) Many candidates were familiar with the connection between atmospheric carbon dioxide and heating of the Earth and its atmosphere. Candidates needed to describe the idea of an 'enhanced greenhouse effect' rather than just the 'greenhouse effect'. The term 'global warming' was accepted as an alternative to the idea of the enhanced greenhouse effect. The second mark was for a consequence such as climate change or one of the many ways that this is affecting the environment. The most common mistake was to suggest that excessive carbon dioxide would have respiratory consequences for humans.

Question 9

(a) (i) Almost every candidate answered this correctly.

(ii) Most candidates were familiar with the relationship $v = f \times \lambda$ and used it to calculate the correct numerical value for the frequency. The correct symbol for the unit of frequency had to be expressed carefully, and so suggestions such as HZ, hz or hZ were not accepted.

(b) (i) Most candidates answered this question correctly.

(ii) Most candidates recalled the numerical value of the speed of light, but it was important that they also included the units. The value could also be expressed as $3.0 \times 10^5\,\text{km/s}$.

(iii) It was important that candidates referred directly to the idea that particles in these waves were oscillating or vibrating rather than simply moving. Answers such as 'in a transverse wave, particles move at right angles to the wave' were not enough. The strongest responses related the oscillation of particles to the direction of propagation of the wave or the direction of energy transfer. Some incorrect responses discussed the need for a medium for a longitudinal wave or the idea that transverse waves had peaks and troughs but longitudinal waves moved via compressions and rarefactions.

(c) This proved to be a demanding question for the majority of candidates. Incorrect responses included the suggestion that moving the lens would alter the focal length. Some discussed real and inverted images or simply re-worded the question with statements such as ‘so the image would not be blurred’. Stronger responses described how rays from a distant object would be refracted to meet at the principle focus or at a point closer to the lens, or that the screen must be moved to where the refracted rays would now meet.

COMBINED SCIENCE

Paper 0653/42
Theory (Extended)

Key messages

Candidates who did well on this paper:

- demonstrated knowledge and understanding in all three science disciplines with good recall of scientific terms and phrases
- used the command words, e.g. describe, explain, calculate, and the number of marks for the question to guide their answers
- recalled equations and showed the steps taken when making calculations
- interpreted diagrams and data by providing explanations as well as descriptions
- used data provided in the rubric to explain or justify conclusions.

General comments

Many candidates performed very well and demonstrated a comprehensive knowledge of the syllabus. Most candidates demonstrated knowledge in all three science disciplines.

Comments on specific questions

Question 1

(a) (i) Most candidates knew that the structure on flower **B** is the stigma and that the pollen is carried by the wind.

(ii) Most candidates could suggest how air sacs help with the transfer of pollen using ideas about making the pollen lightweight, lower in density, increased in surface area, etc.

(b) Most candidates knew that two parents are needed for sexual reproduction. Some candidates used higher level ideas and referred to the role of meiosis, the fusion of haploid cells or the formation of a zygote. Describing the offspring as non-identical was not sufficient – candidates needed to refer to genetic differences.

(c) (i) Most candidates knew that sperm passes through the sperm duct. However, many candidates did not recall that the sperm must pass through the cervix into the uterus.

(ii) Many candidates demonstrated good knowledge of the scientific terms in their responses to this question about sperm cell adaptation.

Question 2

(a) (i) Most candidates knew or could deduce that hydrochloric acid is used in the reaction that produces this metal chloride.

(ii) Candidates who identified hydrochloric acid in **(a)(i)** tended also to answer this question correctly.

(iii) Some candidates were able to describe clearly how magnesium chloride crystals are produced. Candidates should learn that the magnesium oxide must be added to the acid in excess. This ensures that all the acid reacts. The unreacted magnesium oxide must be separated from the

solution by filtering. A common error in describing the next step was that the solution is heated so that 'it' evaporates – candidates need to know that water is also a product of the reaction.

(b) (i) Most candidates were guided by the temperature information in the stem of this question. They suggested a temperature of less than 20 °C for the endothermic reaction.

(ii) Most candidates referred to the release of heat energy to the surroundings in their explanation.

(iii) The idea that Mg and K are in different groups was sufficient for this mark. Many candidates referred to the charges formed by their ions to explain the differences in the number of chloride ions that they bond with.

Question 3

(a) (i) Most candidates interpreted the graph correctly to determine the time taken by the truck to slow down.

(ii) Most candidates labelled the constant speed section of the graph correctly.

(iii) Some candidates read the maximum speed correctly but did not halve their calculated answer for this triangular section of the graph.

(b) (i) Most candidates used the mass and the gravitational force to calculate the weight. Some candidates incorrectly used the vertical height in their equation and calculated the GPE thinking that was the weight. Many candidates did not correctly identify the minimum force needed to lift the force. For the load to move from a stationary position, there must be an unbalanced or resultant force. Any number greater than 25 000 was accepted.

(ii) Most candidates used the data in the stem to calculate the GPE change.

(c) Many candidates were distracted by the reference to constant speed in the stem of this question. They gave explanations about balanced forces. However, the question asked why the truck still needs to use fuel. Stronger responses used ideas about energy to explain either that the truck does work against forces such as friction on the road or that thermal energy is released to the surroundings.

Question 4

(a) (i) Most candidates identified the organisms in this food web that matched the correct terms. Some candidates appeared to misunderstand the term carnivore. They often did not identify the blackbird or the thrush as carnivores – the diagram shows them feeding on caterpillars and beetles.

(ii) Almost all candidates referred to energy in their answers. Candidates need to refer to the energy that is lost at a trophic level, not simply in the food chain, and they should give an example of how energy is lost. A common misconception is that there is not enough energy in the hawk to transfer to a higher trophic level – candidates must refer to the energy at the level of the hawk. Some candidates also demonstrated their knowledge of the syllabus statement and stated that most food chains have fewer than five trophic levels.

(b) (i) Almost all candidates interpreted the bar chart correctly to explain carbon storage in mature and young forests.

(ii) Almost all candidates interpreted the bar chart correctly to identify the correct tree species.

(c) Most candidates were guided by the four marks available for this question and the five lines in which to write their response. This meant that they gave appropriately detailed answers using many correct terms relating to photosynthesis.

Question 5

(a) (i) Most candidates identified magnesium and correctly referred to its reactivity in comparison to zinc and copper.

(ii) Some responses stated that only that copper does not produce gas. Strong responses explained the idea that no gas is released because copper cannot displace the hydrogen from the hydrochloric acid.

(iii) Most candidates predicted a suitable volume of gas for the reaction with iron. Stronger responses explained that the reactivity of iron is somewhere between zinc and copper.

(b) (i) Many candidates correctly used ideas about the increased kinetic energy of the particles and some candidates also referred to more particles with the activation energy needed to cause a reaction. Some candidates referred to the effect on the reaction rate rather than the volume of gas. Some candidates thought that at 20 s the reaction had already finished - the question stem states, 'during the first 20 s'.

(ii) Only the most able candidates understood from the stem of the question that since some magnesium has not reacted, then all the acid must have reacted. With no acidity, the pH is 7. Many candidates predicted a reduction in acidity, but some went further and predicted an alkali pH. Candidates should learn that water is one of the products of this reaction and that it is neutral.

Question 6

(a) (i) Most candidates correctly drew straight line rays crossing through the focal point. Some candidates were imprecise and did not draw continuous rays.

(ii) Most candidates determined the focal length using the data provided.

(b) (i) Most candidates recalled and applied the wave equation to calculate the frequency. Some candidates did not convert the wavelength from centimetres to metres for the calculation.

(ii) Most candidates knew the relationship between loudness and amplitude. Fewer candidates also related this to the energy of the wave.

(c) Most candidates placed radio waves in the correct location on this diagram of the electromagnetic spectrum.

Question 7

(a) Most candidates knew that arteries have thick walls to withstand the pressure of the blood they carry.

(b) (i) Strong responses explained how the blockage in the coronary artery reduces the blood flow with the further explanation that blood carries oxygen with it (hence less oxygen is supplied to the heart cells). Some responses only referred to the reduction in oxygen. There was also a misconception evident that the blockage increases the distance through which oxygen must diffuse into the heart.

(ii) Most candidates suggested appropriate risk factors for coronary heart disease.

Question 8

(a) (i) Most candidates could recall or deduce the correct balancing of this blast furnace reaction.

(ii) Only the most able candidates could explain that carbon monoxide has reduced the iron oxide by removing an oxygen atom from it.

(b) (i) Most candidates knew that the oil prevents contact between the nail and oxygen and/or water.

(ii) Most candidates suggested paint as another method of preventing rusting.

(c) (i) Candidates needed to give an answer relevant to 'this atom' as stated in the question stem, e.g. this atom has 6 outer shell electrons and so it is in Group VI. Some candidates gave answers that were too generic.

(ii) Most candidates could recall or could use the Periodic Table to deduce that there are two shared pairs in the oxygen molecule bond and that each atom has another four unbonded electrons.

Question 9

(a) Most candidates recalled and applied the equation $P = I V$ to calculate the power output of the wind turbine. A common incorrect unit was J.

(b) (i) Candidates used 18 A for their calculation in **(a)**. Table 9.1 shows that there is a current of 12 A in floodlight **F** and 6 A in floodlight **G**. The more able candidates recognised that the total current has been split and therefore the floodlights must be connected in parallel.

(ii) Most candidates used the data to state that floodlight **G** is twice the distance from the turbine than floodlight **F**. Many candidates explained that this increased (doubled) the resistance in the cables. Only the strongest responses then applied the relationship between V, I and R to explain why this doubling of resistance caused halving of the current.

COMBINED SCIENCE

Paper 0653/43
Theory (Extended)

Key messages

Those candidates who did well on this paper:

- were familiar with the definitions of scientific terms and the required physics equations shown in the syllabus
- understood the different requirements of the command words 'describe' and 'explain' for example in **Question 4(a)(iii) and Question 4(b)(ii)**
- set out clear and precise answers using the correct scientific terminology
- used the number of marks for an item as a guide to the amount of detail required; for example, in **Question 5(b)**, strong responses included both period and group to gain all three marks
- ensured that they included working and formulas in questions involving calculations and that these were set out clearly enough for partial credit to be awarded where possible.

General comments

Many candidates performed very well and demonstrated a comprehensive knowledge of the syllabus. Most candidates demonstrated knowledge in all three science disciplines.

Comments on specific questions

Question 1

(a) (i) Most candidates were able to identify the ribs on Fig. 1.1. Fewer could correctly name the diaphragm. Incorrect answers included lung and backbone.

(ii) The majority of candidates correctly referred to mucus being produced by the goblet cells. Some candidates confused goblet cells with cilia and stated that the goblet cells trapped and moved the mucus.

(b) (i) The majority of candidates correctly identified student 2.

(ii) Most candidates correctly calculated the average difference. Some candidates did not give their answer to the nearest whole number.

(iii) Many candidates answered in terms of the body needing more oxygen, rather than the idea that carbon dioxide concentrations in the blood increase during physical activity. Only the strongest responses included ideas about respiration and carbon dioxide concentration in the blood.

Question 2

(a) (i) Very few candidates answered this question correctly. The most common mark awarded was for water being the source of the hydroxide ion. Although many candidates correctly provided the formula of the hydrogen ion and the sodium ion, they were unable to demonstrate understanding of what happens to the concentration of these ions during electrolysis. Some candidates thought the charges on the hydrogen ion and the sodium ion were negative to match the chloride and hydroxide ions given in the table.

(ii) Some candidates were able to provide a complete description of what happens to chloride ions. Weaker responses tended to just say that the ions were attracted to the positive electrode because they were negative. Many candidates correctly stated that the chloride ion lost one electron.

(b) (i) The majority of candidates correctly stated one property specific to electrolysis. Candidates should be encouraged to be specific and avoid giving vague answers such as general properties of metals.

(ii) Few candidates answered this question correctly. Many candidates provided general properties of metals.

Question 3

(a) (i) Most candidates were able to state the correct answer of radiation. Incorrect answers included conduction, convection and thermal.

(ii) Most candidates understood that the water would boil or become a gas.

(iii) Most candidates showed some understanding of density and either stated the correct formula or used the values for volume and density correctly. The most common error was converting 1800 dm^3 to 1.8 m^3. Many multiplied by a 1000 rather than divided.

(b) (i) The majority of candidates correctly calculated the mass of the fire engine. The most common error was to multiply rather than divide.

(ii) Most candidates correctly stated the units. However, only the stronger candidates could use the formula and provide the correct units. Many incorrectly used mass rather than force in their calculation. When stating Pa for the units for pressure, candidates should be encouraged to ensure that P is clearly a capital letter.

Question 4

(a) (i) Candidates generally correctly identified the position of the gall bladder. Some candidates labelled the appendix. A few candidates did not answer the question.

(ii) Most candidates successfully identified amylase as the enzyme. Candidates should refer to simple(r) sugars as the product, though glucose and maltose were accepted.

(iii) Only the strongest responses fully described how soluble food molecules are absorbed. Many just repeated the stem of the question using slightly different wording. Although some mentioned walls, they referred to the small intestine given in the question rather than capillary walls or cell membranes. Very few specified that the molecules entered the plasma for transport, and most just said the molecules entered the blood, which again was given in the question.

(b) (i) The majority of candidates identified the correct temperature of 10 °C.

(ii) Most candidates correctly stated that the enzyme had denatured, and many candidates also referred to the substrate being unable to fit the active site of the enzyme. Only the stronger responses provided a full explanation that included a description of what happens to the active site when the enzyme denatures. A common misconception is that the substrate changes shape or that the active site is on the substrate.

Question 5

(a) (i) Most candidates calculated the percentage of other gases correctly.

(ii) The majority of candidates correctly identified oxygen.

(b) The stronger responses provided a complete description that included ideas about both period and group number. Many candidates understood the relationship between group number and electrons in the outer shell but did not use the diagram. Therefore, they did not state that argon was in Group VIII and has 8 electrons in the outer shell. Instead, they made a generic statement such as the group number equals the number of electrons in the outer shell. The same was often true for the period number. Candidates should be encouraged to use the group numbers on the Periodic Table provided in the paper rather than versions that label Group VIII as Group 18.

(c) The majority of candidates were able to state 4 electrons or mention the double bond. Some candidates stated there were 2 electrons because oxygen requires 2 electrons to complete the outer shell. These candidates did not take into account that electrons were being shared and therefore did not count the electrons from carbon.

(d) Most candidates answered correctly. Some candidates did not place 4 electrons in the double bond and therefore placed 6 outside the bond.

Question 6

(a) (i) The majority of candidates correctly calculated the extension. The most common incorrect answer was not deducting the original length, leading to an answer of 12.

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

(iii) Most candidates understood that the stored energy was elastic. Kinetic was the most common incorrect response.

(b) (i) Successful candidates were able to clearly show their understanding of period and amplitude. However, candidates should be encouraged to use a ruler and be precise about the length of their label arrows. When showing the period of a wave, candidates should be encouraged to choose two clear points, such as the points where the wave crosses the time axis or two adjacent maxima.

(ii) The majority of candidates were able to state the correct formula for kinetic energy. However, many found using the formula more challenging. The most common error was omitting to square speed.

(iii) Candidates found it challenging to provide a reason for their answer. Only the strongest responses answered in terms of work done against friction. The most common correct answer was the idea of energy being conserved.

Question 7

(a) (i) Most candidates knew that one function of xylem is transport. Fewer candidates mentioned support as a second function.

(ii) The majority of candidates knew that root hair cells have a large surface area.

(b) (i) Candidates usually identified photosynthesis as the process and most correctly stated chemical energy.

(ii) Strong responses provided a clear and precise explanation. Some weaker responses incorrectly assumed that the algae used up the oxygen. Candidates should be encouraged to make it clear in their responses that it is the respiration of decomposers that uses the oxygen not just the process of decomposition. Some candidates assumed that the nitrates took up all the space leaving less room for the oxygen.

Question 8

(a) (i) Most candidates correctly deduced the general formula of alkanes.

(ii) The majority of candidates correctly completed the table. The most common mistake was in the formula of octane, where the pattern in the column was considered rather than the number of carbon atoms, leading to an incorrect answer of C_5H_{12}.

(b) (i) Many candidates provided a correct reason for propane being saturated; however, some did not complete their answer by providing a reason for it being a hydrocarbon.

(ii) A large proportion of correct structures were observed. Weaker candidates tended to either put two double bonds or no double bonds into the structure.

Question 9

(a) (i) The majority of candidates correctly placed ultraviolet and visible light into the electromagnetic spectrum.

(ii) Most of the candidates were able to provide one danger of ultraviolet radiation. Candidates should be encouraged to be precise with their answer and refer to skin cancer or burns to skin rather than general cancer or cell damage.

(iii) Most candidates correctly calculated the current. Incorrect candidates either divided voltage by power or multiplied the two numbers together.

(b) Some candidates answered this question correctly; many found it challenging. Some candidates stated correct values for the resistors but could not provide a complete explanation. There was evidence of some candidates realising that they needed to use the parallel resistor formula but then being unable to quote it accurately.

COMBINED SCIENCE

Paper 0653/51
Practical Test

Key messages

Candidates should ensure they read through the whole question before starting to answer. This would help them plan their answers and ensure all parts of the question are answered.

In planning questions, it is important that candidates take care that they are investigating the relationship asked for in the question.

Candidates need to take care with measuring and reading from scales, including those on graphs. They need to ensure they know whether the scale is increasing or decreasing and work out what each division of the scale represents.

Values in a results table should be quoted to the same number of decimal places. Candidates can use existing data in the table as a guide for any values they are adding.

General comments

Candidates generally answered all questions. There were few omissions, and most candidates attempted the planning question at some length.

A pencil, eraser and ruler are essential for any alternative to practical exam. There was evidence that some candidates did not have these and therefore were not able to correct errors. An example of this was when drawing the line of best fit.

Comments on specific questions

Question 1

(a) (i) Most candidates were able to give a thermometer reading that was below 40 °C, the initial temperature of the water-bath.

(ii) Candidates were able to collect juice in both measuring cylinders. Tube **E** was expected to have a much greater volume of juice collected. Centres where the Supervisor results were different were accepted. Candidates were also expected to give both their results in the table to the same number of decimal places.

(iii) Candidates were generally able to link the presence of the enzyme to a greater volume, or faster production, of fruit juice.

(iv) There were two ways that candidates could approach this question. Both of which were credited.

1. Temperature was a source of error because the temperature of the water-bath was not maintained/decreased during the investigation.
2. Temperature was not a source of error because the samples were in the same water-bath and therefore they were both at the same temperature during the investigation.

A number of candidates gave descriptions of the general action of enzymes and the optimum temperature, which were not relevant to the question.

(v) Many candidates identified that the apple puree was not measured or that half-full was subjective. Apparatus such as a measuring cylinder to measure a set volume or a balance to measure a set mass were suitable answers. Candidates should also consider the practicality of the apparatus they suggest. A syringe (which has a narrow nozzle) is not really practical for something with the consistency of a puree though was accepted in this instance.

(b) Candidates demonstrated some good drawing skills. Some drawings were too small (not greater than half of the box provided) and in some the outline was not a clear and continuous line.

(c) (i) Most candidates were able to give the length of **AB** in mm.

(ii) Stronger candidates were able to use their measurement in the equation provided to calculate the actual width and then give their answer to two significant figures.

Question 2

(a) (i) Most candidates were able to obtain a result and record it to the nearest second.

(ii) Most candidates were awarded a further two marks for obtaining more results and a third mark for those results being similar.

(iii) Most candidates were able to calculate the rates of reaction to plot on their graph.

(b) (i) Graph skills were generally good, and most candidates were awarded at least two marks for their graph. It was usual to see graphs drawn with labelled axes and care taken to plot points precisely using crosses. Common errors included:

- omission of labels or units from axes
- inverting the axes
- choosing inappropriate scales - scales should be linear and chosen so that plotted points occupy at least half of the grid.

Candidates were using their own data for the graph, which was taken into consideration. Some allowance was made for scales that were sensible but did not quite use half the grid provided but had made ‘best use’ of the grid provided. Candidates are reminded that unless instructed to do so, they do not have to start their scales at 0.

(ii) There were frequent errors in the line of best fit. These included joining points dot-to-dot either freehand or using a ruler.

(iii) Most candidates identified that as the length increased the rate also increased. Candidates need to take careful note of the question so that they describe the relationship being investigated. The question asked for rate, but there were numerous references to time.

(c) Step 5 was using the glass rod to keep the magnesium ribbon under the surface of the acid. Stronger responses referred to this ensuring that both sides of the ribbon/all of the surface area is in contact with the acid at the same time. A number of responses referred to all of the ribbon reacting; however, this will happen without the use of the glass rod so was not accepted.

(d) Some candidates identified that the source of uncertainty was judging when all the magnesium ribbon had reacted (is no longer visible) and then stopping the stop-watch at that time.

(e) A number of candidates realised that if the magnesium ribbon is in excess then not all of it would react and went on to give an observation, which the question asked for, such as if there were unreacted magnesium ribbon, it would be visible or there would be some remaining in the beaker.

Question 3

(a) Most candidates were able to give the correct value for the angle of incidence.

(b) (i) Candidates demonstrated they could place the pins on the correct line. However, the question then stated 'at least 5 cm apart'. It is good practice for candidates to read through the whole question, so they know all of the detail required. Many did not move their pins to correct their position, suggesting they did not read all of the question.

(ii) Many candidates were able to place the pins to the left of the normal.

(c) Candidates were generally able to join the pin positions with a line but only the stronger responses had a line that also went through position **Y**. A common error was labelling the angle between P_3P_4 and the normal, rather than P_3P_4 and **XZ** as instructed. Some candidates were able to correctly measure angle θ.

(d) There were a number of practical difficulties that candidates could describe. The most common given referred to difficulties in lining up the pins or inserting them vertically.

Question 4

Candidates found this question demanding. Candidates needed to consider the relationship to be investigated (in this case, the relationship between the temperature of the apple juice and the time taken for the ice cubes to melt). Candidates needed to write a plan that addressed each bullet point. The bullet points are intended to support candidates in their answers. A number of candidates made notes against the bullet points before writing their responses, which is good practice.

Some candidates used the number or mass of ice cubes as the independent variable. Some procedures did not fully address the question or did not make it clear that different temperatures needed to be tested. A number only suggested one experiment at one temperature.

The following points should be noted.

- The plan should investigate the relationship given in the question (in this case temperature and time).
- It needs to be clear how the apparatus will be used in order to earn apparatus marks. Some candidates stated apparatus, such as a measuring cylinder, without making it clear how it will be used. Giving detail about using it for measuring the volume of apple juice or giving a stated volume was sufficient.
- The method needs to include how to do the experiment. It needs to be in a manner such that another candidate could follow the instructions and carry out the investigation as described. The method needs to be clear about which quantities will be varied and which will be kept constant.
- It is good practice to suggest at least five values for the independent variable, in this case, the temperatures used. This mark was often awarded from a correctly labelled results table.
- When discussing processing of values, it is important to be specific. Some responses contained statements about taking repeats that were considered too vague to be accepted. 'Repeat and take an average' was frequently seen. It must be clear what conditions are used in the repeated experiments and/or what the purpose of the repeated measurements is. Stronger responses contained clearer statements such as 'repeat the experiment with the same mass of ice at the same temperature'.
- The question wording uses the phrase 'to determine the relationship between…'. Answers which say 'draw a graph to determine the relationship between…' are repeating the question. Candidates needed to show that they understood what this means by defining the axes of the graph, either by a sketch or by a statement such as 'with time on the vertical axis and temperature on the horizontal axis'.

COMBINED SCIENCE

Paper 0653/52
Practical Test

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

COMBINED SCIENCE

Paper 0653/61
Alternative to Practical

Key messages

Candidates need to take careful note of instructions given in the question. For example, in **Question 1(a)(ii)**, where they are instructed to 'record your answer to the nearest 0.5 cm^3', it is essential that values are given to one decimal place, which may be .0 or .5.

Candidates should also take care when directed by the question paper to answer using a specific piece of information. For example, in **Question 1(a)(iii)**, candidates were directed to 'use the results', but some answered in general terms about rates of reaction.

For planning questions, it is important that candidates read the question carefully and be sure to investigate the relationship stated. Some candidates did not correctly identify the independent and dependent variables and so described plans for a different investigation. Additionally, candidates should take care to address all the bullet points listed in the question rubric.

For graph questions, candidates should refer to the guidance given in the syllabus. Some candidates did not label axes appropriately or choose suitable scales.

General comments

Candidates generally answered all questions. There were few omissions and almost all candidates attempted the planning question at some length.

Comments on specific questions

Question 1

(a) (i) Almost every candidate read the thermometer correctly to give a value of 37, but not all included the decimal place to give 37.0. In this case, there was no instruction in the question that the reading needed to be to a resolution smaller than a whole degree, so 37 was accepted.

(ii) In this question, there was an instruction to record the volume 'to the nearest 0.5 cm^3'. Therefore, the correct reading for the first volume was 41.0. A common incorrect answer was 41. However, most candidates correctly recorded the second volume as 18.5.

(iii) There was an instruction to 'Use the results…'. Many candidates answered using their own knowledge rather than interpreting the results, giving answers in terms of an enzyme increasing the rate of reaction such as 'the reaction is faster'. Strong responses referred directly to the results, such as 'using this enzyme produces a greater volume of apple juice'.

(iv) Candidates could either say that temperature was a source of error due to the temperature decrease, or that it was not a source of error because both test-tubes were under the same conditions of temperature throughout. However, specific reference to temperature was required to explain the decision.

(v) In step 2, a spatula was used to add the apple puree. Strong responses identified that the volume or mass was not measured (or controlled) and then suggested suitable apparatus to do so (e.g. a measuring cylinder or a balance). Responses that suggested measuring apparatus which would not work in practice (e.g. a burette) were not accepted.

(vi) Candidates were referred to step 5, so it was essential that they identified why a clean glass rod needed to be used specifically in that step. Unqualified answers such as 'to avoid contamination' were considered too vague. Strong responses identified that at step 5 the enzyme could be transferred between test-tubes at that point, and therefore using a clean glass rod prevented transfer of the enzyme.

(b) Many candidates gained all three marks by showing a large clear diagram with the fine details of the features of the apple shown. Some candidates drew very small diagrams; the diagram must fill at least half of the available space. The outline must be clear and continuous; feathered, broken or double lines are not accepted. Scientific diagrams should not be shaded; candidate shading sometimes obscured the clarity of the outline. Some candidates did not show the three main features: the stem, the pips and the part at the bottom of the apple (the calyx).

(c) (i) Almost all candidates correctly measured the width of the apple cell in mm.

(ii) Although most candidates were able to correctly substitute values into the provided equation, some did not give an answer to two significant figures.

Question 2

(a) Almost all candidates knew the test for hydrogen gas. A few incorrectly stated that a glowing splint, rather than a lighted splint, is used as the test.

(b) (i) The question stressed that candidates needed to suggest one other piece of apparatus to measure the volume of dilute acid, rather than the measuring cylinder used in step 1 of the method. However, measuring cylinder was a common incorrect answer. Other incorrect answers included syringe and burette.

(ii) Step 3 referred to the use of a glass rod to keep the magnesium under the surface of the acid. Strong responses related the idea that this brought the whole of the surface area of the magnesium into contact with the acid. Weaker responses tended to repeat/rewrite the information given in the stem, e.g. 'this keeps the magnesium submerged'.

(iii) The measurement of the (chemical) reaction time depended on two factors: the student's judgment of the end of the reaction, and the student's reaction time in stopping the stop-watch. Both of these were accepted. Unqualified statements such as 'human error' or 'the student may have made a mistake' were not accepted.

(iv) In questions where data must be entered into a table, it is essential that the number of decimal places used is the same as that of the data already entered. Furthermore, it is essential that values are correctly rounded. The correct answers here were 30 and 31. Some candidates gave answers to two decimal places. Some incorrectly rounded the second value to 30.

(v) Most candidates correctly substituted values into the equation to calculate the rate. Error carried forward on incorrect values from **(b)(iv)** was applied here.

(vi) The approach to marking graphs is similar for each examination session. Detailed guidance on how to construct graphs is given in the syllabus.

The first mark is awarded for correct labels with units. Best practice is to label axes using the wording from the headings of the relevant columns of the table (in this case 'length of magnesium ribbon / mm' and 'rate of reaction in mm / s'). Not all candidates labelled their axes. Some omitted units. Some inverted the axes, confusing which variable should go on the vertical axis and which on the horizontal axis.

The second mark is for selecting a suitable scale (and labelling major gird lines accordingly). In this case, it was appropriate for both axes to begin at 0 so that the origin was (0,0), but this is not always the case. Awkward scales that make plotting difficult are not accepted. Scales that are non-linear are also not accepted.

The third mark is for accurate plotting. Most candidates who chose suitable scales completed the plotting of points correctly.

A further common error was to plot the wrong data; some candidates did not read the question carefully and plotted reaction time rather than rate of reaction.

(vii) The line of best fit in this case was a straight line. Most candidates drew this accurately. It should be noted that where points do not exactly fit on a line, as is the case for this question, the line should be drawn with an even spread of points on either side of the line. Candidates may find that a transparent ruler helps them to do this.

(viii) This question was well answered. Most recognised that the graph shows that the rate increases as the length increases. Some candidates identified that the graph line shows a proportional relationship. In this case, the relationship is proportional as it is a straight line that goes through the origin.

(c) The question asks for an observation. The strongest responses clearly stated that 'solid magnesium remains after the fizzing stops' or other similar observations. Many answers were not given in terms of something that could be observed. Some students stated that not all the magnesium reacts; this is true but is not an observation that leads to the conclusion given. Some candidates mentioned precipitates or crystals, implying that a product of a reaction was formed rather than that unreacted magnesium remained.

Question 3

(a) Most candidates answered correctly, although a small minority of candidates measured the angle between the incident ray and the mirror, leading to an incorrect answer of 35°.

(b) (i) The instruction was that P_1 and P_2 should be marked with a cross and that they needed to be at least 5 cm apart. Most did this correctly, though some candidates wrote P_1 and P_2 near the line but did not clearly indicate the position of the pins with crosses.

(ii) Candidates found this demanding. Many lines were drawn that did not start at **Y**. Those that started in the correct place often did not meet the pupil of the eye and did not go through the cross at P_3. The strongest responses showed a line from **Y** that went through point P_3 and hence hit near the centre of the pupil. P_4 could then be indicated on this line.

(c) Candidates were generally able to join the pin positions with a line. The most common error was labelling the angle between P_3P_4 and the normal, rather than P_3P_4 and **XZ** as instructed. Stronger candidates were able to correctly measure angle θ.

(d) (i) Almost every candidate identified the anomalous reading correctly, although some circled 'reading 3' in the heading, and some circled more than one value.

(ii) The issue was an anomalous reading in the data. Hence the simplest way to improve the data is take the reading again at the same value of i and check that it is similar to readings 1 and 2. Answers such as 'do more repeats' or 'take more readings' were not specific enough. A second accepted approach was to increase the number values of i measured, either by using other interim values between 30° and 60° or by extending the range at either extreme. Answers suggesting using different values of θ were not accepted as θ is the dependent variable rather than the independent variable in the experiment.

Question 4

For planning questions, best practice is to consider the bullet points carefully and use these to structure responses. Many plans addressed some but not all of the bullet points. For full marks, it is essential that a response to each bullet point is included.

Candidates were asked to determine the relationship between the temperature of apple juice and the time it takes for ice cubes to melt when added to it. Many candidates investigated other variables: some varied the amount of ice; some measured the temperature of the ice; some measured the temperature before and after melting. A further error was to keep the temperature constant, which means that the relationship in the question cannot be determined.

Most candidates suggested appropriate measuring instruments (a thermometer, some type of timer, a balance and a measuring cylinder). However, not all candidates made it clear in their method how these instruments would be used (for example by saying that the measuring cylinder was needed to measure the volume of apple juice).

In the method, it was necessary to state exactly how timing will take place. It was insufficient to state only 'measure the time to melt' (since this is in the question and does not describe a method). Strong responses gave clear statements such as 'Start the timer when the ice is placed into the apple juice. Stop timing when no more ice can be seen'.

It should be noted that to 'control' a variable means to keep that variable constant. Candidates often stated that they would 'control the temperature', which is ambiguous. Taken literally this means that the temperature is kept constant. For clarity, candidates should state clearly which variable they are changing, which they are measuring, and which variables they intend to keep constant. When stating which variables will be kept constant, note that 'use the same amount' does not state how that is achieved practically. Therefore, candidates needed to state 'volume' or 'mass', for example, 'use the same volume of apple juice' or 'use the same mass of ice cubes'.

The instruction to include a results table was not always followed. Those candidates who did include a table sometimes omitted units or used non-SI units.

The strongest responses included a sketch of the axes of a graph that could be used to process the results and draw a conclusion. Some responses contained statements about taking repeats that were considered too vague to be accepted; it must be clear what conditions are used in the repeated experiments and/or what the purpose of the repeated measurements is. Stronger responses contained clearer statements such as 'repeat the experiment with the same mass of ice at the same temperature'. Some plans gave instructions to average the wrong data, for example, averages of readings taken with different masses of ice or at different temperatures.

COMBINED SCIENCE

Paper 0653/62
Alternative to Practical

Key messages

Candidates should ensure they read through the whole question before starting to answer. This would help them plan their answers and ensure all parts of the question are answered.

In planning questions, it is important that candidates take care that they are investigating the relationship asked for in the question.

Candidates need to take care with measuring and reading from scales, including those on graphs. They need to ensure they know whether the scale is increasing or decreasing and work out what each division of the scale represents.

Values in a results table should be quoted to the same number of decimal places. Candidates can use existing data in the table as a guide for any values they are adding.

General comments

Candidates generally answered all questions. There were few omissions, and most candidates attempted the planning question at some length.

A pencil, eraser and ruler are essential for any alternative to practical exam. There was evidence that some candidates did not have these and therefore were not able to correct errors. An example of this was when drawing the line of best fit.

Comments on specific questions

Question 1

(a) (i) Candidates were generally able to use the information from Fig. 1.1 which showed one heart beat to calculate the number of heart beats in 5 s for each ECG in Fig. 1.2.

(ii) Most candidates were able to calculate the heart rate in bpm from the equation given.

(iii) The graph skills shown were generally good. It was usual to see graphs drawn with labelled axes and care taken to plot points precisely using crosses. Most candidates were awarded at least two marks for their graph. Common errors included:

- omission of labels or units from axes
- inverting the axes
- choosing inappropriate scales - scales should be linear and chosen so that plotted points occupy at least half of the grid.

(iv) There were frequent errors in the curve of best fit. These included joining points dot-to-dot either using a ruler or freehand and not drawing a curve as instructed.

(v) There were two parts to the shape of this graph, both were needed for the mark to be awarded. Most candidates were able to describe that as the running time increased the heart rate also increased. This was correct for 0–15 minutes. However, the heart rate remained at 144 bpm from 15–25 minutes. Many omitted to state this or give a relevant description.

(vi) A number of candidates realised that heart rate is affected by running speed and so identified why it was important that the running speed was kept constant during the investigation.

(b) Most candidates were able to correctly read the voltage and calculate the time from the ECG.

(c) Stronger candidates were able to give a detailed answer. Candidates needed to make it clear which part they were comparing (by use of the letters) and which ECG they were describing. Candidates found it difficult to clearly describe a difference which was in the **S** and **T** regions.

Question 2

(a) Most candidates were able to read the mass and round up to 1.2 g although some omitted to round to one decimal place.

(b) Candidates were told in the question that the reaction was slow at room temperature, and many therefore realised that stirring was used to increase contact between the reactants in order to speed up the reaction. References to dissolving the iron were not accepted. A number of candidates made references to temperature which were not relevant.

(c) Many candidates were able to correctly link the squeaky pop with a lighted splint to hydrogen.

(d) Most candidates identified filtration as the method of separation and attempted to draw the appropriate apparatus. There was a large variation in the quality of diagrams. A pencil and a ruler should be used for straight lines and the filter paper needed to be clearly distinguishable from the filter funnel with both labelled. A beaker or conical flask would be the most appropriate collecting vessel, which also needed a label. The filtrate and residue needed to be shown and correctly labelled in the respective pieces of apparatus.

(e) (i) Many candidates were able to identify sulfate correctly.

(ii) A number of candidates correctly identified iron(II) although some omitted the (II).

Question 3

Candidates found this question demanding. Candidates needed to consider the relationship to be investigated (in this case, the relationship between mass of citric acid and the pH of the solution obtained). Candidates needed to write a plan that addressed each bullet point. The bullet points are intended to support candidates in their answers. A number of candidates made notes against the bullet points before writing their responses, which is good practice.

A number of candidates treated the acid as a liquid and incorrectly measured volume instead of mass or measured the change in pH. Some methods did not fully address the question, and some did not make it clear that different masses needed to be tested; some appeared to only do one experiment with one mass.

The following points should be noted:

- Candidates need to ensure that the experiment they plan investigates the relationship given in the question (in this case mass and pH).
- It needs to be clear how the apparatus will be used in order to earn apparatus marks. Some candidates stated apparatus, such as a measuring cylinder, without making it clear how it will be used. Giving detail about using it for measuring the volume of sodium hydroxide or giving a stated volume was sufficient.
- The method needs to include how to do the experiment. It needs to be in a manner such that another candidate could follow the instructions and carry out the investigation as described. The method needs to be clear about which quantities will be varied and which will be kept constant.
- It is good practice to suggest at least five values for the independent variable, in this case, the mass of citric acid added. This mark was often awarded from a correctly labelled results table.
- When discussing processing of values, it is important to be specific. Some responses contained statements about taking repeats that were considered too vague to be accepted. ‘Repeat and take an average’ was frequently seen. It must be clear what conditions are used in the repeated experiments and/or what the purpose of the repeated measurements is.

- The question wording uses the phrase ‘to determine the relationship between…’. Answers which say ‘draw a graph to determine the relationship between…’ are repeating the question. Candidates needed to show that they understood what this means by defining the axes of the graph, either by a sketch or by a statement such as ‘with time on the vertical axis and temperature on the horizontal axis’.

Question 4

(a) (i) Most candidates demonstrated that they could correctly read the volume from the bottom of the meniscus using a measuring cylinder.

(ii) Many candidates were able to describe how to avoid a parallax error.

(b) (i) Candidates were generally able to correctly take the readings on the thermometer diagrams but not all recorded their answers to the correct precision of 0.5 °C in line with the rest of the data in the table.

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(ii) Candidates were generally able to calculate the change in temperature for each beaker.

(iii) Candidates were generally able to calculate the average rate of cooling for each beaker. Fewer candidates were able to correctly express their answers to two significant figures and give the correct unit.

(iv) Candidates found this a demanding question and approached it in different ways. Some started by working out the difference between the values (0.3) and then working out whether this is greater or less than 10% of either of the original values. Others calculated the value given by a 10% increase in the lower value or a 10% decrease in the higher value and showed that these were not within 10% of each other. Either route was accepted.

COMBINED SCIENCE

Paper 0653/63
Alternative to Practical

Key messages

Candidates need to take careful note of instructions given in the question; for example, in **Question 3(d)(ii)**, candidates were instructed to 'record the mass of solid **H** to two decimal places'.

For planning questions, it is important that candidates read the question carefully and be sure to investigate the relationship stated. Some candidates did not correctly identify the independent and dependent variables and so described plans for a different investigation. Additionally, candidates should take care to address all the bullet points listed in the question rubric.

For graph questions, candidates should refer to the guidance given in the syllabus. Some candidates did not label axes appropriately or choose suitable scales.

General comments

Candidates generally answered all questions. There were few omissions and almost all candidates attempted the planning question at some length.

Comments on specific questions

Question 1

(a) (i) Many candidates correctly identified the two factors needed for photosynthesis but fewer were able to link the results provided in the question to their explanation.

(ii) The strongest responses identified that the colour change with iodine would be seen if the leaf was no longer green.

(b) Most candidates were able to recall that Benedict's solution should be used to test for reducing sugar with many going on to state brick red as the observation for a positive result.

Question 2

For planning questions, best practice is to consider the bullet points carefully and use these to structure responses. Many plans addressed some but not all of the bullet points. For full marks, it is essential that a response to each bullet point is included.

Candidates were asked to determine the relationship between the concentration of urease and the pH of the solution formed. Many candidates investigated other variables, with a common mistake being to vary the volume of urease. Few candidates stated that they needed to add water to the urease to change the concentration. Some candidates suggested using litmus to measure the pH, which would not give a pH value; Universal indicator would allow a pH value to be determined using a pH colour chart.

It should be noted that to 'control' a variable means to keep that variable constant. For clarity, candidates should state clearly which variable they are changing, which they are measuring, and which variables they intend to keep constant. When stating which variables will be kept constant, note that 'use the same amount' does not state how that is achieved practically. Therefore, candidates needed to state 'volume', for example, 'use the same volume of urea'.

Most candidates suggested appropriate measuring instruments (measuring cylinder and thermometer). However, not all candidates made it clear in their method how these instruments would be used (for example by saying that the measuring cylinder was needed to measure the volume of urea solution).

The strongest responses included a sketch of the axes of a graph that could be used to process the results and draw a conclusion. Some responses contained statements about taking repeats that were considered too vague to be accepted; it must be clear what conditions are used in the repeated experiments and/or what the purpose of the repeated measurements is. Stronger responses contained clearer statements such as 'repeat the experiment with the same concentration of urease'.

Question 3

(a) (i) Most answers were correct, with candidates estimating the pH as 9.

(ii) Candidates found it challenging to suggest why the pH colour chart could not give an exact value for the pH, with many writing about human error or integers. Stronger responses simply stated that the blue-green colour was not on the pH chart.

(b) (i) Most candidates correctly stated that limewater turns milky with carbon dioxide.

(ii) Most candidates were able to identify the anion as carbonate.

(c) (i) Many candidates were able to state the gas produced as ammonia.

(ii) A majority of candidates identified the cation as ammonium.

(d) (i) Most candidates stated measuring cylinder as a suitable piece of apparatus to use.

(ii) Most candidates correctly rounded 1.154 g to 1.15 g. Some candidates used one decimal place rather than the two stated in the question.

(iii) Candidates generally correctly recorded the reaction time to the nearest second. Some candidates misread the units shown on the stop-watch and gave their answer as 97 s.

(iv) Many candidates used the equation provided and gave their answer to two significant figures. A common mistake was to record to only one significant figure.

(v) This was a demanding question with most candidates suggesting human error when using a stop-watch as the reason it was difficult to measure the reaction time. With reference to step 5 of the method, stronger responses stated that it was difficult to judge when the reaction, or fizzing, had ended.

(vi) Many candidates simply stated 'repeat' as a way to improve the procedure. Very few went on to explain how this would improve confidence in the rate of reaction. Stronger responses described how a repeat would allow for identifying anomalous results, or that repeating and averaging would reduce the effect of random errors.

Question 4

(a) Most candidates recorded the distance as 21 cm. A few did not seem to realise that the scale was on a metre rule.

(b) (i) This question was generally well answered with a majority of candidates measuring correctly to the nearest 0.1 cm.

(ii) Most candidates correctly used the scale provided to determine the height of the image.

(c) (i) The correct value of *M* (0.5) was calculated by most candidates.

(ii) The approach to marking graphs is similar for each examination session. Detailed guidance on how to construct graphs is given in the syllabus.

The first mark is awarded for correct labels with units. Best practice is to label axes using the wording from the headings of the relevant columns of the table (in this case 'object distance / cm' and 'magnification'). Not all candidates labelled their axes. Some omitted the unit for object distance. Some inverted the axes, confusing which variable should go on the vertical axis and which on the horizontal axis.

The second mark is for selecting a suitable scale (and labelling major gird lines accordingly). In this case, it was appropriate for the *x*-axis to begin at 25. Awkward scales that make plotting difficult are not accepted. Scales that are non-linear are also not accepted.

The third mark is for accurate plotting. Most candidates who chose suitable scales completed the plotting of points correctly.

(iii) Many candidates correctly drew the curve of best fit. A common error was to draw multiple, sketchy lines instead of one smooth curve.

(iv) Many candidates were able to read the value of *u* from the graph.

(v) This part was well answered with nearly all candidates dividing their value from **(c)(iv)** by two.

(d) (i) Few candidates were able to state two precautions they should take to obtain a sharp image. Some were able to give correct ideas of using a dark room or making sure the lens was clean.

(ii) Most candidates correctly described how to avoid a parallax error.