COMBINED SCIENCE

Paper 0653/11
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Questions 1**, **4**, **6**, **9**, **11** and **13**. **Questions 3**, **8**, **10**, **17**, **20**, **39** and **40** proved the most challenging for candidates.

Comments on specific questions

Question 1

Most candidates were able to identify the outermost layer of animal and plant cells. Some candidates chose option **C** or **D** forgetting that animal cells do not have cell walls.

Question 2

Many candidates thought that the characteristic exhibited by the car was either excretion or nutrition. Few correctly selected option **D**, respiration.

Question 3

Some candidates found this question challenging. The Benedict's test and the ethanol emulsion test were positive indicating the presence of reducing sugars and oils respectively.

Question 7

Many candidates chose the correct answer, option **C**. Some candidates incorrectly chose option **B**. This was the phloem rather than the xylem.

Question 8

Most candidates selected the incorrect answer. The incorrect answer that was chosen preferentially was option **C**. This indicates that most thought that increased physical activity increases the rate of breathing but decreases the depth. Candidates need to realise that the volume of air of each breath increases and therefore depth of breathing will increase.

Question 9

Most candidates correctly selected option **B**. Where candidates chose the incorrect option, they chose option **C**. This is incorrect because adrenaline increases the beathing rate.

Question 10

Most candidates found this question very challenging. Many incorrectly chose option **B**, indicating that the root response was caused by gravitropism and the shoot response was caused by phototropism. Candidates needed to read the question carefully as the seedling was in a light-proof box and therefore the plant could not be affected by light.

Question 11

Most candidates chose the correct answer, that germination needs warmth, water and oxygen. A significant number incorrectly selected option **A** indicating that germination needs cold, water and carbon dioxide. This may be because candidates recognised that plants need water and carbon dioxide for photosynthesis.

Question 12

Most candidates correctly chose option **A**. Some candidates chose option **C**, secondary consumer. In the food chains shown, the fox is the secondary consumer.

Question 13

Most candidates correctly identified respiration as the process that releases carbon dioxide into the environment. Some candidates incorrectly thought that fossilisation and photosynthesis release carbon dioxide into the environment.

Question 17

Candidates chose the incorrect option **B**, more often than the correct option **D**. Candidates are expected to know which groups in the Periodic Table contain metallic and non-metallic elements and that only non-metallic elements form covalent bonds.

Question 18

Candidates chose the incorrect option **D**, more often than the correct option **B**. Candidates are required to use the symbols of the elements and write the formulae of simple compounds.

Question 20

There was evidence that many candidates were confused about endothermic reactions. Many candidates chose the incorrect option **C**, rather than the correct option **A**. The temperature of an endothermic reaction mixtures decreases, not increases.

Question 22

Some candidates chose the incorrect option **D**, rather than the correct option **C**. Candidates are required to be able to describe the characteristic properties of acids (including dilute sulfuric acid) including their effect on litmus paper and their reactions with metals, bases and carbonates.

Question 23

Candidates chose the incorrect **B** more often than the correct option **A**. Candidates are expected to know that iron(III) ions produce a green precipitate with aqueous sodium hydroxide and that carbon dioxide turns limewater milky.

Question 25

There was evidence that many candidates guessed at the answer. Krypton, Kr, is a noble gas and noble gases are unreactive.

Question 28

Most candidates correctly calculated the density of the object. Some made an error in the power of ten and opted for option **B**.

Question 29

A significant number of candidates incorrectly selected option **A**, believing that a resultant force is needed to keep an object moving at constant speed in a straight line. The most likely confusion here is between a resultant force and a driving force to overcome resistive forces.

Question 34

In this question on reflection, the incorrect options **A** and **B** were commonly chosen, with candidates being uncertain about identifying the angles of incidence and reflection.

Question 35

The most common mistake here was to believe that television remote controllers use microwaves.

Question 38

A significant number of candidates chose option **C** rather than the correct option **D**. This incorrect value could be obtained by dividing the power by the voltage, giving the current rather than the resistance.

Question 39

This question on the effect of a variable resistor in a series circuit proved challenging for many, with options **B** and **D** being chosen frequently. A possibility is that some thought that the correct choice in each column could not be the same, both decrease.

Question 40

Many candidates looked for the greatest number of resistors in an arrangement, believing that this must produce the greatest resistance. Option **D** was a more common choice than the correct option, **A**.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Questions 1**, **6**, **9**, **12** and **13**. **Questions 8**, **10**, **20**, **25**, **39** and **40** proved the most for candidates.

Comments on specific questions

Question 1

Most candidates were able to identify the outermost layer of animal and plant cells. Some candidates chose option **C** or **D** forgetting that animal cells do not have cell walls.

Question 2

Many candidates thought that the characteristic exhibited by the car was either excretion or nutrition. Few correctly selected option **D**, respiration.

Question 3

Most candidates answered this question correctly. Where candidates chose the incorrect option, they had predominantly reversed the correct answer.

Question 4

Most candidates selected the correct option **A**. Some candidates chose option **C**. Whilst the shape of this graph was correct, the axis labels were incorrect. Candidates should take care when looking at the options in this style of question, paying particular attention to the axes.

Question 5

Most candidates selected the correct option **C**. Where candidates selected from the incorrect options, **A** was frequently selected. This shows the misconception that photosynthesis releases carbon dioxide.

Question 7

Many candidates chose the correct answer, option **D**. Some candidates incorrectly chose option **C**. This was the phloem rather than the xylem. Candidates had identified that water moves from the roots to the leaves, but they could not decide between the vessels.

Question 8

Most candidates thought that increased physical activity increases the rate of breathing but decreases the depth. Candidates need to realise that the volume of air of each breath increases and therefore depth of breathing will increase.

Question 9

Most candidates answered this question correctly. Where candidates had chosen the incorrect option, they chose option **A**, all three responses. Pupil diameter increases, not decreases, with the secretion of adrenaline.

Question 10

Most candidates found this question challenging. Candidates predominantly chose the incorrect answer, option **D**. There is positive and negative gravitropism, therefore, option **C** is correct.

Question 13

Most candidates answered this question correctly. Those not choosing the correct answer mostly opted for fossilisation as the arrow emanating from the power station / factory. This may be because they linked the power station / factory to fossil fuels.

Question 20

Candidates chose the incorrect option **D** more often than the correct option, **C**. Candidates are expected to be able to describe endothermic and exothermic reactions, including changes to reaction mixture temperatures and energy transfers.

Question 21

Candidates had difficulty identifying whether carbon and carbon dioxide were oxidised or reduced when they react with each other. The loss of oxygen from carbon dioxide is reduction and the gain of oxygen by carbon is oxidation.

Question 25

There was evidence that many candidates had guessed at the answer. Candidates are expected to know that copper is extracted from copper oxide by heating with carbon.

Question 27

Some candidates chose the incorrect option **C**, rather than the correct option **D**. Candidates should be able to identify alkanes by their names, and they are required to know that methane is the main constituent of natural gas. They are also expected to be able to describe the complete combustion of hydrocarbons to give carbon dioxide and water.

Question 29

This question on mass and weight proved demanding for many candidates. The most common mistake was to select option **C**, these candidates neglecting to convert the mass into kilograms.

Question 31

Some candidates thought that the ball had maximum kinetic energy at point **B**, rather than point **C**.

Question 34

A significant proportion of candidates incorrectly chose option **C**. These candidates thought that heating both the nut and the bolt helps to remove the nut, not realising that the amount of expansion must be different for the two.

Question 35

In this question on wave terms, many candidates were uncertain and chose option **B** or **D**, showing uncertainty about the meaning of amplitude.

Question 36

Many candidates chose option **B**, omitting to double the distance to the wall when calculating speed.

Question 38

Although the majority knew the unit for resistance, there was uncertainty about the unit for potential difference.

Question 39

Many candidates confused the resistance of series and parallel arrangements as many selected option **D**, which has the least resistance of the four options.

Question 40

Many candidates looked for the greatest number of resistors in an arrangement, believing that this must produce the greatest resistance. Option **D** was a more common choice than the correct option **A**.

COMBINED SCIENCE

Paper 0653/13
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Questions 1**, **5**, **10** and **13**. **Questions 2**, **4**, **8**, **11**, **27**, **35**, **37** and **39** proved the most challenging for candidates.

Comments on specific questions

Question 1

Most candidates were able to identify the outermost layer of animal and plant cells. Some candidates chose option **C** or **D** forgetting that animal cells do not have cell walls.

Question 2

Many candidates thought that the characteristic exhibited by the car was either excretion or nutrition. Few correctly selected option **D**, respiration. Candidates tended to focus on the fuel aspect of the question rather than the release of energy part of the question.

Question 3

A significant number of candidates thought that diffusion was the movement of molecules against a concentration gradient.

Question 4

Candidates found this question challenging. Option **B** was the option chosen most frequently but was incorrect as glycerol is not made from glucose molecules. A potential reason for this may be because, like glucose, both molecules start with 'gl'.

Question 5

Most candidates chose the correct answer, option **C**. Where candidates selected from the incorrect options, there was a preference for option **D**, the process being incorrectly identified as respiration.

Question 6

Some candidates incorrectly selected option **C**, the large intestine, as the site for egestion. The correct option was **D**, the anus.

Question 7

Candidates found it challenging to distinguish between the correct answer, option **A** and the incorrect, option **B**. This indicates that the candidates could identify the muscular wall and septum but could not identify the left and right sides of the heart. Heart diagrams are presented as if looking at a heart in another person facing the observer. This means that the left side of the heart is on the right side of the diagram.

Question 8

Candidates found this question challenging. Most incorrectly selected option **C**. The main reason was that most had correctly placed the bronchi and bronchioles, but they had not been able to correctly place the larynx and trachea.

Question 9

Most candidates thought that increased physical activity increases the rate of breathing but decreases the depth. Candidates need to realise that the volume of air of each breath increases and therefore depth of breathing will increase.

Question 11

Most candidates found this question very challenging. Many incorrectly chose option **C**, indicating that the shoot response was caused by phototropism and the root response was caused by gravitropism. Candidates needed to read the question carefully as the seedling was underground and therefore the plant could not be affected by light.

Question 12

Candidates found this question challenging. Many candidates identified the uterus and ovaries as the site of fertilisation. The correct answer, oviducts, was chosen by a small percentage of candidates.

Question 13

Most candidates found this question easy. Where candidates had chosen the incorrect option, they had eliminated **A**: carnivore, and then guessed between the remaining options.

Question 17

Candidates selected the incorrect option **D** more often than the correct option **A**. Candidates are expected to be able to identify the symbols of metallic and non-metallic elements and to understand that covalent bonds only form between non-metallic elements.

Question 21

Candidates had difficulty identifying whether carbon or carbon dioxide was oxidised or reduced when they react with each other. The loss of oxygen from carbon dioxide is reduction and the gain of oxygen by carbon is oxidation.

Question 23

Candidates chose the incorrect option **B** more often than the correct option **A**. Candidates are expected to know that iron(II) ions form a green precipitate with aqueous sodium hydroxide and that carbon dioxide gas turns limewater milky.

Question 24

There was evidence that many candidates guessed at the answer. Krypton, Kr, is a noble gas and noble gases are unreactive.

Question 26

Candidates chose the incorrect options **B** and **C** more often than the correct option **D**. Oxygen would decrease as the iron rusted.

Question 27

Some candidates chose the incorrect option **C**, rather than the correct option **D**. Candidates should be able to identify alkanes by their names, and they are required to know that methane is the main constituent of natural gas. They are also expected to be able to describe the complete combustion of hydrocarbons to give carbon dioxide and water.

Question 29

This question on density proved challenging. The most common mistake was to forget to subtract the mass of the empty bottle, leading to option **C** being selected.

Question 30

Although most candidates appreciated that snowshoes did not change the weight of the man, a significant number thought that they decreased the area of contact with the snow.

Question 32

A significant number of candidates incorrectly believed that tides and wind are non-renewable energy resources.

Question 33

A significant proportion of candidates incorrectly chose option **C**. These candidates thought that heating both the nut and the bolt helps to remove the nut, not realising that the amount of expansion must be different for the two.

Question 34

More candidates incorrectly selected option **A** rather than the correct option **B**, apparently confusing conduction and convection.

Question 35

This question on sound was very poorly answered, with all the incorrect options proving more popular than the correct option **C**. The most common error was to forget to halve the distance calculated, leading to a choice of option **D**.

Question 37

Very few chose both units correctly. Candidates should be reminded that the correct choice in each column can be the same, in this case ‘volt’.

Question 38

Here the popularity of option **D** suggests that several candidates believed the potential difference across the 2.0 Ω resistor to be 12 V, leading them to divide 12 by 2.0 to give a current of 6.0 A.

Question 39

This question on the effect of a variable resistor in a series circuit proved challenging for many, with options **B** and **C** being chosen more often than the correct option **A**. A possibility is that some thought that the correct choice in each column could not be the same (both 'decreases').

Question 40

Many candidates thought that the purpose of a fuse is to increase the voltage if the current becomes too small, therefore choosing option **B**.

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

General comments

Candidates performed very well on **Questions 1**, **3**, **4**, **6**, **9**, **13** and **14**. **Questions 2**, **8**, **10**, **20** and **38** proved the most challenging for candidates.

Comments on specific questions

Question 1

Most candidates were able to identify the outermost layer of animal and plant cells. Some candidates chose option **C** or **D** forgetting that animal cells do not have cell walls.

Question 2

Most candidates identified an option showing an arrow crossing the cell membrane although some had not chosen the correct direction. A cell in concentrated salt solution will lose water by osmosis. A number of candidates chose an option that showed water crossing the cell wall.

Question 3

Most candidates correctly selected option **B**. Some candidates incorrectly chose option **A** but this is incorrect because stomach acid does not slow down all reactions as enzymes in the stomach are more active in an acidic environment.

Question 5

Most candidates correctly selected option **A**. Some candidates incorrectly chose option **B**. They had identified that proteases worked on proteins but they did not correctly identify where the protease was secreted or the end product.

Question 8

Most candidates selected the correct answer. The incorrect answer that was chosen preferentially was option **C**. This indicates that most thought that increased physical activity increases the rate of breathing but decreases the depth. Candidates need to realise that the volume of air of each breath increases and therefore depth of breathing will also increase.

Question 9

Most candidates correctly selected option **B**. When candidates chose the incorrect option, it was frequently option **C**. This is incorrect because adrenaline increases the beathing rate.

Question 10

Most candidates found this question very challenging and incorrectly selected option **B**, indicating that the root response was caused by gravitropism and the shoot response was caused by phototropism. Candidates needed to read the question carefully as the seedling was in a light-proof box and therefore the plant could not be affected by light.

Question 14

Most candidates were able to interpret the results of the tests and thereby identify the chemical change in option **B**.

Question 17

Candidates had some difficulty understanding how increasing the concentration changes the rate of a chemical reaction. When the concentration increases, the particles are closer together and they collide more frequently.

Question 20

Many candidates chose the incorrect option **B** rather than the correct option **C**. They are expected to be able to use the Periodic Table to identify the order in which elements are placed in a group. They are also expected to know that the Group I elements show a decreasing trend in melting point and an increasing trend in density down the group.

Question 29

This question on pressure proved demanding with candidates missing the fact that there were four legs on the table, therefore choosing option **D**. Also, many candidates omitted to multiply the mass by *g* to find the weight, leading to option **B**.

Question 31

In this question many candidates simply multiplied the mass by the speed and therefore chose the incorrect option, **B**.

Question 35

The most common mistake here was to believe that television remote controllers use microwaves, option **A**.

Question 38

This question on the effect of a variable resistor in a series circuit proved challenging for many, with option **C** being chosen frequently. A possibility is that some thought that the correct choice in each column could not be the same, both decreases.

COMBINED SCIENCE

Paper 0653/22
Multiple Choice (Extended)

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

General comments

Candidates performed very well on **Questions 1**, **2**, **4**, **7**, **9**, **11** and **31**. **Questions 8**, **10**, **23**, **32**, **38** and **39** proved the most challenging for candidates.

Comments on specific questions

Question 1

Most candidates were able to identify the outermost layer of animal and plant cells. Some candidates chose option **C** or **D** forgetting that animal cells do not have cell walls.

Question 2

Most candidates answered this question correctly. Where candidates chose the incorrect option, they had predominantly reversed the correct answer.

Question 3

Most candidates correctly selected option **B**. Some candidates incorrectly chose option **A** but this is incorrect because stomach acid does not slow down all reactions as enzymes in the stomach are more active in an acidic environment.

Question 5

This question was well answered by most candidates. A few candidates chose the incorrect option **B**, forgetting that mechanical digestion works on food, not molecules.

Question 7

Most candidates correctly selected option **C**. A number of candidates chose the mirror image of the correct answer.

Question 8

Most candidates selected the incorrect answer, option **C**. This indicates that most thought that increased physical activity increases the rate of breathing but decreases the depth. Candidates need to realise that the volume of air of each breath increases and therefore depth of breathing will also increase.

Question 9

Most candidates answered this question correctly. Where candidates chose an incorrect option, they frequently chose option **A**. This is incorrect because pupil diameter increases with the secretion of adrenaline.

Question 10

Most candidates found this question challenging. The most common incorrect answer was option **D**: grows towards gravity. Candidates need to be reminded that there is positive and negative gravitropism, both are a response to gravity and therefore option **C** is correct.

Question 11

The majority of candidates correctly identified that the position of the stigma was outside the flower. Many incorrectly identified the pollen shape.

Question 15

Candidates understood the differences between elements, mixtures and compounds, and also that noble gases exist as monoatomic gases.

Question 19

Although the candidates knew that the production of crystals of magnesium nitrate involves filtration and evaporation to the point of crystallisation, they appear to have guessed between the incorrect option **B** and the correct option **D**. Candidates are expected to understand that an excess of the solid reagent can be filtered off to leave a solution containing only the dissolved salt.

Question 23

Candidates chose the incorrect option **D** more often than the correct option **B**. Candidates are required to be able to describe and explain the essential reactions in the extraction of iron from hematite in the blast furnace. This includes the reduction of iron(III) oxide, Fe_2O_3, the form of iron oxide present in hematite, by carbon monoxide.

Question 28

Candidates appeared uncertain about this question on the extension of a spring, with all four options proving popular.

Question 30

In this question many candidates selected option **C**, correctly linking doubling power with doubling the work done, but not understanding that halving the time as well would involve doubling the power a second time.

Question 36

Many candidates understood the information provided about electric charge and correctly chose option **B**.

Question 37

The incorrect option **B** was commonly chosen, these candidates believing that the effect of halving the length is cancelled by doubling the cross-sectional area.

Question 38

This question on the effect of a variable resistor in a series circuit proved challenging for many, with option **C** being chosen frequently. A possibility is that some thought that the correct choice in each column could not be the same, both decreases.

COMBINED SCIENCE

Paper 0653/23
Multiple Choice (Extended)

Question Number	Key
1	B
2	B
3	B
4	A
5	A
6	D
7	A
8	D
9	C
10	A

Question Number	Key
11	A
12	B
13	D
14	B
15	D
16	C
17	B
18	A
19	C
20	D

Question Number	Key
21	A
22	A
23	B
24	C
25	D
26	D
27	C
28	C
29	D
30	C

Question Number	Key
31	B
32	D
33	B
34	D
35	A
36	C
37	B
38	A
39	C
40	A

General comments

Candidates performed very well on **Questions 1**, **2**, **4**, **7**, **9**, **14**, **24**, **28** and **30**. **Questions 8**, **10**, **16**, **20**, **27**, **38** and **39** proved the most challenging for candidates.

Comments on specific questions

Question 1

Most candidates were able to identify the outermost layer of animal and plant cells. Some candidates chose option **C** or **D** forgetting that animal cells do not have cell walls.

Question 2

Most candidates correctly selected option **B**. A number of candidates thought that diffusion was the movement of molecules against a concentration gradient.

Question 3

Most candidates correctly selected option **B**. Some candidates chose option **A** but this is incorrect because stomach acid does not slow down all reactions as enzymes in the stomach are more active in an acidic environment.

Question 4

The majority of candidates understood that the function of stomata is gas exchange. A small number of candidates thought that the function of the stomata was the transport of water.

Question 6

This question was well answered by most candidates. Where candidates had chosen an incorrect option, they had incorrectly identified step 1 as chemical digestion.

Question 7

This question was well answered by most candidates. Some candidates incorrectly thought that root hair cells were involved in carbon dioxide uptake.

Question 8

Most candidates selected the incorrect answer, option **C**. This indicates that most thought that increased physical activity increases the rate of breathing but decreases the depth. Candidates need to realise that the volume of air of each breath increases and therefore depth of breathing will also increase.

Question 10

Most candidates found this question very challenging. Many incorrectly chose option **C**, indicating that the shoot response was caused by phototropism and the root response was caused by gravitropism. Candidates needed to read the question carefully as the seedling was underground and therefore the plant could not be affected by light.

Question 13

Some candidates found this question easy although a significant number thought that tuna were quaternary consumers in the food chain shown.

Question 15

Many candidates chose the incorrect option **A** rather than the correct option **D**. Candidates are required to describe the differences between metals and non-metals.

Question 16

There was evidence that many candidates found this question very challenging. Many candidates chose the incorrect option **D** rather than the correct option **C**. Candidates are required to describe electrolysis in terms of the reactions at the electrodes in terms of electron transfer, which includes the external circuit.

Question 20

Candidates chose the incorrect option **C** more often than the correct option **D**. They are expected to be able to use their understanding of the reactions of dilute acids and the information provided to deduce which salt can be formed by the method described.

Question 23

Candidates chose the incorrect option **C** more often than the correct option **B**. Candidates should be able to describe and explain the essential reactions in the extraction of iron from hematite in the blast furnace.

Question 27

Candidates chose the incorrect options **A** and **B** more often than the correct option **C**. Alkenes decolourise aqueous bromine.

Question 31

Many candidates selected the incorrect option **D**. Although the candidates making this mistake knew that increasing the temperature of the gas increases the speed of the molecules, they failed to take into account that the volume of the gas decreased, so the molecular separation decreases.

Question 33

A significant proportion of candidates confused convection with conduction, therefore choosing option **A**.

Question 34

In this question on the wave equation many candidates incorrectly divided the frequency by the speed, leading to option **A**.

Question 35

There was considerable uncertainty about a possible position for the image formed by the lens. A large number of candidates chose positions **B** or **D**, not realising that the image must be further from the lens than the insect and on the same side of the lens.

Question 36

Many candidates were unsure about the speed of sound in different media. A few chose a liquid, but a vacuum was a popular choice, perhaps confusing sound with light.

Question 38

This question on the effect of a variable resistor in a series circuit proved challenging for many, with option **C** being chosen by the majority of candidates. It is possible that some thought the correct choice in each column could not be the same (both 'decreases').

Question 39

A significant proportion of candidates neglected to convert the time to seconds and therefore selected option **A**. Some divided the voltage by the current to arrive at option **B**. Option **C** was the correct answer.

COMBINED SCIENCE

Paper 0653/31
Theory (Core)

Key messages

Candidates who did well on this paper:

- read the questions carefully
- were familiar with the contents of the syllabus
- were able to express their answers in a clear and legible way
- showed their working in numerical answers
- knew the analytical tests for iron(II) and sulfate ions.

General comments

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

Comments on specific questions

Question 1

(a) Many candidates identified the parts of the female reproductive system correctly. The least well-known answer was that fertilisation takes place in part **E**, the oviduct. The most common incorrect answer for this was **D**, the ovary.

(b) During the first few days of the menstrual cycle the lining of the uterus becomes thinner. Some candidates gained credit for expressing this idea. Other candidates said that the lining becomes thicker to prepare for an embryo. This happens later in the menstrual cycle, not at the start.

(c) Some candidates gained full credit for this question. The terms zygote and embryo were not widely known. Common incorrect answers included fetus and baby.

Question 2

(a) (i) The candidates had to identify salt **MX** as the solute, and water as the solvent. Stronger candidates gained full credit. Others wrote them the wrong way round.

(ii) Candidates found this question very challenging. The ions in **MX** were identified using the results of the analytical tests in the first column of the table. Very few candidates gained credit in this question. Candidates are reminded that the analytical tests are provided for the practical examination only, and they should be learned for theory papers.

(b) (i) There were many correct answers to this question. Incorrect answers included evaporation and using a magnet.

(ii) Many candidates correctly identified the separation process as a physical change. They found the explanation more challenging with few candidates stating that no new chemicals are formed.

(iii) Candidates generally gave the correct answer that increasing the temperature increases the rate of the reaction.

(iv) Candidates found this question challenging. Very few knew that cations are formed by the loss of electrons. Some candidates stated incorrectly that the electrons are gained by the metal. Others simply stated that metal **M** becomes a cation during the reaction, which is just restating the question.

(v) During the reaction, the concentration of acid gradually decreases. Therefore, the pH increases. The acid at the start has a low pH value and as its acidity is gradually lost during the reaction, the pH increases. Many candidates answered this correctly, but others stated that the pH decreased so did not gain credit.

Question 3

(a) The correct answer, weight, was stated by only a few candidates. Most candidates wrote gravity. Force **S** is weight, the result of the Earth's gravitational field (gravity) acting on the total mass of the trolley.

(b) (i) Some candidates knew that if the trolley is moving at constant speed the forces on it are balanced. Therefore, the magnitude of force **R** = the magnitude of force **P** = 15 N.

(ii) Some candidates found this question challenging. Credit was awarded for an error carried forward from **b(i)**. The resultant force was 20–15 N (force **R**) = 5 N.

(iii) The resultant force on the trolley means that the trolley will accelerate. Many candidates answered this question correctly. Credit could not be awarded when candidates stated that the motion will increase or that the trolley will move faster or slower.

(c) (i) Candidates found this question challenging. The amount of energy transferred to the trolley equals the amount of work done on the trolley by the man. Very few candidates understood this concept.

(ii) Many candidates entered kinetic energy correctly in the second box. Fewer knew that chemical energy is stored in the man. Some candidates wrote 150 J in the boxes, following on from **b(i)**. These responses were not acceptable because there was no way of knowing how much of the energy applied to the trolley was useful energy and how much was wasted.

(iii) Some candidates gained partial credit by stating that there was no driving force being applied to the trolley. A few responses also described the frictional forces which slow the trolley, and these candidates were awarded full credit. Responses such as 'the man is not pushing' or 'there are no forces on the trolley' were not accepted.

Question 4

(a) (i) Many candidates gave the correct answer, cell membrane. Most of the remainder stated cell wall. Candidates are reminded that cell walls are only found in plant cells. The question states that the image is of a blood cell and is therefore an animal cell.

(ii) Those candidates who correctly identified the cell membrane in **(a)(i)** were more successful in this question. Evidence had to be taken from the diagram, so answers had to be based on observable structures in Fig. 4.1. The absence of a cell wall, large vacuole and chloroplasts were all acceptable answers, but 'no chlorophyll' did not gain credit because chlorophyll is a molecule, and it would not be visible even if a plant cell had been illustrated.

(iii) Either of the functions of white blood cells, phagocytosis or antibody production, were acceptable answers to this question. Very few candidates gained credit. The most common response was 'to fight off infection or disease'. Answers of this type were too vague and did not include the terms in the syllabus.

(b) (i) Candidates generally answered this question correctly.

(ii) This question was challenging to most candidates. To gain full credit, candidates had to explain that oxygen moves by diffusion from the lungs, where there is a high concentration of oxygen, to the red blood cells which have a low concentration of oxygen. Many responses described that oxygen moves from the lungs into the red cells, as stated in the question, and then around the body. These answers did not describe the process of diffusion and so were not awarded credit.

(c) (i) Many candidates gained credit for this question, The most common incorrect answer was starch.

(ii) This was generally well answered, with many candidates scoring full credit.

Question 5

(a) (i) Many candidates correctly stated exothermic as the answer. The wording of the question meant that specific reactions were excluded, for example combustion. Other incorrect answers included thermal reaction and thermal energy.

(ii) Some candidates answered the question correctly, stating natural gas. Incorrect responses seen included coal, oil and paraffin.

(iii) Generally, most candidates found the dot-and-cross diagram challenging. A few of the stronger candidates scored full credit. Many of the other candidates drew four straight lines between the carbon atom and the hydrogen atoms to represent four C-H bonds.

(b) (i) In this question, many candidates knew that the magnesium was oxidised. To gain full credit a correct explanation had to be stated and fewer candidates did this successfully. An example of an inadequate explanation stated that it is oxidised because it reacts with oxygen, rather than stating that the oxygen is added to the magnesium.

(ii) Several candidates stated either magnesium oxide (compound **Y)** or magnesium sulfate (compound **Z**) correctly, but few candidates stated both correct answers to gain full credit.

(iii) There were many acceptable answers to this question, as shown in the mark scheme, and many candidates scored full credit.

Question 6

(a) (i) Many candidates gained partial credit by stating radiation. Fewer candidates gave the required explanation that it is the only method of heat transfer that can take place without a medium. Incorrect answers included ‘it travels from the Sun’, ‘it travels in waves’ and ‘it goes through anything’.

(ii) Many candidates scored at least partial credit for this question, with many scoring full credit. Water waves and sound waves were some examples of incorrect waves entered in the electromagnetic spectrum.

(iii) Very few candidates gave the correct answer, eight minutes. These candidates seemed unaware that all electromagnetic waves travel at the same speed and therefore the time taken for ultraviolet waves to reach the Earth is eight minutes, the same as visible light. Many explanations referred to the different frequency that ultraviolet waves have compared with visible light. However, this only affects the wavelength, not the speed.

(b) (i) Candidates had to show a ray of light coming from the Sun, reflecting off the puddle and entering the man’s eye. The angle at which the incident ray from the Sun hit the puddle had to match the reflected ray from the puddle. To gain full credit the virtual image also had to be shown. Many candidates gained partial credit by drawing the ray diagram but did not include the virtual image. Full credit could not be awarded to those candidates who did not start their ray from the Sun, or did not draw the reflected ray entering the man’s eye. Only a few candidates managed to include the virtual image of the Sun as shown in the mark scheme.

(ii) To gain full credit in this question candidates had to describe what happens to the water molecules when the Sun transfers energy to the puddle. The answer required, involved the gain in kinetic energy of water molecules at the surface of the puddle enabling the more energetic molecules to escape. Not many candidates made both points. Some credit was awarded to those candidates who stated that the water molecules evaporated.

Question 7

(a) (i) Some candidates gained full credit for this question, but most found this question challenging. Many responses focused on the position of the producers in the food chain, stating that the producers are at the start of the food chain, or that they produce food for animals. Candidates should be aware that producers make their own nutrients by the process of photosynthesis using light energy from the Sun.

(ii) Candidates generally answered this question well.

(iii) The majority of candidates answered this question correctly giving two out of the three possible answers. A minority misinterpreted the flow of energy shown by the arrows and stated orca and leopard seal.

(iv) This question was answered correctly by most candidates. The most common error was the arrow going from the orca to the fish.

(b) (i) The two processes of combustion and fossilisation were known by a few candidates who gained credit. The most common incorrect responses included respiration for process **P** and decomposition for process **Q**.

(ii) Many candidates scored full credit in this question, stating a wide variety of correct answers. Some candidates referred to more carbon dioxide and there were various references to global warming. Careful reading of the question indicates that increased carbon dioxide concentration and its effects should not be included in responses.

Question 8

(a) (i) Many candidates gained credit in this question. Others seemed to misunderstand the question and wrote about other properties, for example reactivity and melting point.

(ii) The trend for the colours to become darker going down Group VII was known by many candidates. Those who were not familiar with the trend wrote several specific colours or just one colour.

(iii) Many candidates scored well in this question. Most of the correct responses stated that the elements in Group VIII are all gases.

(b) Many candidates gained partial credit for writing sodium as the most reactive metal. The place of aluminium was more challenging with many candidates putting it at the bottom of the list instead of iron.

(c) Some candidates scored full credit in this question. Others reversed the numbers, wrongly stating that there are 12 protons and 11 neutrons. Another common error was writing 23 for either response.

(d) This question was generally answered well. Most responses stated the use of helium in balloons to make them float. Describing the use of helium in hot air balloons was the most common answer that did not gain credit.

Question 9

(a) Many candidates gained partial credit with many scoring two marks. The first and third responses were the most common correct responses, with many candidates writing resistance for the second response.

(b) (i) Some candidates drew the circuit diagram correctly. Others were unfamiliar with the electrical symbols and frequently drew a picture of the components instead of using the correct symbols.

(ii) Candidates found this question challenging. The use of the switch to add the second lamp into the circuit causes the total resistance of the circuit to reduce, and therefore the current increases. Many candidates wrongly stated that the voltage increased when the switch is closed. Others did not understand that there was already a current of 0.5 A flowing in the circuit before the switch was closed and made statements like ‘now the electrical current can flow’.

COMBINED SCIENCE

Paper 0653/32
Theory (Core)

Key messages

Candidates who did well in this paper:

- read the questions carefully
- were familiar with the contents of the syllabus
- were able to express their answers in a clear and legible way
- showed their working in numerical answers.

General comments

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

Comments on specific questions

Question 1

(a) Many candidates correctly identified the larynx and the alveoli.

(b) This question, a comparison between inspired air and expired air, was answered correctly by most candidates.

(c) (i) The majority of candidates identified **A**, the person with the largest estimated lung volume.

(ii) Candidates had to state a trend, a relationship between the height and the estimated lung volume. This was done successfully by most candidates. Only a few did not express their answer in a comparative way to show the trend. Some incorrect responses stated that the relationship between height and lung volume was either proportional or directly proportional.

(d) (i) Some candidates identified the pulmonary vein correctly. Most placed the letter **P** in the lower part of the diagram which concerns the circulation around the body. The pulmonary vein carries oxygenated blood from the lungs back to the heart, so the correct blood vessel connects the lungs and the heart at the top right of the diagram.

(ii) Many candidates answered this correctly.

(e) There were two marks for this question. Many candidates gained credit for the role of the red blood cells in transporting oxygen. Only a few mentioned the role of haemoglobin in combining with oxygen in the red blood cells.

Question 2

(a) (i) Many candidates correctly stated reduction. Incorrect answers included deoxidation and exothermic.

(ii) This question was answered correctly by many candidates who wrote endothermic. The most common mistake was exothermic.

(iii) Stronger candidates compared the reactivities of the two metals with carbon. Many candidates compared the reactivities of the two metals but did not include carbon in their answers so could not be awarded full credit. Candidates are reminded that carbon can be used to extract zinc, a less reactive metal from its oxide but it cannot be used to extract magnesium in the same way because magnesium is more reactive than carbon.

(b) (i) The reaction between the base, zinc oxide, and dilute sulfuric acid produces a salt and water. Many candidates correctly stated that the salt was zinc sulfate, knowing that sulfuric acid produces sulfate salts. Fewer candidates gave water as the second product. Incorrect answers included hydrogen and oxygen.

(ii) During the reaction the concentration of sulfuric acid gradually decreases as it reacts with the zinc oxide. The sulfuric acid at the start has a low pH value and as it is used up in the reaction the pH increases. Many candidates answered this correctly but others stated that the pH decreased so did not gain credit.

(c) Some candidates scored full credit in this question. Others reversed the numbers, wrongly stating that there are 35 electrons and 30 neutrons. Another common error was writing 65 for either response.

Question 3

(a) (i) The correct answer, weight, was stated by only a few candidates. Most candidates wrote gravity. The question gives a definition for weight, the result of the Earth's gravitational field (gravity) acting on the total mass of the candidate and the scooter. Therefore, the answer gravity was unacceptable. Other incorrect answers included gravitational force and gravitational potential energy.

(ii) Many candidates answered this question correctly by multiplying the mass by 10 to give 350 N. The most common mistake was dividing the mass by 10, resulting in the incorrect answer of 3.5 N.

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

(ii) The maximum speed had to be multiplied by the time travelled at that speed to calculate the distance. Some candidates gained full credit, but many used an incorrect time, for example 12 s. In this type of question, candidates should state the formula so that partial credit can be awarded even if the final answer is incorrect.

(iii) The number of metres in 3.6 km and the number of seconds in an hour both had to be calculated. The answers, 3600 m and 3600 s, could then be used to show that the speed was 1.0 m / s. Stronger candidates gained full credit for this question.

Question 4

(a) (i) Some candidates correctly identified the scrotum. The most common mistake was testis which is the structure inside the scrotum.

(ii) A minority of candidates named the prostate gland correctly. Incorrect answers included penis and semen.

(b) Many candidates gained partial credit for this question. A common misconception was stating that fertilisation takes place in the uterus instead of the oviduct. The second response, zygote, was relatively rarely stated.

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

(ii) Many candidates found this question challenging. The thickness of the uterus lining changes in three stages. It decreases, then increases, then remains constant. To gain full credit all three stages had to be stated along with a suitable reference to data from the diagram. Some candidates did this successfully, but others gave an incomplete interpretation of the thickness, or omitted the reference to data altogether. Some answers included the level of hormones in the blood which was not relevant to this question.

(d) Many candidates gained credit in this question. Unacceptable responses were vague statements, for example 'to have a balanced diet' and 'the mother needs it for the baby'.

Question 5

(a) (i) Generally well answered. Most candidates stated electrolysis as the process.

(ii) Many candidates correctly stated cathode for the negative electrode. The most common mistake was writing anode.

(iii) A few candidates named either platinum or carbon as an example of the element making up the electrodes. There were many incorrect responses, including metals that would react with the water in the electrolyte.

(iv) The type of bonding, ionic, was stated by the stronger candidates. The most common mistake was covalent bonding. This was not correct because there are no charges on a covalent molecule. Ionic compounds have positive and negative charges which can be attracted to the oppositely charged electrodes.

(v) Some candidates answered this question correctly. There were many incorrect answers, including hydrogen and ammonia. Chloride was not acceptable because the element chlorine was needed for the correct answer, not the negative ion.

(vi) The most important key to answering this question was to decide whether a new substance is formed. In the electrolysis experiment shown, new substances are made at the two electrodes, therefore it shows a chemical change. Many candidates identified the electrolysis as a chemical change but did not provide an adequate explanation.

(b) (i) Candidates generally found this question challenging. An element containing only one type of atom was the important point to state in the answer. Therefore, responses that stated that an element is only one atom did not gain credit. In a similar way, it was not adequate to state that a compound has two atoms. They had to be two or more different atoms joined together.

(ii) The ideas that a compound is one single substance (made up from the joining together of two or more different atoms), and a mixture is made up from two or more substances that are not combined chemically were crucial to answering this question. Some candidates wrote an acceptable answer, but many candidates found it difficult to express their ideas.

(c) (i) There are two chemical tests for water as stated in the syllabus, one with copper(II) sulfate and the other with cobalt(II) chloride. Very few candidates knew either of them. Some of the common errors included testing with pH paper, reacting with sodium and assessing physical characteristics, for example boiling point and colour.

(ii) Many candidates answered this question correctly, stating distillation. Incorrect responses included boiling, filtration and crystallisation.

Question 6

(a) This question was answered well by most candidates who demonstrated a good knowledge of the electromagnetic spectrum.

(b) (i) The Ohm's Law calculation was generally answered well. The most common incorrect answer was 253 Ω which candidates obtained by multiplying the voltage by the current instead of dividing the voltage by the current. Many candidates were unsure of the correct unit, Ω. Incorrect answers for the unit of resistance were volts, amps and watts.

(ii) The advantages of connecting the bulbs in parallel were in the context of the use by the farmer. Most candidates stated that if one bulb goes out, the other will stay on. Less frequently stated was that the bulbs can be independently controlled, allowing for adjustment of the amount of heat reaching the chicks.

(c) (i) Many candidates interpreted the information correctly and concluded that when the frequency decreases the pitch of the sound becomes lower.

(ii) This question involved deciding whether the frequencies of sound from the chick were within the human range of hearing from 20 Hz – 20000 Hz. Therefore, some explanation was needed as well as the answer 'yes'.

Question 7

(a) (i) This question was generally answered well. Candidates interpreted the information to write a correct food chain with the arrows going in the correct direction. The arrows represent the flow of energy which is from the phytoplankton through to the penguins.

(ii) Many candidates identified the krill as the only possible answer. The krill feed on the phytoplankton which are the microscopic (very small) producers.

(b) Many candidates gained credit for stating that chlorophyll is required for photosynthesis. Fewer stated that the chlorophyll absorbs light energy or that photosynthesis causes carbohydrates to be made.

(c) The flowchart of the pathway of food through the human alimentary canal was well answered by most candidates.

Question 8

(a) The whole of this question was answered correctly by only a few candidates. Many could identify propene, the alkene, because there was a double bond present in the molecule. The candidates were confused about which of the remaining two compounds was the alkane and which one was not a hydrocarbon. Candidates are reminded that a hydrocarbon contains only hydrogen and carbon, so that should indicate that ethanol, containing oxygen, is not a hydrocarbon. The remaining compound, poly(ethene) has only single bonds visible. Candidates may have been unfamiliar with the formula of a polymer, or they may have seen the word ethene in the name of the polymer. When ethene molecules form a polymer, the double bonds disappear as they are used to connect the molecules of ethene.

(b) This was generally well answered by most candidates who stated oxygen as the gas in the air which reacts with the compounds shown in Table 8.1.

(c) There were very few correct answers given here. The most common mistake was fractional distillation stated for either response.

Question 9

(a) (i) Some candidates scored full credit by stating all the correct names for the energy transfer. Since the diagram showed a heater, many candidates correctly stated 'thermal energy' as the end result of the energy transfer. Only a few candidates wrote chemical potential for the initial form of energy in the battery. The most common mistake was electrical energy for this response.

(ii) Many candidates found the electrical circuit challenging. Although some candidates scored full credit, there were many who did not know the symbol for a variable resistor or the battery. The symbol for a switch should always be shown in the open position.

(b) (i) The majority of candidates knew that when a thermometer is placed in a hot liquid the level of liquid inside the thermometer goes up. Fewer explained why this happened in terms of expansion of the liquid.

(ii) Candidates found this question challenging. By studying the table, candidates had to decide on a liquid that was in the liquid state at both –10°C and +110 °C so that it would include the scale of the thermometer. Very few candidates stated liquid **C**, the correct answer. All other liquids were seen.

(iii) Some answers were correct, stating that since the freezing point is below –10°C and the boiling point is above 110°C, liquid **C** must be in the liquid state over the range of the thermometer.

COMBINED SCIENCE

Paper 0653/33
Theory (Core)

Key messages

Candidates who did well in this paper:

- read the questions carefully
- were familiar with the contents of the syllabus
- were able to express their answers in a clear and legible way
- showed their working in numerical answers.

General comments

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

Comments on specific questions

Question 1

(a) Most candidates connected the boxes successfully and were awarded full credit.

(b) Most candidates could identify **A**, the stigma, as the place where pollination takes place. They found the part that makes pollen more challenging to identify, with many candidates stating **C** instead of **E**.

(c) This question required candidates to describe fertilisation. The process of fertilisation occurs when two nuclei fuse. In this case, the nuclei are found in the pollen grain and in the ovule. Therefore, fertilisation occurs deep inside the flower. Most candidates described the process of pollination, so no credit could be awarded.

(d) (i) Asexual reproduction was stated by many candidates.

(ii) Most candidates correctly ticked the first box stating that the advantage of asexual reproduction is that all the offspring will be genetically identical.

Question 2

(a) (i) This question was about one of the tests for water (vapour) in the air. Very few candidates identified this correctly. The majority wrote carbon dioxide or oxygen, so did not gain credit.

(ii) This question was about the use of anhydrous copper(II) sulfate to test for water (vapour) in the air. Candidates were unfamiliar with this test, and many wrote brown as the initial colour.

(b) Some candidates were able to make the comparison between clean air and air from the candidate's lungs to gain credit. Some statements were not accepted, for example 'the candidate expired pure carbon dioxide'.

(c) This question was asking for an acidic air pollutant that would turn the damp blue litmus paper red. Carbon dioxide was excluded by the question, and methane is not an acidic gas, so these answers did not gain credit.

(d) (i) Some candidates scored credit for this question by stating methane. Incorrect answers included oxygen and carbon dioxide.

(ii) This question was generally answered well.

(iii) The answer required was exothermic, a general name for chemical reactions that give out heat. Therefore, specific reactions, for example combustion, were not accepted.

Question 3

(a) (i) Candidates had to add a force arrow to show the gravitational force acting on the block. This meant that the force arrow had to touch the block and point vertically downwards. There were many force arrows drawn which did not touch the block, so did not gain credit.

(ii) The answer to this question required candidates to show the arrow pointing upwards from the table. Many arrows drawn by candidates did not touch the table, so these scripts could not be awarded credit.

(iii) Some candidates stated correctly that the force from the table had to balance the force from the block, 300 N, otherwise the block would move.

(iv) Stronger candidates gained full credit in this question by dividing the weight, 30 N by the gravitational force per unit mass, 10 N / kg to get the correct answer, 3.0 kg. A common error was multiplying the weight by 10 and stating 300 kg.

(v) There were many correct answers to this density calculation. The mass calculated in part **(iv)** was used in this calculation. Therefore, an error carried forward was allowed if the mass calculation was inaccurate. Candidates are reminded that partial credit is awarded for a correct formula so it is always advisable to show working.

(b) Some candidates gained full credit for this question. Others entered incorrect forms of energy. Very few candidates knew that chemical energy was the form of energy stored in the student.

Question 4

(a) (i) Many candidates identified the parts of the heart correctly. A common error was to confuse the labels for the atrium and the ventricle.

(ii) The arrows on the diagram clearly show the direction of blood flow. The blood flowing through vessel **V** is on its way to the lungs, leaving the heart. Therefore, vessel **V** is an artery.

(iii) Stronger candidates named the circulatory system correctly.

(b) Many candidates stated the phloem and xylem to gain full credit.

(c) (i) Generally well answered by most candidates.

(ii) Candidates found this question challenging. Fig. 4.2 contains information about petroleum jelly which makes leaf **B** waterproof and blocks the stomata, therefore preventing water loss.

Question 5

(a) Candidates had to use their knowledge of the trends of Group I metals. Many candidates gained partial credit for this question. The most common error was stating sodium as having the highest melting point.

(b) (i) Some candidates stated correctly that diatomic molecules contain two atoms. Others stated that they contain two molecules so did not gain credit.

(ii) Most candidates found the dot-and-cross diagram challenging. To gain full credit the diagram should show one pair of shared electrons representing the covalent bond, and three lone pairs on each atom.

(iii) Some candidates gained credit in this question by stating covalent (bonding). The most common error was ionic.

(c) (i) Stronger candidates gained full credit by writing about electron loss by the sodium atoms and electron gain by the chlorine atoms. Incorrect responses included descriptions of the two atoms sharing electrons to form a covalent bond.

(ii) The fact that sodium is a metal means that it conducts electricity in both solid and molten states. In the case of sodium chloride, which is ionic, conduction of electricity will only occur when the ions are free to move in the molten state. In the case of chlorine, a molecular gas, it is unable to conduct electricity.

Question 6

(a) (i) Most candidates identified ice as the substance fitting the description, which is a solid.

(ii) The process of melting was stated by most candidates who scored credit. Fewer candidates stated that the temperature at which melting occurs is 0 °C.

(b) (i) Some candidates gave refraction as their answer and therefore gained credit. Incorrect responses included reflection and reflaction.

(ii) The angle of incidence was known by a few candidates. The most common errors were refraction angle, acute angle and numerical values of the angle in degrees.

(c) (i) Candidates had to perform a unit conversion in this question. They could either convert the width of the glacier to 95 000 m wide, then divide by the speed of sound, 3800 m / s given in the question, or change the speed of sound from 3800 m / s to 3.8 km / s and divide this into the 95 km given. Each calculation leads to 25 s. Some candidates gained full credit. Others either did not do the conversion correctly or used the wrong equation.

(ii) Candidates had to know the hearing range in adults and then decide whether the hearing range of the penguin is within this range. Many of the responses were too vague and did not give enough detail about the ability of both humans and penguins to hear specific frequency ranges.

Question 7

(a) (i) A few candidates gained credit in this question. The most common error was stating nutrients, for example carbohydrates, proteins and fats.

(ii) Some candidates correctly circled fatty acids. Fewer selected glycerol as their second choice. Glycogen was frequently selected instead.

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

(c) Many candidates gained credit by stating that the maximum activity occurs at pH 9. Stronger candidates also described both the increasing activity before pH 9 and the decreasing activity after pH 9.

Question 8

(a) (i) The question was asking for alkanes, the general name for saturated hydrocarbons. Many candidates wrote the individual names of fractions taken from the diagram. Careful reading of the stem of the question shows that the description applies to all hydrocarbons obtained from the column.

(ii) The use of gas oil in diesel engines was stated by few candidates. Many incorrect answers did not contain enough detail, for example for trucks or in your car. Other errors included being used in cooking.

(b) (i) Some candidates stated cracking and gained credit. Incorrect responses included polymerisation and fractional distillation.

(ii) Some candidates knew that during combustion the reactant, in this case ethene, reacts with oxygen. The products, carbon dioxide and water, were not widely known.

(c) (i) Candidates were not familiar with the formation of polythene from ethene. Most candidates found this question challenging.

(ii) The majority of candidates were not familiar with the term addition polymerisation.

Question 9

(a) Many candidates knew the symbol for a voltmeter. Fewer placed their voltmeter in parallel across one cell. The most common error was drawing the symbol for the voltmeter in series in the circuit near one of the cells.

(b) (i) The Ohm's Law calculation was successfully answered by many candidates. The most common error was by those candidates who multiplied the voltage by the current instead of dividing it.

(ii) Many candidates understood that the 3.0 V produced by the two cells would be enough to light up the lamps. Fewer explained that the full 3.0 V is available to both lamps in a parallel circuit.

(iii) The idea that the current in each branch of the circuit adds up to 2.4 A was understood by some candidates who stated that the current from the source is greater than in each branch.

COMBINED SCIENCE

Paper 0653/41
Theory (Extended)

Key messages

Those candidates who did well on this paper:

- prepared thoroughly for this type of examination and were familiar with the required knowledge and definitions of scientific terms shown in the syllabus
- read the questions carefully and used the number of available marks to guide the detail required in their answers
- ensured that their handwriting was legible
- ensured that they included working and relationships in questions involving calculations and that these were set out clearly enough for partial credit to be awarded even if the final answer was incorrect
- successfully applied their knowledge to unfamiliar contexts e.g. **Questions 3(c)(i)** and **9(c)(i)**.

General comments

Candidates often showed that they had prepared well for most sections of the syllabus and were familiar with the examination techniques required for success. Candidates usually wrote answers of appropriate length and detail taking note of the number of marks and the space allocated for each answer.

Comments on specific questions

Question 1

(a) (i) The majority of candidates correctly identified the alveoli.

(ii) Diaphragm was selected by many candidates although intercostal muscle was also a popular choice.

(iii) Many candidates knew that carbon monoxide bound to haemoglobin reduces the oxygen carried in the blood. Some of these candidates went further and described the consequence of this on respiration. Stronger candidates understood the difference in meaning between the terms breathing and respiration and so avoided suggesting that carbon monoxide damages the lungs.

(iv) Some candidates had learned this part of the syllabus thoroughly and were awarded full credit. Many candidates did not mention mucus, or they suggested that goblet cells themselves trap pathogens. Some answers revealed confusion between the functions of goblet cells and ciliated cells.

(b) (i) The majority of candidates correctly read 6% from the graph.

(ii) Generally, this was answered very well and many candidates were awarded full credit. A common mistake was to describe single points of interest rather than trends in the data. For example, ‘there is a high incidence of COPD in people over 80’ is not a trend and could not be awarded credit.

Question 2

(a) Most candidates correctly chose Group 7.

(b) Stronger candidates showed excellent understanding of this part of the syllabus. In their explanation of why the ionic charge is 2–, candidates had to state that two electrons are gained and that this completes the outer shell/achieves stability. Several incorrect suggestions revealed that candidates had reversed the electrical charge of protons and electrons.

(c) (i) The majority of candidates correctly identified the compound and both elements.

(ii) Many candidates were very familiar with drawing dot-and-cross diagrams. The two most common mistakes were to draw a single pair of shared electrons or an incorrect number of non-bonding electrons. Some candidates appeared to be unfamiliar with these diagrams.

(iii) This question produced a very wide variety of different suggestions and revealed several misconceptions. One group of incorrect answers showed that candidates had not realised that the diagrams of atoms in Fig. 2.1 showed only outer shell electrons. This led to answers such as **X** is not lithium because lithium has three electrons. Stronger answers focused on chemical bonding, although if candidates used the pronoun ‘it’ in their answer, then they risked the mark if it was not clear whether ‘it’ referred to element **X** or to lithium.

(iv) This was generally well-answered and most candidates identified hydrogen. The most popular incorrect answers were other Group 1 elements.

Question 3

(a) (i) Most candidates showed the direction of force **R** correctly. A few drew arrows that were not horizontal and the remainder showed force **R** pointing in the direction of travel of the trolley.

(ii) Most candidates were awarded this mark. The most common mistake was to evaluate 15 ÷ 10 and a small number calculated 15 – 10.

(iii) Most candidates realised that force **Q** would also be 150 N and most justified their answer by stating that forces **Q** and **S** have to be ‘balanced’. However, this was not sufficient for credit. Candidates had to explain that the trolley did not move in the vertical direction and any suggestion which implied this was credited. One misconception that emerged was that there is no known force opposing gravity and so force **Q** must be zero.

(b) (i) Many candidates were familiar with KE = $\frac{1}{2}mv^2$ and were awarded a mark if the formula appeared in their working. Full credit was awarded to candidates who correctly extracted the value of velocity from the graph and used the value of mass and not weight in their calculation. Frequent mistakes were to omit squaring the value of velocity and to take the value 1.0 m / s rather than 0.4 m / s from the graph.

(ii) This calculation was completed successfully by many candidates. As in all calculations it is important to show working. In this question a mark was available for the correct formula and the possibility of a mark for an error carried forward for the same misreading of the velocity if it occurred in part **(b)(i)**.

(iii) Many candidates were familiar with the formula, work = force × distance, and extracted the value of distance from the graph to produce the correct final answer. As in other calculations, clear working can only increase candidates’ chances of being awarded at least partial credit.

Question 4

(a) (i) Stronger candidates avoided confusing pollination and fertilisation and correctly labelled the ovary rather than either the anther or stigma. Several candidates carefully labelled the filament that passed in front of the ovary but this was not awarded the mark.

(ii) Candidates were familiar with the characteristics of wind-pollinated flowers but their two pieces of evidence had to be visible in the diagram. So, answers such as ‘no nectary’ or ‘no brightly coloured petals’ could not be awarded credit. Vague answers such as ‘parts are sticking out’ similarly could not be awarded marks.

(b) (i) Candidates were very familiar with the balanced equation for photosynthesis and many were awarded full credit. The terms ‘sun’ or ‘sun’s rays’ are not accepted as alternatives for light.

(ii) Most candidates knew that chlorophyll absorbs light and the better candidates avoided the phrase 'chlorophyll attracts light'. The second mark for stating that the absorbed light energy is converted into chemical energy was not so frequently seen. Several misconceptions were revealed including the ideas that chlorophyll converts light into starch, that chlorophyll digests starch or that chlorophyll stores energy.

(c) Most candidates restricted their answers to descriptive statements and so could not be awarded full credit. Almost all candidates stated that the transpiration rate decreased between 12.00 and 18.00 but they did not explain the effects of decreasing temperature on evaporation rate or the diffusion of water vapour through the stomata.

(d) Only a small number of candidates understood that stomata provide the entry point for carbon dioxide which is then used in photosynthesis. Answers revealed misconceptions including the idea that water for photosynthesis enters the plant through stomata. Many statements about the passage of compounds through the stomata were given but credit was only awarded for reference to the entry of carbon dioxide.

Question 5

(a) (i) The essential points that candidates needed to make were that the universal indicator paper had to make contact with the solution to develop a colour and that the colour indicates the (approximate) pH. Most candidates were familiar with this test. Some candidates missed credit because they did not make the final point that the colour shows the pH or they did not mention colour at all. A small number of candidates confused the test with paper chromatography.

(ii) Most candidates discussed the greater accuracy of using a digital pH meter compared with universal indicator paper. These answers either cited that a meter produced precise pH values rather than a range or they focused more on the advantage of avoiding subjective judgements of colour. Suggested advantages that did not gain credit included ideas referring to ease of use, speed of use or supposed safety issues.

(b) (i) This balanced equation was completed correctly by a very small number of candidates. The most common incorrect suggestion was $2NH_4 + SO_4 \rightarrow (NH_4)_2SO_4$.

(ii) Many candidates were awarded the mark for stating nitric acid. The most common incorrect suggestion was nitrogen.

(iii) Many candidates had some idea how to obtain ammonium sulfate crystals and credit was frequently awarded for stating that the solution should be heated. Few candidates made the point that the aim of heating was to evaporate some of the water from the solution.

Question 6

(a) (i) Many candidates recalled 3×10^8 (or 3×10^5) but omitted the units and so could not be awarded the mark.

(ii) The formula, distance = speed × time was very familiar and was awarded a mark if it appeared in working. A number of candidates correctly completed the pair of unit conversions that were required before full credit could be awarded. An incorrect value for the speed of light from part **(a)(i)** was carried forward.

(iii) Many candidates were familiar with the electromagnetic spectrum. Many who were not had to guess where IR should be placed and a common incorrect position was the extreme high frequency end. Several candidates filled in all the spaces in the diagram and some omitted to add IR to any of the boxes.

(b) (i) Many candidates suggested that the rays refract because they pass from one medium into another which was not quite enough for the one available mark. The change of medium causes the change in speed which was the required answer. The alternative idea that the rays pass into a medium of different density was also accepted. Answers that occurred frequently but which were not credited included 'the rays hit the ozone layer', 'the Earth's gravity attracts the rays' or 'the atmosphere acts like a lens'.

(ii) The two marks were for stating the theory that dark absorbs and shiny reflects radiant energy and that the dark bricks absorb more radiation. Most candidates made the first of these points but the second was rarely stated.

Question 7

(a) (i) Most candidates recognised the liver. The most common incorrect suggestion was kidney.

(ii) Many candidates had learned the syllabus definition of chemical digestion and so were awarded the mark. Candidates should be encouraged to learn all definitions appearing in the syllabus.

(b) This was answered very well and most candidates were awarded full or partial credit. The mark for the similarity was usually awarded for stating that amylase and lipase are enzymes. Candidates were very familiar with the roles of amylase and lipase and two marks for the differences were frequently awarded. A common error was to suggest that one of the enzymes helped in the digestion of protein.

(c) Most of the stronger candidates correctly stated plasma. The full range of components in blood were suggested by other candidates with the most popular being haemoglobin and red and white blood cells.

Question 8

(a) (i) Candidates, that knew that equation 3 showed reduction, usually found an acceptable way of justifying their choice. Candidates were expected to describe the removal of oxygen from iron oxide but many candidates found equally valid alternatives and were awarded the mark. Some candidates attempted to answer in terms of electron gain but they needed to ensure that they were referring to electron gain by iron ions or Fe^{3+}.

(ii) This was answered very well and many candidates were awarded full or partial credit. The question asks for the names of the gases and so credit was not awarded for chemical formulae alone. Candidates should be advised to avoid using the everyday term ‘carbon’ when they mean carbon dioxide. Several candidates suggested the answer ‘causes environmental problems’ for carbon dioxide but answers like this are too general. Other candidates suggested that carbon monoxide caused breathing problems rather than discussing the harmful effect on respiration.

(iii) Candidates had to specify that the charge on the iron ion was 3+ rather than simply stating that it was positive.

(b) (i) Stronger candidates understood the connection between reactivity and the tendency of metal atoms to lose electrons and form positive ions. They had to identify the metal and explain that it is the most reactive metal of those given in the table, not because it is highly reactive or because it is in Group 1.

(ii) Those candidates who had learned the part of the reactivity series shown in the syllabus were awarded full or partial credit. Almost all of these candidates correctly referred to the relative reactivity of copper and magnesium with carbon.

Question 9

(a) (i) Most candidates correctly substituted voltage and current into Ohm’s Law. The better answers also showed full working. Common mistakes included evaluating V × I and I ÷ V.

(ii) Candidates that answered part **(a)(i)** correctly tended to gain both marks for this question. Common mistakes included evaluating V ÷ I and attempting to use the resistance of the lamp in the calculation.

(b) Many candidates were awarded full credit for their circuits. Candidates should be encouraged to draw electrical circuit symbols exactly as they appear in the syllabus. Voltmeters should not show the connecting wire running through the meter and switches should always be drawn in the open position. The least familiar symbol was the variable resistor.

COMBINED SCIENCE

Paper 0653/42
Theory (Extended)

Key messages

Those candidates who did well on this paper:

- prepared thoroughly for this type of examination and were familiar with the required knowledge and definitions of scientific terms shown in the syllabus
- read the questions carefully and correctly interpreted command words for example 'Explain..' in **Question 1(b)(ii)**
- ensured that their handwriting was legible
- ensured that they included working and relationships in questions involving calculations and that this was set out clearly enough for partial credit to be awarded where possible.

General comments

Candidates often showed that they had prepared well for most sections of the syllabus and were familiar with the examination techniques required for success. Candidates usually wrote answers of appropriate length and detail taking note of the number of marks and the space allocated for each answer.

Comments on specific questions

Question 1

(a) (i) Most candidates identified the aorta. The most common incorrect labels were to the vena cava and the left atrium.

(ii) Strong responses referred to blood flowing into the left atrium although the simpler idea that blood flows backwards was allowed. There was evidence that candidates confused the terms atrium and aorta. Several candidates wrote answers that lacked precision, for example 'both valves are open' ignores the fact that the diagram shows three open valves.

(iii) The main risk factors for CHD were familiar to most candidates and any recognised factor was accepted. Smoking, stress and age were the most popular answers. Some candidates were not awarded credit as they stated 'exercise' rather than 'lack of exercise'.

(b) (i) Candidates should be encouraged to show their working in calculations. Many candidates were awarded at least partial credit for correct steps shown in their working. Mistakes in calculating the percentage increase in heart rate included evaluating (140 ÷ 60) × 100 and (140 ÷ 80) × 100. Some candidates did not give their answer to the nearest whole number.

(ii) Almost every candidate was awarded one mark for stating that the heart rate decreased during the period. Stronger candidates wrote excellent, detailed explanations in terms of the decrease in energy and/or oxygen needs resulting from decreased respiration. The three-mark allocation and the command word 'Explain' is a guide that more than a description of the graph was required.

Question 2

(a) (i) Candidates needed to compare solids and liquids with gases in terms of what happens when the plunger is pushed in. This proved to be challenging for most candidates. Most were awarded at least partial credit for describing the effect on volume. Several candidates did not see or interpret the reference on the diagram to the 'sealed syringe end' and so explained the reduction in gas volume in terms of escaping molecules.

(ii) Many candidates were awarded the mark for stating that the kinetic energy of the particles increases when temperature is increased. Credit was not awarded for vague suggestions such as 'particles move more'. Stronger candidates also made the second point that particles moved further apart.

(b) (i) This was answered very well and most candidates realised that a figure between 35 and 40°C was required. 40 was an acceptable answer but 35 was not.

(ii) This was answered very well and most candidates avoided guessing a value of the boiling point and gave the conclusion that the boiling point must be greater than 45°C.

(c) Some candidates knew the simple answer that new substances are made in a chemical change but not in a physical change. Many lengthy and complex answers were suggested which sometimes included the essential idea and sometimes did not. Some of the suggestions that did not gain credit included 'melting is just a change of state' and 'in a chemical change the elements are different'. Although it is not a safe answer, credit was awarded for the idea that physical changes can easily be reversed (not always true) and that chemical changes cannot be reversed (also not always true). Candidates should be encouraged to avoid this way of distinguishing between chemical and physical changes.

Question 3

(a) Most candidates stated 340 N correctly but they also needed the explanation to gain the available mark. The majority stated that the forces **Q** and **S** have to be 'balanced'. However, the mark was awarded for stating the idea that the scooter was not moving in the vertical direction. Only a minority made this point.

(b) (i) Most candidates seemed reluctant to write kinetic in both boxes.

(ii) Candidates were generally very familiar with the formula, work = force × distance and gained one mark for stating it in their working. Many worked through to the correct final answer. The most common mistake was to evaluate force ÷ distance.

(iii) Many candidates were familiar with the relationship, power = work ÷ time and used their answer to part **(b)(ii)** to work through to the correct final answer. An error in **(b)(ii)** was allowed to be carried forward. Many candidates wrote incorrect final answers, but did not present any working and so may have unnecessarily lost partial credit.

Question 4

(a) The table was completed correctly by many candidates. Some candidates reversed the functions of the anther and the stigma and several suggested that the function of the anthers was to produce flowers.

(b) This was a challenging question for a large number of candidates. A common reason for credit not been awarded was that candidates often wrote suggestions that concerned pollination or reproduction generally, rather than confining their answers to fertilisation. Thus, differences often included the role of a pollinator, the ability of some plants to self-pollinate or the ability of some plants to reproduce asexually. Marks were more frequently awarded for similarities with the need for male and female sex cells and the formation of a zygote being the most popular choices.

(c) Only a small number of candidates were awarded full credit. Many candidates confused the roles of the placenta and the amniotic sac or fluid in protecting the fetus. The most popular correct points were the provision of nutrients and oxygen to the fetus. The term 'food' was not accepted as an alternative for nutrients.

Question 5

(a) Candidates needed to compare the properties of brass and copper and choose properties that were important in the context of a key. Popular correct answers were that brass is harder or stronger than copper and more resistant to corrosion. References to rust or rusting were not accepted. A variety of irrelevant properties were suggested including electrical conductivity and cost of manufacture.

(b) (i) This was very well answered and most candidates realised that the given percentages for zinc and copper did not total 100%.

(ii) This was fairly well answered although some candidates repeated their answer to part **(b)(i)** even though the question directed them to find two other reasons. Candidates needed to express their answers carefully. For example, the suggestions 'zinc atoms are bigger' and 'zinc atoms are smaller' both probably showed that the candidates were trying to express the idea that the zinc atoms in the diagram should have been drawn larger than the copper atoms.

(c) (i) Candidates had to ensure that they mentioned copper (metal) to explain the orange colour. This was not seen very often. Many candidates suggested that the zinc rod became coated with copper ions, but this could not be credited. Many others correctly stated that the zinc rod had reacted with the copper ions but they needed to add that copper is formed. The answer 'zinc has displaced copper' was accepted.

(ii) Stronger candidates knew that the blue colour in the solution is caused by dissolved copper ions and that their concentration decreases. Many chemically correct statements were made including, 'zinc displaces copper' and 'zinc is more reactive than copper' and 'zinc sulfate is produced' but all of these omit the key fact that the concentration of copper ions decreases.

(iii) Stronger candidates knew that zinc is more reactive than copper and were able to explain why no change would be observed. Many other candidates suggested that copper would displace zinc and described what would be seen if such a reaction occurred.

Question 6

(a) Most candidates had learned the electromagnetic spectrum and were awarded full credit.

(b) Most candidates were aware of the dangers of exposure to UV radiation although they needed to avoid the vague answer 'causes skin diseases'. Any alternative correct suggestion was accepted.

(c) Many candidates were awarded credit by avoiding vague answers such as 'TV' or 'satellites' or obviously incorrect ones such as 'for radios'. Although 'heating (or cooking) food' was accepted, the suggestions 'for heating' or 'as microwaves' were not.

(d) Full credit was very often awarded here. However, almost every one of the distracting answers were seen with no particular pattern, suggesting that some candidates had to guess.

(e) (i) Stronger candidates were familiar with the formula $f = c \div \lambda$ and successfully worked through to the final answer. The most common reasons for credit not being awarded included arithmetic mistakes handling the exponents, evaluating $\lambda \div c$ and mistakes with the units. Candidates were expected to state the units as Hz. Hertz and hertz were accepted but hz or hZ were not. A frequently suggested incorrect unit was m / s.

(ii) Stronger candidates were familiar with the formula $I = P \div V$, and as in all questions requiring calculation, at least partial credit was awarded if the formula appeared in working. One way through this calculation was to calculate the current through one of the lamps and then multiply the result up to three lamps. Several candidates omitted the final step and so missed gaining full credit. Another common mistake was to evaluate $V \div P$.

Question 7

(a) (i) Most candidates identified the mouse, although grass, snake and leopard were all seen.

(ii) Some candidates were familiar with the energy losses between trophic levels making higher levels increasingly unsustainable. One common misconception suggested by candidates unfamiliar with energy losses was that the food chain shown in the question was an uncommon one and that baboons and leopards would not live in the same area.

(b) (i) Precise answers were required here. Thus, the main function of palisade cells had to be specified as photosynthesis rather than absorbing light. The main function of the spongy mesophyll had to be specified as gaseous exchange rather than diffusion of gases. Many candidates suggested the function of the spongy mesophyll was to soak up water or to allow water to evaporate.

(ii) Full credit was not awarded without reference to chlorophyll, and the mark for the idea of less photosynthesis was not awarded unless it was stated to be the consequence of reduced chlorophyll.

(c) Two important functions of stomach acid were very familiar to many candidates and full credit was frequently awarded.

Question 8

(a) The activation energy concept appeared to be unfamiliar to many candidates.

(i) Only a very small number of candidates could state and explain that reaction 2 had the greater activation energy. Of those candidates who did choose reaction 2, most gave an incorrect explanation in terms of the endothermic nature of the reaction.

(ii) Many candidates wrote at length about the effect of temperature on rate of reaction including detail that was often correct but which showed a lack of understanding of activation energy. When candidates did mention activation energy, they frequently revealed the misconception that activation energy can change with temperature.

(b) This question was answered more successfully than part **(a)**, and many candidates identified reaction 1 because it was exothermic.

(c) Candidates often correctly placed ticks showing energy taken in and released but were less successful when interpreting bonds being broken or formed.

(d) (i) Correct and incorrect answers were seen with similar frequency. The most common incorrect answer was 2.

(ii) Stronger candidates discussed that propane followed the general formula of alkanes and wrote phrases that meant that the molecule was saturated. Credit was not awarded for answers such as ‘it has single bonds’ or ‘it contains carbon and hydrogen’.

Question 9

(a) This proved to be a challenging question and it appeared that many candidates were uncertain of the answer. There was no particular pattern to the incorrect suggestions seen.

(b) (i) Candidates should be encouraged to draw electrical circuit symbols exactly as they are shown in the syllabus. Some candidates were unfamiliar with the required symbol and others came close, missing only the arrow head or drawing the symbol for a thermistor. The symbol for a potentiometer was not accepted.

(ii) Some candidates were familiar with the use of the formula $E = I \times V \times t$ and worked through to the correct numerical answer. As in all calculations, partial credit is awarded to correct steps shown in clear working, and several candidates were awarded credit this way. Some candidates missed one mark by omitting the final step of converting 18000 J to 18 kJ.

(iii) Stronger candidates were familiar with the idea that the potential differences across individual components in a series circuit add to give the total voltage available. The most popular incorrect answer was 4 V.

(iv) Some candidates were awarded both marks for realising that energy would be lost as heat and that this would occur when the current passed through components in the circuit including the connecting wires. Sound and light were not accepted, neither was the vague suggestion that heat would be lost to the surroundings.

COMBINED SCIENCE

Paper 0653/43
Theory (Extended)

Key messages

Those candidates who did well on this paper:

- had prepared thoroughly for this type of examination and were familiar with the required knowledge and definitions of scientific terms shown in the syllabus
- read the questions carefully and used the number of available marks to guide the detail required in their answers
- understood the different requirements of the command words 'describe' and 'explain' for example in **Question 4(b)(i)**
- ensured that their handwriting was legible
- ensured that they included working and relationships in questions involving calculations and that this was set out clearly enough for partial credit to be awarded where possible
- did not cross out their working in calculations.

General comments

Candidates often showed that they had prepared well for most sections of the syllabus and were familiar with the examination techniques required for success. Candidates usually wrote answers of appropriate length and detail taking note of the number of marks and the space allocated for each answer.

Comments on specific questions

Question 1

(a) (i) Candidates had no difficulty identifying the stomach and the mouth. Amylase was not quite so familiar. A common incorrect suggestion was protease.

(ii) Candidates usually labelled the large intestine correctly. The most common mistake was to label the small intestine.

(b) Candidates were required to give the specific answer that protease breaks down protein to form amino acids. The general answers 'to break down food' or 'to break up large molecules' or 'acts as a biological catalyst' were not awarded credit.

(c) Candidates had to state that the walls of arteries are thicker than the walls of veins. The answer 'arteries are thicker than veins' could not be awarded credit. Very few candidates referred to the narrower centre (lumen) in arteries and a common mistake was to suggest that the lumen in arteries was much wider than in veins. The presence of valves only being present in veins was well-known by many candidates. Credit was not available for answers that correctly described non-structural aspects of these blood vessels.

(d) The ideas that coronary heart disease refers to the coronary artery becoming blocked and that a common risk factor is genetic predisposition were familiar to some candidates.

Question 2

(a) Almost every candidate was awarded this mark.

(b) Candidates should have used the statements in Table 2.1 as a guide to answering this question. If their answer clearly suggested that the reaction of lithium would be similar but slower than the other metals in the table then the mark was awarded.

(c) (i) Many different colour changes were given suggesting that some candidates were familiar either with the use of universal indicator or with the formation of an alkaline solution when sodium reacts with water.

(ii) Some candidates identified sodium hydroxide. A popular incorrect choice was sodium oxide.

(d) (i) The relationship between number of outer electrons in an atom and the group number of the element in the Periodic Table was familiar to most candidates.

(ii) Candidates had to discuss electron arrangement as instructed in the question. This meant that answers such as ‘potassium has more electrons’ or ‘potassium has a larger atomic number’ could not be credited. Many candidates did, however, refer to the greater number of electrons shells in potassium. Any correct alternative to shells such as energy levels or orbitals was accepted.

(e) (i) This was answered correctly by most candidates. The relative reactivity of iron and sodium was more familiar than melting point or density.

(ii) This was answered very well by many candidates who wrote detailed explanations which specified that the iron had to be protected from contact with oxygen and/or water. Air was not accepted as an alternative to oxygen.

Question 3

(a) (i) The great majority of candidates answered this question correctly. The most common mistake was to calculate 75 N × 10 N/kg.

(ii) Many candidates were awarded at least partial credit for correct ideas shown in their working. If their answers included the formula PE = m × g × h then candidates were awarded at least one mark. Candidates should be advised to always show their working in calculation questions.

(iii) Stronger candidates knew that the pressure in pascals is calculated using force ÷ area in m^2 and so the area of the base of the bucket has to be converted from cm^2. Partial credit was awarded if the only mistake was to omit this unit conversion. Another reason for credit not being awarded was the use of the incorrect formula, pressure = mass ÷ area.

(b) The idea that bucket **A** cools effectively by conduction because metal is a good heat conductor was frequently suggested. The poor heat conduction of plastic was usually given as the reason why bucket **B** cooled more effectively by radiation. Stronger candidates discussed the superior radiative properties of a black dull surface over shiny metal or that shiny surfaces are better reflectors.

Question 4

(a) (i) Only a small number of candidates identified part **P** as the larynx. Most suggested trachea. Candidates had to be careful with the spelling of bronchus for part **Q**. Bronchi was accepted but poorly spelled suggestions that appeared more like bronchiole did not gain credit.

(ii) Stronger candidates restricted their answers to features of a gas exchange surface and avoided describing the processes that occur during gas exchange. The most popular answers included ‘thin’, references to a ‘good blood supply’ and a ‘large surface area’.

(b) (i) The strongest answers made the connection between increased energy demanded by muscles when working harder and that this extra energy is provided by increased respiration which in turn requires an increased oxygen supply. Full credit was awarded to a small number of candidates, and many were awarded at least two marks for a correct discussion of increased oxygen supply to allow increase respiration. Many answers that could not be awarded credit described the information shown on the graph rather than explaining the processes that were occurring in the athlete’s body.

(ii) This question was answered well by many candidates. One common reason for not being awarded credit was to suggest the answer ‘a lower volume of air/oxygen is taken in’ as an alternative to ‘shallower’. Candidates needed to take care to specify a ‘lower volume per breath is taken in’.

(c) Almost every candidate correctly identified nicotine.

Question 5

(a) Many candidates were awarded credit for associating the double bond with alkenes. Some candidates chose to show that ethene fits the general formula for alkenes.

(b) The production of ethene by cracking was not very familiar. The most common suggestion was fractional distillation.

(c) (i) and **(ii)** Only a small proportion of candidates appeared to be familiar with polymerisation, and so very few marks were awarded for **(c)**.

(d) (i) Candidates could choose anhydrous copper(II) sulfate or anhydrous cobalt(II) chloride as a chemical test for water. Few candidates were familiar with either test.

(ii) The majority of candidates recognised condensation. Incorrect suggestions included evaporation and melting.

(iii) Many candidates correctly stated carbon dioxide. Many others appeared to be guessing and popular choices included carbon monoxide, hydrogen and oxygen.

Question 6

(a) (i) Many candidates gave the answer 4°C rather than 0°C.

(ii) Almost all of the candidates chose the correct words from the list and were awarded full credit.

(b) Stronger candidates took care to write answers that compared ice to water. They described how the particles in water move around more than the (vibrating) particles in ice. They also were very clear that higher forces of attraction exist between particles in ice. Candidates needed to avoid vague phrases such as ‘particles in liquids move more’ or ‘there is less motion in solids’. Candidates should be advised to avoid making assumptions about temperature, kinetic energy or particle speed when asked to make a general comparison of a liquid and a solid. For example, several candidates made statements such as ‘liquids always have more energy than solids’.

(c) (i) Almost all candidates were able to show this by using the relationship time = distance ÷ speed.

(ii) Most candidates knew that they had to state that light travels faster than sound and so many gained at least partial credit. The question asks them to ‘Use data’ and this meant that they had to recall and state the speed of light and ideally compare this to the speed of sound given in the previous question.

(iii) This proved to be a challenging question and only a small number were awarded credit. Some sensible ideas were seen, the most popular being that the scientist had moved closer to the glacier. Credit was awarded to any candidate who suggested that sound travelled faster than the speed stated in part **(c)(i)**.

Question 7

(a) Most candidates correctly identified the shrimp. The most common mistake was to identify the frog. The frog is a secondary consumer at trophic level three.

(b) Some stronger candidates were familiar with the sequence of events occurring during eutrophication. From those candidates attempting to describe these processes, two main approaches were seen. Some described the stimulation of plants/producers and consequences of this, and others started with the idea that excess nitrate would poison all animal life. The required approach was the former and candidates needed to describe the key ideas of screening the water from sunlight, death of plants, excessive aerobic respiration by decomposers removing oxygen from the water. Partial credit was awarded for a reference to the toxicity of nitrate.

(c) The idea that trees remove carbon dioxide from the atmosphere and use it in photosynthesis was widely known and large numbers of candidates were awarded full credit. Some candidates appeared to know the relevance of photosynthesis but answered in terms of increased oxygen without referring at all to carbon dioxide.

Question 8

(a) Carbon dioxide was recognised by some candidates. The most popular incorrect suggestion was hydrogen. The question requires the name of the gas and so CO_2 did not gain credit.

(b) This was answered correctly by many candidates. Candidates needed to present the formula of calcium chloride perfectly in order to gain the mark. Letters in the symbols must be clearly upper and lower case and the figure 2 must be shown as a subscript.

(c) (i) Candidates were generally very familiar with the relationship between temperature and reaction rate. All they needed to do was to state that the rate increases. Some gave unnecessary detailed explanations in terms of collision theory.

(ii) Most candidates showed good understanding, in terms of controlled variables, why experiments 3 and 4 or 1 and 5 showed the effect on reaction rate of changing the temperature.

(iii) Most candidates were awarded at least one mark for stating that the acid concentrations in experiments 1 and 4 were different. The remaining marks were for describing different acid concentration in terms of different numbers of acid particles in a given volume and the consequent effect on the frequency of collisions with calcium carbonate. This was challenging for almost all the candidates and full credit was very rarely awarded.

(d) (i) Even the strongest candidates were relatively unfamiliar with how to label the activation energy. Those who knew that the activation energy was something to do with the idea of an energy barrier, simply labelled the maximum in the curve. A popular suggestion was to label the point where the energy started to increase from the energy of the reactants. Another frequently seen idea was a curved arrow passing over the maximum in the curve.

(ii) Candidates answered this question more successfully than part **(d)(i)**. Popular incorrect suggestions included labelling the point where the descending curve joined the energy level of the products or the vertical distance between the energy level of the products and the horizontal axis.

Question 9

(a) (i) The majority of candidates were able to locate visible light correctly.

(ii) Stronger candidates knew that they had to recall and use the speed of light in the relationship $\lambda = c \div f$. A significant proportion of candidates recalled both the relevant relationship and the speed of light, but made arithmetic slips in dealing with the exponents in the final calculation.

(b) (i) Many candidates were familiar with the relationship $I = P \div V$ and worked through to the correct numerical answer. A common mistake was to evaluate $V \div P$. The answer should be given to the same number of significant figures as in the data in the question and so the expected answer was 0.55 A.

(ii) This mark was awarded if the answer was double the candidate's answer to **(b)(i)**. Very often, the answer suggested was either half of, or the same as, the answer to **(b)(i)**. Candidates generally found this question to be challenging.

(iii) Candidates were generally familiar with the advantages of connecting lamps in parallel. Suggestions that did not gain credit included the ideas that each lamp has the same p.d. across it and any references to brightness.

COMBINED SCIENCE

Paper 0653/51
Practical Test

Key messages

Candidates must ensure that they read the questions carefully before starting to answer. This is particularly important for planning questions. To gain full marks in a planning question a candidate's answer must include all the areas of the task indicated by the bullet points.

When drawing graphs, candidates should:

- label the axes with a quantity and a unit
- draw a line of best fit as a single, smooth line
- plot small, neat points to cover at least half of the grid.

General comments

Candidates generally showed a positive approach to the Practical Test. Candidates found the planning question challenging.

Comments on specific questions

Question 1

(a) Many candidates were able to give the expected order. Only a few candidates did not use the letters of the test-tubes and so were unable to score.

(b) Most gave a correct relationship between concentration and colour score. When candidates are asked to give a relationship, they need to take care to use the factors given. Although alternatives for 'the higher the concentration….' such as 'the more ethanol the darker the colour' or 'the greater volume of ethanol added the darker the colour' were accepted, fully correct answers should have been in terms of ethanol concentration and colour score.

(c) Candidates often did not address the main point of the question. Many said that the water was used to dilute the ethanol. Although this is true, it does not address the point that different volumes of water are added. Strong responses referenced the need to control the total volume of solution.

(d) Some candidates did not express their ideas clearly and often could not be awarded the mark. For instance, stating that syringes 'stop ethanol and water from being mixed together' is ambiguous because ethanol and water are mixed together within the procedure. Strong responses discussed contamination or how ethanol or water remaining in a syringe could change the concentration of solutions.

(e) Safety precautions need to be specific. Answers such as 'wear gloves and goggles to stop chemicals getting into your eyes or on your skin' are not accepted. Strong responses addressed precautions relating to the flammability of ethanol and the need to avoid naked flames. Some discussed the procedural risk of using a knife and the need to cut on a board and make sure that fingers are kept away from the blade. Using gloves to prevent an injury from the knife was not accepted. The need for very fine control to cut the very thin discs of beetroot makes this suggestion unworkable in practice. Thin gloves do not provide protection from cuts.

Question 2

Candidates who earned most marks typically took care to address every bullet point. Where apparatus is shown in the question it is not necessary to describe it in words. Some candidates wrote at length about how they would set up the apparatus which was provided. It is only necessary to discuss any changes that could be made.

Some common approaches to planning questions are more likely to lead to higher marks than others. It is recommended that:

- Candidates structure their answer with sections such as apparatus, method, measurements, constant variables and processing to match the bullet points.
- Every bullet point in the question is addressed. Candidates who tick off or cross out the aspects of the question as they answer are more likely to address all aspects of the question. Weaker responses commonly only address one or two areas of the questions, allowing themselves access to only some of the available marks.
- The response clearly states which factors will be kept the same, what measurements will be made and how the results will be processed. These are the bullet points which are most often omitted.

Common reasons why candidates earned lower marks included:

- Stating that light intensity would be varied without describing how this could be achieved. The most common correct approach was to measure and vary the distance between the lamp and the beaker. Some candidates used different lamps or different numbers of lamps. However, ‘vary the light intensity’ alone is not sufficient for a method.
- Safety precautions were often vague and based on laboratory rules rather than linked to the procedure. Suggestions such as ‘wear gloves and goggles and tie hair back’ were not credited. Some correctly identified the risk relating to the use of water and electricity in the same experiment.
- Some did not include any control variables in their answer.
- Answers which said ‘repeat it’ should be specific about what they intend to repeat and how they will use the repeats, for example ‘measure the number of bubbles in 1 minute several times at each distance and take a mean of the results’.
- Many candidates omitted to describe how they would process the results. ‘Look at how light intensity affects the rate’ is simply a repeat of the question.

Question 3

(a) (i) and (ii) Some candidates knew that sulfuric acid contains sulfate ions as shown by the white precipitate formed but a range of incorrect answers were seen.

(b) Most candidates correctly described the observation of bubbles or fizzing but few then went on to describe the change in appearance of the solution.

(c) (i) Most candidates knew that hydrogen gives a squeaky pop with a lighted splint.

(ii) The question asked for the time to be recorded to the nearest second and the answer line had ‘s’ as units. The fully correct answer was to convert the value to seconds and round to the nearest second. Some candidates expressed their answer incorrectly by using minutes and seconds.

(d) (i), (ii) and (iii) For all three parts of this question, values were usually correctly recorded.

(iv) Most correct answers suggested using either a lid or insulation.

(v) Candidates typically did not answer in terms of ensuring an even temperature of the solution. Common answers were to just imply mixing of reagents, e.g. ‘to mix it up’.

(vi) Many candidates correctly stated that this method takes into account variation in results or that repeating allows outliers/anomalous results to be excluded from average calculations. However, common errors included stating that this makes the experiment ‘more accurate’ or that this ‘prevents anomalous results’. Neither of these answers is correct. Anomalous results may still occur, but repeating the experiment allows for them to be identified and taking an average reduces the impact of variation on the overall value.

Question 4

Where a question asks for measurements to be made, it is very important that candidates take time to consider carefully where those measurements should start and finish. The instructions asked candidates to take the reading at the bottom of the spring and further stated 'Do not include the lower ring'. This instruction was ignored by many candidates, leading to errors and incorrect values throughout the question.

(a) The most common error was to read the value to the nearest cm, not the nearest 0.1 cm. Some candidates had clearly measured at the wrong point giving an answer that was too small, even allowing for centres that had possibly set the clamp at 0.0 rather than a few centimetres lower as indicated in the confidential instructions.

(b) (i) and (iii) Almost all candidates were able to obtain a set of results with the expected trend.

(ii) Most answers showed an understanding of how to avoid line-of-sight errors but did not express themselves well enough to earn the mark. Common answers which were not given credit include:

- Stand straight on to the experiment.
- Look parallel to the ruler.
- Bend down when you take the measurement.

Strong responses discussed making sure that line of sight was perpendicular to the bottom of the spring and the scale or that another ruler would be placed perpendicular to the reading in line with the bottom of the spring. Both of these would help to ensure that no parallax error occurred.

(iv) Most calculated the extension based on their measurement. Error Carried Forward was allowed on an incorrect value given in **(a)(i)**/**(iii).**

(c) (i) The graph was usually well constructed. Many candidates took care to label axes with units, they plotted points accurately, considered the scale and used a scale which occupied the majority of the grid.

Common errors and omissions included:

- Omitting the units from the axes.
- Reversing the axes.
- Using non-linear scales.
- Some used inappropriate or complex scales such as going up in 3s. Candidates should use standard scales such as intervals of 10, 5 or 2 for the main gridlines.

(ii) Most gave an acceptable line of best fit. The most common error was to try to artificially force the relationship to go through zero either by curving the bottom of the line or by displacing the entire line away from the pattern shown by the points.

(d) (i) and (ii) Many candidates were able to repeat the procedure to get a value for the extension with **O** and then use the graph to determine its mass. A number omitted to show their working on the graph and so did not gain all the marks available. Some gave an answer that did not correspond to the value from their graph, which also did not gain credit.

COMBINED SCIENCE

Paper 0653/52
Practical Test

Key messages

Candidates must ensure that they read the questions carefully before starting to answer. This is particularly important for planning questions. To gain full marks in a planning question a candidate's answer must include all the areas of the task indicated by the bullet points.

When drawing graphs, candidates should:

- label the axes with a quantity and a unit
- draw a line of best fit as a single, smooth line
- plot small, neat points to cover at least half of the grid.

General comments

Candidates generally showed a positive approach to the Practical Test. Candidates found the planning question challenging.

Comments on specific questions

Question 1

(a) (i), (ii) and (iii) Most candidates were able to record the initial mass, final mass and then go on to calculate the change in mass correctly for each dialysis tubing bag.

(iv) Many candidates gave a correct description for the effect of temperature on the mass of water entering. When candidates are asked to give an effect or relationship, they need to take care to use the factors given. In this case, fully correct answers should have been in terms of temperature increasing or decreasing and mass of water entering increasing or decreasing as a result.

(v) Better candidates were able to deduce that without drying, there would be water left on the outside of the dialysis tubing, which would cause the mass to be higher than it should be.

(b) (i), (ii), (iii) and (iv) Most candidates were able to draw an enlarged drawing with a good continuous outline and provide detail of the segments and pith. Measurements were generally accurate with most then correctly calculating the magnification.

Question 2

(a) (i) Candidates were given the observations for solid **P** as a guide to how they should structure their answer. Many did not follow this and so were not able to give a full enough description to gain full credit. Common errors included not specifying solid or liquid or having an incorrect colour. Candidates need to be careful not to state clear when they should state colourless. The idea of clear means it is see-through, rather than opaque. Clear solutions can have a colour, for example, copper sulfate solution is clear but it is blue.

(ii) Most candidates omitted to include **P** as an insoluble solid, even though the observations were provided in the table.

(b) Candidates failing to score both marks invariably gave an answer that was not to the nearest 0.5°C, for example 20 instead of 20.0.

(c) Candidates found this a challenging question, with only the best candidates stating that the temperature change would be slower in air, thus enabling a more accurate reading to be taken using the thermometer.

(d) (i) The graph was usually well constructed. Many candidates took care to label axes with units, they plotted points accurately, considered the scale and used a scale which occupied the majority of the grid.

Common errors and omissions included:

- Omitting the units from the axes.
- Reversing the axes.
- Using non-linear scales.
- Some used inappropriate or complex scales such as going up in 3s. Candidates should use standard scales such as intervals of 10, 5 or 2 for the main gridlines.

(ii) Most candidates drew an acceptable curve of best fit.

(iii) Many candidates gave a correct description for the relationship between the mass of **Q** in the solution and the temperature when crystals first appear.

(iv) Many candidates were able to use their temperature in **(b)** to read off the graph in order to estimate the mass of **Q** used.

Question 3

(a) Most candidates were able to record temperatures in the expected range. The most common error was not recording all three temperatures to the nearest 0.5°C.

(b) (i) and (ii) Candidates that followed the instructions carefully were able to calculate the differences in temperature and then use their answers to calculate the changes in thermal energy to gain full credit. Common errors were reversing the values needed for R and H, or using the same value for both calculations.

(c) Stronger candidates were able to identify that thermal energy would be transferred to the surroundings, particularly as no insulation was used.

Question 4

Candidates who earned most marks typically took care to address every bullet point. When a diagram is shown in the question it is not necessary to describe it in words.

Some common approaches to planning questions are more likely to lead to higher marks than others. It is recommended that:

- Candidates structure their answer with sections such as apparatus, method, measurements, constant variables, processing to match the bullet points.
- Every bullet point in the question is addressed. Candidates who tick off or cross out the aspects of the question as they answer are more likely to address all aspects of the question. Weaker responses commonly only address one or two areas of the questions, allowing themselves access to only some of the available marks.
- The response clearly states which factors will be kept the same, what measurements will be made and how the results will be processed. These are the bullet points which are most often omitted.

Common reasons why candidates earned lower marks included:

- Omitting to name the piece of apparatus being used to take a measurement, particularly a ruler for measuring the distance. A number of candidates did not link the measurement of force with the need for a Newton meter.
- Some did not include any control variables in their answer.
- Not having enough different distances from the pivot. A minimum of five values is needed in order to plot a graph but credit was given for those who gave three or more distances.

- Not providing a results table despite there being a specific bullet point asking for one.
- Not knowing the unit for force
- Answers which said ‘repeat it’ should be specific about what they intend to repeat (in this case at the same distance from the pivot or from different distances) and how they will use the repeats, for example to take a mean of the results
- Many candidates omitted to describe how they would process the results. ‘Look at how the force needed varies with the distance’ is simply a repeat of the question.

COMBINED SCIENCE

Paper 0653/61
Alternative to Practical

Key messages

When candidates are asked to add values to a table, they need to judge the number of significant figures or decimal places based on the size of the scale on the instrument. Where possible, for example in **Question 3(b)(ii)** and **4(a)(i)**, instruments should be read to at least one decimal place.

In planning questions, candidates need to address all areas of the task to access the full mark range. They are guided in this by the bulleted list included in the task.

When drawing graphs, candidates need to ensure that the axes are the right way around, that they choose scales so that the plotted results occupy more than half the grid, plot carefully and draw considered, finely drawn lines of best fit.

General comments

Candidates generally showed a positive approach to the Alternative to Practical Paper. The planning question was well answered.

Comments on specific questions

Question 1

(a) Almost all candidates were awarded two marks for interpreting the diagrams to judge the darkness of the colour. The most common reason for not earning the third mark was that many gave different values for test-tubes **D** and **E**. These were the same shade on the diagram.

(b) Most candidates stated a correct relationship between concentration and colour score. When candidates are asked to give a relationship, they need to take care to use the factors given. Alternatives such as ‘the more ethanol the darker the colour’ or ‘the greater the volume of ethanol added the darker the colour’ were less good than answers in terms of concentration and colour score.

(c) Candidates often did not address the main point of the question. Many said that the water was used to dilute the ethanol. Although this is true, it does not address the point that different volumes of water are added. Strong responses referenced the need to control the total volume of solution.

(d) Some candidates did not express their ideas clearly enough. For example, stating that syringes ‘stop ethanol and water from being mixed together’ is ambiguous because ethanol and water are mixed together within the procedure. Strong responses discussed contamination or how ethanol or water remaining in a syringe could change the concentration of solutions.

(e) Safety precautions need to be specific to the procedure described in the question. Answers such as ‘wear gloves and goggles to stop chemicals getting into your eyes or on your skin’ are too general. Strong responses addressed precautions relating to the flammability of ethanol and the need to avoid naked flames. Some discussed the procedural risk of using a knife and the need to cut on a board and make sure that fingers are kept away from the blade. However, using gloves to prevent an injury from the knife was not accepted. The need for very fine control to cut the very thin discs of beetroot makes this suggestion unworkable in practice. Thin gloves do not provide protection from cuts.

Question 2

Candidates who earned most credit typically took care to address every bullet point. Where apparatus is shown in the question it is not necessary to describe it in words. Some candidates wrote at length about how they would set up the apparatus which was provided. It is only necessary to discuss any changes that could be made.

Some common approaches to planning questions are more likely to lead to higher credit than others. It is recommended that:

- Candidates structure their answer with sections such as apparatus, method, measurements, constant variables and processing to match the bullet points.
- Every bullet point in the question is addressed. Candidates who tick off or cross out the aspects of the question as they answer are more likely to address all aspects of the question and access all available credit.
- The response clearly states which factors will be kept the same, what measurements will be made and how the results will be processed. These are the bullet points which are most often omitted.

Common reasons why candidates earned only partial credit include:

- Stating that light intensity would be varied without describing how this could be achieved. The most common correct approach was to measure and vary the distance between the lamp and the beaker. Some candidates used different lamps or different numbers of lamps. However, stating 'vary the light intensity' alone is not a method.
- Safety precautions were often vague and based on laboratory rules rather than linked to the procedure. Suggestions such as 'wear gloves and goggles and tie hair back' were not credited. Some did correctly identify the risk relating to the use of water and electricity in the same experiment.
- Some did not include any control variables in their answer.
- Answers which said 'repeat it' needed to be specific about what to repeat and how to use the repeats. For example, 'measure the number of bubbles in 1 minute several times at each distance and take a mean of the results.'
- Many candidates omitted to describe how they would process the results. 'Look at how light intensity affects the rate' is simply a repeat of the question.

Question 3

(a) (i) Some candidates knew that sulfuric acid contains sulfate ions (as shown by the white precipitate formed), but many incorrectly chose 'chloride'.

(ii) Most candidates earned partial credit, but found drawing the filtration apparatus challenging.

The following points should be noted:

- Diagrams of apparatus should be two-dimensional without lines across open tubes e.g., the bottom of a filter funnel and the top of a test-tube should be open.
- Filtration apparatus should include both a funnel and a filter paper. The filter paper should be shown with a clearly closed 'V' shape at the bottom and the funnel should have an open tube at the bottom.
- All apparatus should be labelled.

This question asked the candidates to label the precipitate and the filtrate. Many did not do so and some used alternative words such as solution and solid.

(b) (i) Almost all candidates knew that hydrogen gives a squeaky pop with a lighted splint.

(ii) The question asked for the value to be recorded in seconds. In addition, the answer line had 's' as units. The fully correct answer was to convert the value to seconds and round to the nearest second, giving 88 s. Many candidates expressed their answer incorrectly by using minutes and seconds, such as 1:28.

(c) (i), (ii) and (iii) Values were usually read correctly. The most common error was to record the first value as 21 rather than 21.0°C. The instructions specifically asked for a reading to the nearest 0.5°C so 21 is incorrect.

(iv) Most correct answers suggested using either a lid or insulation. However, a significant number of candidates incorrectly suggested providing an external heat source, such as a Bunsen burner or water-bath. This shows an incorrect understanding of preventing heat loss when measuring a temperature change for an exothermic reaction.

(v) Candidates typically did not answer in terms of ensuring an even temperature of the solution. Common answers were to just imply mixing of reagents, e.g., ‘to mix it up’.

(vi) Many candidates correctly stated that this method takes into account variation in results or that repeating allows outliers to be excluded from average calculations. However, common errors included stating that this makes the experiment ‘more accurate’ or that this ‘prevents anomalous results’. Neither of these answers is correct. Anomalous results may still occur, but repeating the experiment allows for them to be identified and taking an average reduces the impact of variation on the overall value.

Question 4

Where a question asks for measurements to be made, it is very important that candidates take time to consider carefully where those measurements should start and finish. The instructions asked candidates to take the reading at the bottom of the spring and further stated ‘Do not include the lower ring’. This instruction was ignored by many candidates, leading to errors and incorrect values throughout the question.

(a) (i) The most common error was to read the value at the wrong point, commonly at the bottom of the lower ring.

(ii) Most answers showed understanding of how to avoid line-of-sight errors but did not express themselves well enough to earn the mark. Common answers which were **not** given credit include:

- Stand straight on to the experiment.
- Look parallel to the ruler.
- Bend down when you take the measurement.

Strong responses discussed making sure that your line of sight was perpendicular to the bottom of the spring and the scale or that another ruler would be placed perpendicular to the reading in line with the bottom of the spring. Both of these would help to ensure that no parallax error occurred.

(b) Most correctly calculated the extension based on their measurements. Error carried forward was allowed on an incorrect value given in **(a)(i)**.

(c) (i) The graph was usually well constructed. Many candidates took care to label axes with units, they plotted points accurately, considered the scale and used a scale which occupied the majority of the grid.

Common errors and omissions included:

- Omitting the units from the axes.
- Reversing the axes.
- Using non-linear scales.
- Using inappropriate or complex scales such as going up in 3s. Candidates should use standard scales such as intervals of 10, 5 or 2 for the main gridlines.

(ii) Most drew an acceptable line of best fit. The most common error was to try to artificially force the relationship to go through zero either by curving the bottom of the line or by displacing the entire line away from the pattern shown by the points.

(d) (i) Answers were sometimes not well phrased. Many said that the reading should be checked to ‘see if it changes’, which was not sufficient for credit. Better answers stated that the spring may have been moved or extended beyond its elastic limit.

(ii) In common with **(a)(i)**, measurements were often made between incorrect points.

(iii) Some candidates omitted this question. Those who attempted it usually earned the mark. Error carried forward on an incorrect value in **(d)(ii)** was allowed.

(iv) Many candidates also omitted this question. However, most correctly indicated on their graph using horizontal and vertical lines from each axis to show how they had arrived at their reading. Error carried forward from **(d)(i)** and **(iii)** was allowed.

COMBINED SCIENCE

Paper 0653/62
Alternative to Practical

Key messages

Candidates should be encouraged to learn the tests and results for the ions and gases in the qualitative analysis notes of the syllabus.

When drawing graphs, candidates should:
- label the axes with a quantity and a unit
- draw a line of best fit as a single, smooth line
- plot small, neat points to cover at least half of the grid.

General comments

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

Comments on specific questions

Question 1

(a) (i) The majority of candidates giving answers to one decimal place were able to do this correctly. Several candidates simply recorded the masses shown on the balances.

(ii) The change in mass was correctly calculated by most candidates.

(iii) Many candidates commented upon the mass increasing or changing. A significant number linked this to how the temperature changed.

(iv) Many candidates commented about obtaining accurate results, without explaining the water on the outside of the tubing would increase the mass.

(v) A significant number of candidates named Benedict's correctly, with biuret and iodine being common incorrect answers.

(b) (i) Most candidates drew suitably sized diagrams occupying over half of the box. A few drew the diagram so big it went out of the box. The outline was often not continuous. Many showed the detail in the diagram including the correct number of segments, plus the pith and the centre.

(ii) The majority of candidates were able to measure the line correctly, though some gave an answer in centimetres.

(iii) The majority of candidates were able to measure the line correctly, though some gave an answer in centimetres. Several candidates failed to draw a line or label points **A** and **B**.

(iv) This was generally well answered**.** However, a small minority did the calculation by dividing part **(ii)** by part **(iii)**.

(v) Many candidates knew iodine was used to test for starch, though some said the flesh had starch and the skin had none. Common incorrect answers were about glucose or acid being present.

Question 2

(a) (i) Many candidates selected **M** as being insoluble but failed to identify **P**.

(ii) Many diagrams did not have a funnel, the filtrate was often labelled 'water' and some diagrams had no apparatus labels.

(iii) Candidates need to be familiar with the qualitative analysis tests. Some candidates mentioned a precipitate being formed but only a small number correctly said a light blue precipitate.

(b) (i) This was generally well answered with many candidates selecting appropriate equipment, although some candidates stated a pipette or beaker would be suitable to measure the volume of water.

(ii) A very small number of candidates described the rate of cooling in air being less than in cold water. Many candidates had the idea that the air would provide a 'natural' temperature to form crystals.

(c) (i) Many candidates labelled the axes with temperature on the vertical axis and mass on the horizontal axis, though a significant number omitted to put units with the labels. Most candidates chose simple scales that covered most of the grid and as a result they were able to plot the points correctly.

(ii) Several candidates drew straight lines rather than a curve. Those attempting a curve, often joined points dot-to-dot, or neglected to draw a continuous smooth curve.

(iii) This was generally well answered with most correctly describing the relationship.

(iv) Many candidates used their graph to give a suitable answer. Some candidates omitted to show how they had used their graph.

Question 3

(a) Many candidates were able to read the temperatures correctly from the diagrams. Some candidates did not record the readings to the nearest 0.5°C.

(b) A small minority of candidates realised that this was to ensure the temperature was the same throughout the beaker. A common answer was 'to get accurate results' without any explanation of how this would be achieved.

(c) (i) The majority of candidates were able to calculate the changes from the recorded data.

(ii) Most candidates were able to calculate the increase in thermal energy correctly.

(iii) Most candidates were able to calculate correctly and those rounding to two significant figures were generally correct. A significant proportion of candidates failed to round their answer as required.

(d) Very few candidates appreciated that heat would be lost or that the apparatus was not insulated. Many thought that the difference was due to different volumes of hot and cold water being used.

Question 4

Candidates scoring well on this question clearly attempted to address the bullet points given in the question and often made notes to cover these before starting their response. Points covered well in responses were using several distances, repeating the experiments and drawing a suitable table to record the results. Some candidates did not know the name 'Newton meter' or 'force meter' when selecting apparatus. Some used gloves for safety but did not consider trapping fingers as the issue and few considered the control in terms of the door just moving or pulling in the same direction or angle.

COMBINED SCIENCE

Paper 0653/63
Alternative to Practical

Key messages

Candidates should be encouraged to learn the tests and results for the ions and gases in the qualitative analysis notes of the syllabus.

When drawing graphs, candidates should:

- label the axes with a quantity and a unit
- draw a line of best fit as a single, smooth line
- plot small, neat points to cover at least half of the grid.

When referring to a quantity of a substance, candidates need to use words such as 'mass' and 'volume' rather than 'amount'.

General comments

Candidates generally showed a positive approach to the Alternative to Practical. The planning question in particular was well answered.

Comments on specific questions

Question 1

(a) Almost all candidates were awarded one mark for correctly counting the number of seeds that germinated.

(b) Most candidates correctly calculated the percentage of seeds germinated. A few did not follow the pattern in the table and gave values to more than one decimal place.

(c) (i) Most candidates were able to earn partial credit for correctly labelling the axes of the graph and plotting a linear scale. However, some candidates plotted the number of seeds germinated rather than the percentage. A common mistake was to use a non-linear scale on the *x*-axis (percentage oxygen concentration). Points need to be plotted correctly, ± half a square. A significant number of candidates chose to plot their points using a circle that occupied one whole square of the graph. This meant that the mark for plotting could not be awarded. It is recommended that candidates use crosses to plot points or keep circles smaller than half a square.

(ii) Few candidates were able to draw the line of best fit for their points. A straight line needed to be drawn with a ruler and go through as many points as possible. Many candidates joined the points dot-to-dot or drew their lines missing most of the points.

(iii) Almost all candidates were able to state that increasing the oxygen concentration increased the number of seeds germinated.

(d) Most candidates were able to describe one other effect of increasing oxygen concentration.

(e) (i) Few candidates were able to suggest that multiple seeds were used to identify anomalous results. The most common error was to state that using 12 seeds would avoid anomalous results. Anomalous results will still occur with multiple seeds but they can be more easily identified.

(ii) Candidates found it challenging to identify two improvements to the procedure, with many suggesting repeats or calculating a mean. The given procedure contained basic errors such as adding 'some water' and omitted some constant variables, e.g. leaving the trays at the same temperature. Candidates need to be able to identify these errors and omissions and then suggest improvements. Some candidates stated that the 'amount' of water should be kept the same. This was not accepted as an alternative to using the same 'volume' of water.

(f) Almost all candidates identified a factor that was kept constant in the investigation.

(g) Candidates need to know the test for carbon dioxide and the observation for a positive result. Many candidates omitted this question.

Question 2

(a) (i) This question was answered well with most candidates gaining full credit.

(ii) Nearly every candidate was able to use their values from **(a)(i)**, and the equation provided, to calculate the two rates of reaction.

(iii) Many candidates were able to identify the experiment with the fastest rate of reaction but did not gain the mark as they were unable to explain how they knew. Many candidates stated that there was more gas produced but did not go on to say that it was produced in the same time. Some candidates merely stated that the reaction with zinc and iron had the higher rate of reaction. This was not credited.

(iv) Some candidates were familiar enough with the apparatus in this experiment to correctly state that some gas would escape before the stopper was replaced. A common error was to suggest that the gas escaped through the stopper or the gas syringe.

(b) Many candidates identified hydrogen as the gas that produced a squeaky pop.

Question 3

Candidates who gained the most credit typically took care to address every bullet point.

Some common approaches to planning questions are more likely to lead to higher marks than others. It is recommended that:

- Candidates structure their answer with sections such as apparatus, method, measurements, constant variables, processing to match the bullet points.
- Every bullet point in the question is addressed. Candidates who tick off or cross out the aspects of the question as they answer are more likely to address all aspects of the question. Weaker responses commonly only address one or two areas of the questions, allowing themselves access to only some of the available marks.
- The response clearly states which factors will be kept the same, what measurements will be made and how the results will be processed. These are the bullet points which are most often omitted.

Common reasons why candidates earned lower marks included:

- Stating that the amount or size of zinc could be varied rather than the 'mass' of zinc powder.
- Safety precautions were often vague and based on laboratory rules rather than linked to the procedure. Suggestions such as 'wear gloves and goggles and tie hair back' were not awarded credit.
- Many did not measure the temperature of the iron(II) sulfate before adding the zinc powder, and again at the end of the reaction. Some candidates suggested using a Bunsen burner to heat the reaction mixture.
- Some did not include any control variables in their answer.
- Answers which said 'repeat it' should be specific about what they intend to repeat and how they will use the repeats, for example 'calculate the change in temperature for each mass of zinc. Repeat the experiment for each mass and calculate a mean change in temperature'.

Question 4

(a) (i) Most candidates were awarded full credit for correctly reading the voltmeter and ammeter scales.

(ii) Candidates were able to use the equation given, and their values from **(a)(i)**, to calculate the total resistance of the two lamps.

(b) (i) Very few candidates knew that when one lamp in a series circuit breaks, the current stops flowing and so the other lamp would also go out. Many suggested that the second lamp would get brighter, or stated that only the broken bulb would not light. Some suggested reasons why the lamp might have broken which was not what the question required.

(ii) Most candidates were unable to describe how to use the circuit components to test to see which lamp works.

(c) (i) Many candidates were awarded two marks for drawing the two lamps connected in parallel and placing the ammeter so it would measure the total current in the circuit. Few candidates were able to place the voltmeter in parallel so that it would measure the total p.d. across both lamps. The most common error was to place the voltmeter in series.

(ii) The switch was correctly placed by most candidates.

(d) (i) Most candidates were able to calculate the total resistance in the parallel circuit and many were able to give their answer to two significant figures.

(ii) Most candidates were unable to state that the bulbs would be brighter in the parallel circuit. A common error was to suggest that the bulbs would be of different brightness in the series circuit but the same brightness in the parallel circuit, or *vice versa*.