COMBINED SCIENCE

Paper 0653/11
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Question 9**, **11** and **13**. **Question 3**, **12**, **17**, **34**, **35**, **37** and **39** proved the most difficult for candidates.

Comments on specific questions

Question 1

Most candidates correctly identified option **A** as the actual size of the cell. Some candidates selected option **D**, obtained by multiplying 200 by 0.08. Candidates need to understand the relationship between actual size, image size and magnification.

Question 2

Most candidates correctly identified option **C**. Some candidates chose option **A**, possibly thinking that oxygen enters the cell via active transport.

Question 3

Candidates found this question challenging. Most candidates incorrectly selected option **B**. This option contained the elements that occur in carbohydrates and fats / lipids / oils. Proteins all contain nitrogen so option **B** could not be correct.

Question 4

Most candidates recognised that liquid 4 was blue / black and therefore selected either option **A** or **C**. Fewer candidates realised that liquid 2 would be green because it contained chlorophyll from the leaf.

Question 5

The correct option, **B**, was chosen more than other options but D was also a common answer, indicating that candidates thought vitamin D, or possibly iron, could reduce scurvy.

Question 8

The equation for aerobic respiration, option **C**, was successfully chosen by most candidates. The most common incorrect answer was option **B**, the equation for photosynthesis.

Question 9

Most candidates correctly selected option **A**. Some candidates incorrectly thought that adrenaline causes the pupils to narrow.

Question 10

Most candidates chose the correct option, **A**. A significant number of candidates chose option **C**, the photographic negative of the parent plant. Asexual reproduction produces offspring that are identical to the parent.

Question 11

Nearly all candidates realised that the sperm duct transports sperm and therefore selected option **A** or **B**. Some incorrectly thought that the urethra only carried urine.

Question 12

A significant number of candidates incorrectly selected option **B**. Perhaps candidates confused primary consumers with producers.

Question 13

Most candidates correctly identified that plants were involved in removing carbon dioxide from the air. Most of these candidates had correctly identified the process as photosynthesis, option **C**. A number of candidates thought plant respiration was responsible for the removal of carbon dioxide from the air.

Question 17

There was evidence that candidates were unsure of the answer to this question. During the electrolysis of dilute sulfuric acid, oxygen would be produced at the positive electrode, option **D**.

Question 24

Candidates chose the incorrect option **C** more often than the correct option, **B**. Candidates are expected to know that brass, as an alloy, is a mixture of metals and conducts electricity in all states. They should know that sodium chloride, an ionic compound, does not conduct electricity in the solid state, but does conduct when molten. It is expected that they understand that naphtha, a fraction obtained from petroleum, contains covalent hydrocarbon molecules and that these do not conduct electricity in any state.

Question 27

There was some uncertainty about the answer to this question. Ethene is made by cracking larger alkanes, it is used as a monomer in the addition polymerisation reaction that forms poly(ethene) and as an unsaturated hydrocarbon it decolourises aqueous bromine. Therefore, option **C** is the correct choice.

Question 28

Candidates were well prepared to answer this question on measurement, with a very high proportion choosing the correct option.

Question 30

A significant number of candidates opted for option **B** (mass and time taken) or option **A** (mass and acceleration), this latter group possibly confusing power with force.

Question 32

Although it was widely understood that evaporation involves the most energetic molecules, many believed that it occurs throughout a liquid, therefore selecting option **D**.

Question 34

Some candidates incorrectly divided the number of wavelengths by the time taken in minutes instead of seconds. This led them to option **C**.

Question 35

Candidates found this question challenging. Candidates should be aware that the speed of all electromagnetic waves is the same and hence options **B** and **D** are possible correct answers. Gamma has a higher frequency than radio waves so option **D** is the correct choice.

Question 37

Many candidates knew that the voltmeter reading would stay constant, but many of these thought that the ammeter reading would increase as the resistance of the variable resistor was increased.

Question 39

Many candidates incorrectly believed that adding the second lamp would cause the brightness of lamp P to decrease, possibly confusing this parallel circuit with a series circuit.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Question 1**, **4**, **10**, **12**, and **30**. **Question 11**, **15**, **27** and **39** proved the most difficult for candidates.

Comments on specific questions

Question 1

Most candidates successfully selected option **D**. Where candidates chose the incorrect answer, most thought that the cell wall was involved in photosynthesis or that it was the site of chemical reactions.

Question 2

Most candidates correctly identified option **C**. Some candidates chose option **A**, possibly thinking that oxygen enters the cell via active transport.

Question 3

Most candidates could recall that biuret reagent is used to test for the presence of protein. The incorrect options were also popular choices, suggesting that candidates were unsure of the tests for biological molecules.

Question 4

Most candidates identified enzymes as biological catalysts. A few candidates incorrectly selected antibodies, and hormones.

Question 5

Most candidates recognised that liquid 4 was blue / black and therefore selected either option **A** or **C**. Fewer candidates realised that liquid 2 would be green because it contained chlorophyll from the leaf.

Question 9

The equation for aerobic respiration, option **C**, was successfully chosen by most candidates. The most common incorrect answer was option **B**, the equation for photosynthesis.

Question 10

Most candidates correctly selected option **D**. Some candidates incorrectly thought that an effect of adrenaline was to decrease pupil size.

Question 11

Candidates found this question difficult. Many candidates incorrectly selected the uterus, option **A**. Fertilisation occurs in the oviducts, option **D**.

Question 12

Most candidates identified the snake as a consumer and a carnivore, option **A**. Some candidates thought that the snake was a herbivore, even though an arrow did not directly link the snake to the grass.

Question 13

Most candidates correctly identified that plants were involved in removing carbon dioxide from the air. Most of these candidates had correctly identified the process as photosynthesis, option **C**. A number of candidates thought plant respiration was responsible for the removal of carbon dioxide from the air.

Question 15

There was evidence that candidates were uncertain about the answer to this question. Candidates are required to know that air is a mixture of gases and that brass, as an alloy, is a mixture of metals. They should also know that sodium chloride, as a compound, is a single substance.

Question 16

For a particle to have no overall charge it must have the same number of protons as electrons. Therefore, option **D** is the correct option.

Question 17

Some candidates chose the incorrect option **C** rather than the correct option, **D**. Candidates should remember that the anode is positively charged and the cathode is negatively charged.

Question 19

Candidates chose the incorrect option **A** more often than the correct option, **C**. Aqueous Q had a pH value of 1 and therefore was an acid. Aqueous P caused the pH of the mixture to increase so P must have been an alkali.

Question 20

A significant number of candidates chose the incorrect option **B**. Aqueous chloride ions form a white precipitate with aqueous silver ions, and therefore option **C** is the correct choice. Aqueous barium ions are used in the test for sulfate ions, not chloride or nitrate ions.

Question 23

Noble gases, in Group VIII or 0, are colourless elements and because they are unreactive, they will not burn in air.

Question 27

Candidates frequently chose incorrect option **B.** Fractional distillation does not produce alkenes, it simply separates a mixture. Alkenes are produced by cracking alkanes.

Question 28

Many candidates either overlooked the fact that the acceleration had to be non-zero, or chose graph **A** because it represented constant non-zero speed rather than acceleration.

Question 30

Candidates were well prepared to answer this question on measurement, with a very high proportion choosing the correct option.

Question 35

Some candidates incorrectly divided the number of wavelengths by the time taken in minutes, instead of seconds, leading them to option **C**.

Question 36

Many knew that the image formed by a plane mirror is virtual, but a large majority of these believed that it would form at position X.

Question 37

Many candidates knew that the voltmeter reading would stay constant, but many of these thought that the ammeter reading would increase as the resistance of the variable resistor was increased.

Question 39

Many candidates treated the two resistors as if they were in series and so added their values to produce a combined resistance of 6.0 Ω. The two resistors were in parallel so the combined resistance would be less than 3.0 Ω.

COMBINED SCIENCE

Paper 0653/13
Multiple Choice (Core)

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

COMBINED SCIENCE

Paper 0653/21
Multiple Choice (Extended)

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

General comments

Candidates performed very well on **Question 1**, **4**, **8**, **13**, **14** and **16**. **Question 18**, **26**, **36** and **37** proved the most difficult for candidates.

Comments on specific questions

Question 2

Most candidates correctly identified option **C**. Some candidates chose option **A**, possibly thinking that oxygen enters the cell via active transport.

Question 3

Candidates found this question challenging. Most candidates incorrectly selected option **B**. This option contained the elements that occur in carbohydrates and fats / lipids / oils. Proteins all contain nitrogen so option **B** could not be correct.

Question 4

Most candidates correctly identified option **C**. Some candidates chose option **A**, missing the fact that the equation was not balanced.

Question 7

Most candidates correctly worked out that 24 molecules of carbon dioxide were produced by four molecules of glucose during aerobic respiration. Some candidates calculated that 12 molecules of carbon dioxide were produced, perhaps thinking that a carbon dioxide molecule contains two atoms of carbon.

Question 8

Most candidates correctly selected option **A**. Some candidates incorrectly thought that adrenaline causes the pupils to narrow.

Question 9

Most candidates chose the correct option, **A**. A significant number of candidates chose option **C**, the photographic negative of the parent plant. Asexual reproduction produces offspring that are identical to the parent.

Question 10

Most candidates identified that the plant was wind pollinated. Most went on to identify structure X as a stigma. A significant number thought that structure X was an anther.

Question 12

A significant number of candidates opted for either **C** or **D**. Candidates that opted for **C** had identified the correct number of primary consumers and secondary consumers but may have thought that the fox and eagle were both tertiary consumers based on their position on the diagram. Those that opted for **D** seemed to confuse primary consumers with producers.

Question 13

Most candidates correctly identified that plants were involved in removing carbon dioxide from the air. Most of these candidates had correctly identified the process as photosynthesis, option **C**. A number of candidates thought plant respiration was responsible for the removal of carbon dioxide from the air.

Question 18

Many candidates incorrectly chose option **A**, rather than the correct option, **D**. Molten aluminium oxide and dilute sulfuric acid both produce oxygen at the anode.

Question 21

There was evidence that candidates were uncertain about the answer to this question. Candidates should ensure that they understand how to make a given salt from suitable starting materials, given appropriate information such as solubility in water.

Question 26

Many candidates chose the incorrect option **D** rather than the correct option, **A**. Carbon dioxide and methane are greenhouse gases and when their concentration in the air increases, they may contribute to climate change. Sulfur dioxide causes acid rain, rather than climate change.

Question 27

Almost all candidates knew that hydrocarbons contain only carbon and hydrogen atoms.

Question 29

Many candidates thought that diagram 2 represented constant acceleration. They either missed the fact that the question specified that it must be non-zero, or they confused constant speed with constant acceleration.

Question 30

Most candidates recognised point X as the limit of proportionality, but some miscalculated the spring constant as extension / load.

Question 35

A significant number of candidates chose option **A**, confusing the direction of vibration of particles in longitudinal and transverse waves.

Question 36

The use of a converging lens as a magnifying glass was found problematic by many. Many candidates incorrectly believed that the object is placed between *F* and 2*F*, rather than less than *F*.

Question 37

This was a very demanding question with few candidates choosing the correct option, **D**. Many failed to notice that the current was given in milliamps, leading them to select option **C**.

Question 38

Many candidates knew that the voltmeter reading would stay constant, but many of these thought that the ammeter reading would increase as the resistance of the variable resistor was increased.

Question 39

Some candidates correctly calculated the energy transferred by the lamp. Many multiplied together all the values given, thereby incorrectly arriving at option **B**.

COMBINED SCIENCE

Paper 0653/22
Multiple Choice (Extended)

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

General comments

Candidates performed very well on **Question 5**, **6**, **8**, **9**, **11**, **23, 26**, **27** and **28**. **Question 14, 19**, **31** and **34** proved the most difficult for candidates.

Comments on specific questions

Question 1

Most candidates identified the substance being moved as mucus. Fewer realised that the direction of movement was towards the trachea.

Question 2

Most candidates correctly identified option **C**. Some candidates chose option **A**, possibly thinking that oxygen enters the cell via active transport.

Question 3

Most candidates identified enzymes as biological catalysts. A few candidates incorrectly selected antibodies, and hormones.

Question 4

Most candidates correctly selected option **C**. Some candidates selected option **A**, the balanced equation for aerobic respiration with the correct cell type for photosynthesis.

Question 6

Most candidates correctly selected option **B**. A number of candidates thought the liver was the site of digestion and absorption.

Question 7

Most candidates correctly identified the correct option, **B**. Some candidates thought that the root hair was involved in glucose uptake.

Question 8

Most candidates correctly worked out that 24 molecules of carbon dioxide were produced by four molecules of glucose during aerobic respiration. Some candidates calculated that 12 molecules of carbon dioxide were produced, perhaps thinking that a carbon dioxide molecule contains two atoms of carbon.

Question 9

Most candidates correctly selected option **D**. A number of candidates thought that adrenaline decreases the blood glucose concentration, rather than increases it.

Question 10

The majority of candidates identified that the shoot would grow towards the light. Fewer identified that the distribution of auxin was best represented by diagram **A** because auxin accumulates on the unlit / darker side of the shoot. Many candidates incorrectly selected option **B**.

Question 11

Most candidates correctly identified the oviducts, option **D**, as the site of fertilisation. Some candidates incorrectly selected the uterus, option **A**.

Question 12

Some candidates thought that the caterpillar was at trophic level 1. Trophic level 1 will contain the producers.

Question 13

Most candidates correctly identified that plants were involved in removing carbon dioxide from the air. Most of these candidates had correctly identified the process as photosynthesis, option **C**. A number of candidates thought plant respiration was responsible for the removal of carbon dioxide from the air.

Question 14

For a particle to have no overall charge it must have the same number of protons as electrons. Therefore, option **D** is the correct option.

Question 19

Many candidates chose the incorrect option **A**, rather than the correct option, **C**. As a reaction proceeds, the concentration of the acid would decrease and as the solid gets smaller, the total surface area of the solid decreases. These two factors would cause a decrease in the reaction rate.

Question 22

A significant number of candidates chose the incorrect option **B**. Aqueous chloride ions form a white precipitate with aqueous silver ions, and therefore option **C** is the correct choice. Aqueous barium ions are used in the test for sulfate ions, not chloride or nitrate ions.

Question 27

Almost all candidates knew that hydrocarbons contain only carbon and hydrogen atoms.

Question 28

Candidates were well prepared to answer this question on measurement, with a very high proportion choosing the correct option.

Question 29

Many candidates thought that diagram 2 represented constant acceleration. They either missed the fact that the question specified that it must be non-zero, or they confused constant speed with constant acceleration.

Question 31

The majority of candidates knew that the main source of energy released from the Sun is from a nuclear reaction but many were confused between fission and fusion.

Question 34

A significant number of candidates were unable to recall the equation $v = f\lambda$ and opted for $v = f / \lambda$ instead.

Question 35

Many knew that the image formed by a plane mirror is virtual, but a large majority of these believed that it would form at position X.

Question 36

Many candidates incorrectly selected option **D**, indicating that it is widely thought that the speed of sound is greatest in gases and least in solids.

Question 39

Some candidates correctly calculated the energy transferred by the lamp. Many multiplied together all the values given, arriving at option **B**.

COMBINED SCIENCE

Paper 0653/23
Multiple Choice (Extended)

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

COMBINED SCIENCE

Paper 0653/31
Theory (Core)

Key messages

Candidates should be encouraged to use the correct spelling for scientific terms, e.g. alveoli and nucleus, to avoid confusion with other scientific terms.

Care should be taken when converting units in calculations and it should only be done if necessary to limit the chance of errors.

Candidates should be encouraged to use scientific terminology carefully and in the correct context. Answers should be as specific as possible and address the question being asked.

General comments

Some good answers were seen and candidates demonstrated knowledge from across the Combined Science syllabus.

Some candidates gained only partial credit by not providing sufficient detail in their answer. They are reminded to use the number of marks available for each question as a guide to how much detail to include.

Most candidates showed their working in questions requiring calculation. Marks may be gained for working, even if the final answer is incorrect.

Comments on specific questions

Question 1

(a) Most candidates gained full marks, correctly matching the characteristics and definitions.

(b) A large number of candidates did not know alveoli and many stated bronchi. Many candidates correctly stated diffusion with the main incorrect response being osmosis.

(c) (i) The nucleus was well known by most candidates. Care should be taken when spelling scientific terms.

(ii) There were many correct answers to this question. The most common error occurred when candidates stated chlorophyll instead of chloroplast. Chlorophyll is a chemical that would not be visible in a slide of a plant cell.

Question 2

(a) (i) Some candidates stated the trend correctly. Unacceptable answers included descriptions of a trend of decreasing reactivity and responses which did not state a trend.

(ii) This question was challenging and only a few candidates answered correctly. Many responses stated that helium is a noble gas, without explaining that noble gases are unreactive.

(iii) Many candidates correctly described two differences between the structure of a solid and a gas. Some weaker responses included descriptions that did not refer to the particles in a solid and a gas.

(b) (i) Many candidates described the appearance of bubbles when a gas is given off. A common error was to state that a gas is given off without stating the evidence of what they saw.

(ii) Very few candidates scored full credit in this question. Hydrogen was seen more often than sodium hydroxide.

(c) The most common answer was sodium, which was not correct. Careful reading of the stem shows that the answer should be a compound and not an element.

(d) (i) Some candidates answered the question correctly, stating ionic as the type of bonding. Incorrect chemical bonds frequently seen were covalent and double.

(ii) There were very few correct answers to this electrolysis question. A wide range of incorrect responses included sodium and hydrogen.

Question 3

(a) Some candidates knew that electrons are the particles that flow in an electric current. Incorrect responses included electrodes and electricity.

(b) (i) Many candidates drew the correct ammeter and voltmeter symbols. Very few showed the voltmeter in the correct position. Common errors seen were the ammeter and voltmeter symbols in square boxes, or drawn with a line though the symbols.

(ii) Candidates did not understand that altering the resistance alters the current, which was rarely mentioned. There was confusion about the correct function of a variable resistor. Incorrect ideas stated that it alters electricity, power and voltage. Many responses repeated the question without adding any extra information.

(iii) A large number of candidates divided the resistance by the current giving the answer as 40. The equation for Ohm's Law was incorrectly recalled by these candidates.

(iv) Almost all candidates stated incorrectly that the resistance increases when the second lamp is connected in parallel to the first one. The resistance actually decreases.

Question 4

(a) (i) Many candidates identified the optimum temperature, 40 °C. Fewer successfully described the trends of increasing activity from 10 °C towards the optimum, and of decreasing activity from the optimum to 50 °C.

(ii) Enzymes are proteins that function as biological catalysts. Many candidates stated catalyst correctly, but only a few named proteins.

(iii) Many candidates correctly named haemoglobin. The most common incorrect response was iron.

(b) (i) The correct box was ticked by many candidates. Light and chlorophyll were selected by a few candidates.

(ii) There was a variety of colours given for the negative starch test. Instead of the correct answer, brown, candidates wrote incorrect answers, including brick red, blue-black, clear and no change.

Many candidates correctly stated starch to complete the second sentence. Incorrect responses included glucose, chlorophyll and photosynthesis.

(iii) Most candidates did not recall that magnesium ions are required to make chlorophyll. Incorrect answers included the raw materials for photosynthesis, chloroplasts and glucose.

Question 5

(a) (i) Many candidates gained full credit in this question. Answers that were not accepted included distillation on its own and refining.

(ii) Most candidates were unfamiliar with the process of cracking. Combustion was the most common error, closely followed by heating.

(iii) The responses given were in roughly equal numbers for chemical change and physical change. A few candidates could support their choice of chemical change with a suitable explanation.

(iv) Very few candidates were familiar with either the test for alkenes, or the result of a positive test.

(b) (i) Several candidates correctly stated carbon dioxide. Some candidates wrote oxygen.

(ii) A complete range of gases was given here, including helium, carbon dioxide, hydrogen and nitrogen. Of those who gave oxygen as the gas, very few wrote the correct percentage.

(iii) This was generally well answered. Many candidates correctly stated C_3H_6. Others are reminded that C3H6 or C^3H^6 are incorrect ways of writing the formula.

Question 6

(a) (i) Many candidates did not know the melting point of water, 0 °C. Incorrect answers covered the complete range of temperatures between –50 °C and 100 °C.

(ii) Similarly, to **(a)(i)**, many candidates were unfamiliar with the boiling point of water, 100 °C. In this case, incorrect answers ranged from 20 °C to 1000 °C.

(iii) Many candidates interpreted the information correctly and described how both the melting point and the boiling point of water were changed by the addition of salt.

(b) (i) There were many correct numerical answers. Fewer candidates gave the correct units, for example they wrote m^3 or kg. Some candidates did their calculation in g/cm^3 and were able to gain full credit if the unit conversions were done correctly.

(ii) Many candidates correctly stated that the salt water was denser than water. Incorrect answers included salt water is heavier, water is lighter or salt is heavier. This highlights the importance of using scientific terminology carefully and in the correct context.

Question 7

(a) (i) Almost all candidates knew the sites of egestion and ingestion.

(ii) There were many correct responses to this question. Digestion and absorption were seen in roughly equal numbers. There was a variety of incorrect responses, including to carry waste and release energy.

(iii) The role of the plasma in transporting the products of digestion was not widely known. The most frequent responses were red and white blood cells.

(b) Many candidates were correct with kidney beans, but some stated both fibre and carbohydrates, therefore scoring just one mark.

(c) Few candidates scored full marks. There were many responses containing colloquial names, or female reproductive parts. Candidates are reminded to learn the scientific terms stated in the syllabus.

(d) Very few candidates gained full marks, though many scored partial credit. The most frequent misconceptions were that asexual reproduction involves the fusion of nuclei and also that it involves gametes.

Question 8

(a) (i) Many candidates correctly named a stop-clock. The most common error was thermometer.

(ii) Some candidates gained credit by suggesting the use of a higher temperature. Those who simply stated temperature could not be awarded the mark. Adding a catalyst was seen and also a few descriptions of increasing the surface area of magnesium. Both of these changes gained credit. Several candidates stated use more acid, use more magnesium or remove the funnel. None of these responses gained credit.

(iii) Some candidates correctly compared the reactivity of zinc and magnesium. Common errors included stating that the reaction would go faster because zinc is more reactive than magnesium and describing that less gas is produced without mentioning the rate of reaction.

(b) (i) Very few candidates knew that alloys are a mixture of metals. The most common error was compounds.

(ii) There were many correct ideas. Most candidates described the alloy as being stronger or harder than pure copper. Resistance to corrosion was also acceptable, but references to rusting were not allowed because this term applies only to iron.

(c) The transition metals were known by a few candidates. Lists of metals in the same period as copper were often given but did not gain credit.

(d) (i) Several candidates correctly described the idea of heating up the mixture. A common error was stating that water has to be added.

(ii) Many candidates were confused by the choice between oxidised and reduced. Of those who chose reduced, very few could explain their choice. Responses which referred to the oxide being taken away from the copper oxide did not gain credit because it is the oxygen element, not the ion, which is being removed.

Question 9

(a) (i) Many candidates identified **Q** correctly. The most common error was force **S**.

(ii) Many candidates gained full credit. Several responses contained three ticks, so did not achieve full credit.

(b) (i) Few candidates knew about the chemical energy in the gasoline. Incorrect answers included nuclear and thermal. There were more correct responses for the rest of the question, with kinetic energy being widely known.

(ii) There were many correct answers that scored full marks. Partial credit was awarded to those candidates who did not convert the units from minutes to seconds but otherwise completed a correct calculation.

(c) Candidates found this question challenging. Some credit was awarded for the correct and accurate labelling of the wavelength and amplitude, with the measurements included.

COMBINED SCIENCE

Paper 0653/32
Theory (Core)

Key messages

Candidates should be encouraged to use the correct spelling for scientific terms, e.g. refraction, to avoid confusion with other scientific terms.

Care should be taken when converting units in calculations and it should only be done when necessary to limit the chance of errors.

Candidates should be encouraged to use scientific terminology carefully and in the correct context. Answers should be as specific as possible and address the question being asked.

General comments

Some good answers were seen, and candidates demonstrated knowledge from across the Combined Science syllabus.

Some candidates gained only partial credit by not providing sufficient detail in their answer. They are reminded to use the number of marks available for each question as a guide to how much detail to include.

Most candidates showed their working in questions requiring calculation. Marks may be gained for working, even if the final answer is incorrect.

Comments on specific questions

Question 1

(a) Most candidates successfully completed the sentences to describe characteristics of living organisms.

(b) (i) Most candidates labelled two out of the three flower parts correctly. The filament was frequently mislabelled as the stigma.

(ii) There were some correct answers to this question. Many candidates wrote anther instead of stigma.

(iii) There were few correct answers to this question. Most candidates wrote ovary. Candidates are reminded that the ovary may contain several ovules, each of which can be fertilised by a pollen nucleus to form a seed.

(c) (i) Most candidates successfully drew lines to connect the parts of the reproductive system with their functions.

(ii) There were very few candidates who gave the correct answer, embryo. Sperm cells and egg were frequently seen.

Question 2

(a) (i) Many candidates gave correct responses about the inability of an insoluble product to dissolve (in water). Very few answers gave a correct description of a compound. Some candidates referred to

there being two or more substances, not elements, and frequently described them as being mixed, not chemically combined.

(ii) Candidates found this question challenging. Most did not describe filtering the mixture at the start, to remove the insoluble solid, and only gained credit for heating to evaporate water.

(b) Some candidates gained full credit for this question. Partial credit was more frequently awarded for the two single covalent bonds between hydrogen and oxygen. Few candidates added the lone pairs of electrons on oxygen to their diagram. H–O–H was frequently given instead of the dot-and-cross diagram.

(c) Most candidates wrote about mass and mass number. Some incorrect responses described adding up the wrong particles, such as protons and electrons, or neutrons and electrons.

(d) Few candidates scored full credit in this question. It was common for one mark to be awarded for the relative mass column, but many wrote the charge on the proton as just + instead of + 1, which was required.

Question 3

(a) (i) There were many who gave correct answers to this question. The most common error was omitting to square the radius in the formula.

(ii) Many candidates successfully applied the formula density = mass / volume to calculate the density of copper.

(b) (i) Many candidates correctly identified sphere **B** as having an excess of electrons but neglected to explain that electrons have a negative charge. The incorrect term, positive electrons, was frequently seen.

(ii) Some candidates correctly explained that opposite charges attract. Unacceptable responses stated that the charges on the spheres are not balanced and they need to be balanced, or just that sphere **B** is negatively charged.

(c) Many candidates used Ohm's law correctly to arrive at the right numerical answer. Fewer gave the correct unit. Volts, joules and ohms were common errors for the unit of current.

Question 4

(a) (i) Most candidates calculated the correct value for the change in mass, 0.7 g.

(ii) Most candidates found this question challenging. Many were unfamiliar with the function of stomata, or the fact that more are found on the lower side of the leaf. Therefore, they could not conclude that the petroleum jelly prevented evaporation from leaf **B,** where the lower surface was covered, but allowed much more evaporation from leaf **C** where the lower surface was exposed.

(b) (i) Some candidates correctly identified a xylem vessel in the centre of the root. Others labelled phloem cells or parenchymal cells.

(ii) Candidates found this question challenging. Nitrate ions are needed for plants to have the nitrogen necessary to make amino acids, and eventually, protein. Many candidates wrote carbon.

(c) (i) This question was generally well answered. Many candidates scored at least two marks. The least known answer was gravitropism, the name of the response.

(ii) There were few correct answers to this question. Many candidates thought that the red blood cells transported enzymes or hormones.

Question 5

(a) (i) Many candidates identified hydrogen as the gas produced. Fewer stated zinc chloride to gain full credit. Common errors included identifying carbon dioxide or oxygen as the gas, and water or salt as the other product.

(ii) The measuring cylinder was named correctly by some candidates. Incorrect responses included just cylinder on its own, or test-tube.

(iii) Most candidates did not know the chemical test for zinc ions, Zn^{2+}. Zinc ions give a white precipitate that is soluble in excess with aqueous sodium hydroxide.

(iv) Many candidates stated that the reaction would proceed faster due to the higher reactivity of magnesium. Those candidates who wrote no change, because the amount of metal and the conditions were the same, missed the point that the reactivity of the metals was different.

(b) The finite nature of the supply of metals from their ores was missed by many candidates. A common answer, which did not gain credit, was so they can be used again.

(c) Many candidates gave a correct response to the chemical trend, but fewer gained credit for the physical trend. Some candidates did not describe a correct trend and simply stated facts, such as they are reactive.

Question 6

(a) (i) Many candidates correctly named chemical energy. Incorrect responses included kinetic energy, thermal energy and mechanical energy, or other things that were not types of energy, for example frictional energy.

(ii) Most candidates successfully named kinetic energy.

(b) Many candidates knew that as the driving force increases, the frictional force also increases. To accelerate, the driving force has to be larger than the frictional force. Few candidates stated this clearly.

(c) Many candidates did the unit conversions successfully and scored full marks.

(d) (i) A few candidates labelled the variable resistor correctly. Incorrect responses included just a resistor on its own, a battery, a switch and an ammeter.

(ii) Many candidates confused the type of circuit for the two lamps and wrote parallel instead of series.

(iii) Candidates found interpreting the diagram very challenging. It was clear from **(d)(i)** that many did not know the correct function of a variable resistor and did not understand the flexibility of having a parallel circuit so that the motor and lights could operate independently.

Question 7

(a) (i) Some candidates correctly labelled the septum which divides the left and right sides of the heart. The label line and letter **A** in incorrect answers frequently pointed to valves and blood vessels.

(ii) Vena cava, the correct answer, was not circled by many candidates. Pulmonary artery and pulmonary vein were the most common choices.

(iii) There were very few correct answers here. Many candidates used options from the previous question, **(a)(ii)**.

(iv) The most common point scored was that arteries have thicker walls than veins. The transport of blood away from the heart in arteries and towards the heart in veins was the second most popular point. Some candidates split their answers, so that the second point was the reverse of the first. These answers were only awarded partial credit. There were some incorrect responses too. For example, arteries transfer blood in the heart and veins transfer blood around the whole body.

(b) (i) Many candidates correctly stated that white blood cells produce antibodies. Incorrect answers included red blood cells and platelets.

(ii) Many candidates answered this question well. Those who gained full marks remembered to make their answers comparative. For example, 'There are a greater number of antibodies after infection than after vaccination' was a good response for one mark.

Question 8

(a) Most candidates successfully wrote a difference for the second marking point in terms of alkenes having a double bond and alkanes having all single bonds. Many candidates wrote that both alkanes and alkenes contain carbon and hydrogen. The question asked about bonding, not chemical composition, so it was not accepted. An acceptable answer was the general statement that both compounds have covalent bonds.

(b) (i) Some candidates gained credit by stating carbon dioxide. Oxygen was frequently seen.

(ii) Only a few candidates knew a chemical test for water. Incorrect tests included limewater, litmus paper and lighted splints.

(iii) A common error stated that oxygen is produced in the reaction, rather than that oxygen reacts with ethane.

(c) Very few candidates could name the polymer, poly(ethene).

Question 9

(a) Very few candidates succeeded in describing expansion.

(b) (i) Between 20 and 25 minutes the process taking place is boiling. Evaporation can take place over a range of temperatures. Some candidates wrote boiling point. This term refers to the temperature at which boiling occurs, not the process, so this was not awarded credit.

(ii) Many candidates had some idea about the molecules moving apart from each other and moving faster, but they found difficulty in expressing it. Consequently, few candidates gained full credit.

(c) Refraction was well known by many candidates.

(d) (i) The type of radiation was correctly answered by most candidates.

(ii) The candidates who scored a correct answer in **(d)(i)** usually placed the radiation in the correct box in the incomplete electromagnetic spectrum. An error carried forward was allowed if the candidate had incorrectly stated ultraviolet or gamma rays in **(d)(i)** and placed them correctly in the spectrum.

COMBINED SCIENCE

Paper 0653/33
Theory (Core)

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

COMBINED SCIENCE

Paper 0653/41
Theory (Extended)

Key messages

Candidates should read each question carefully and take particular note of the command word. Describe and explain require very different answers and candidates are often confused by the requirements of each command word.

Care should be taken when converting units in calculations and it should only be done when necessary to limit the chance of errors. Numerical answers should always be given to an appropriate number of significant figures.

Candidates should be encouraged to use scientific terminology carefully and in the correct context. Answers should be as specific as possible and address the question being asked.

Candidates should ensure they draw electrical circuit symbols as they are shown in the syllabus.

General comments

Many candidates had a very good understanding of most of the syllabus and gave clear, well-organised answers. Performance across the three Science disciplines was well balanced. Candidates usually showed their working in questions requiring calculation, whether instructed to do so or not, and this is good practice. This often allows partial credit to be awarded even when an incorrect final answer is stated.

Some sections of the syllabus proved a little more challenging than others.

In Biology, the difference between mechanical and chemical digestion, (**4(b)(i)**), was not always explained carefully. Candidates often found it difficult to explain the advantages of the double circulatory system in humans, (**7(a)(ii)**).

In Chemistry, not all candidates could describe how an energy profile shows that a reaction is exothermic, (**5(b)(i).** Some candidates were unfamiliar with the physical properties and the relative reactivities of the halogens, (**8(a)(i)** and **8(c)**).

In Physics, many candidates had difficulty in explaining that constant speed of a boat can only be maintained if work is done to balance resistive forces, (**3(a)(ii)**). The idea that balanced forces are acting on an object moving at constant speed is a difficult one for many candidates. Many candidates found it difficult to predict the way the main current in an electric circuit would divide between wires of different, known resistance connected in parallel, (**9(b)(i)**).

Comments on specific questions

Question 1

(a) (i) Most candidates knew that the nucleus contains genetic material. Any correct reference to genetic material was accepted and the mark was also awarded to candidates who stated that the nucleus controls cell activity. The most common mistake was to describe the function of the sperm rather than the nucleus.

(ii) Most candidates identified the flagellum. The term tail was accepted although candidates should be encouraged to use flagellum.

(iii) Most candidates correctly named the testes.

(b) (i) Guard cells were familiar to some candidates. A large number of incorrect suggestions were seen, some of the more common ones being cytoplasm, chloroplast and chlorophyll.

(ii) Many candidates correctly identified chloroplast or the cell wall. Chlorophyll did not gain credit since the question asks for a structure. Cytoplasm was a common mistake. Many candidates may have misread the question because they described a structure within a sperm cell.

(c) (i) Most candidates calculated the average correctly and nearly all rounded the answer to the nearest whole number. Although this is a relatively simple calculation, candidates should always show their working whether or not the question asks them to do so.

(ii) One mark was frequently awarded for a correct statement describing the relationship between either light intensity or distance of the lamp and the rate of photosynthesis. The second mark was for recognising that the rate levels off when the lamp is closer to the plant. Candidates are more likely to recognise this when data is presented in the form of a graph and they should be encouraged to look for it in data tables.

(d) The role of chlorophyll was widely understood by many candidates and full credit was often awarded. Candidates should be encouraged to be precise by referring to the light rather than more vague references to the Sun or radiation or the Sun's energy. They should also avoid suggesting that chlorophyll attracts light.

Question 2

(a) (i) Most candidates referred to shared electrons. Answers that showed some relevant but insufficient knowledge included suggestions such as they share, there is a dot and a cross, and the electrons are between the atoms.

(ii) Candidates often gained at least partial credit for referring to the double bond in oxygen and the single bond in hydrogen. Explaining the different numbers of electrons required candidates to refer to complete outer shells in oxygen and hydrogen and tended to discriminate the stronger candidates. Candidates were required to discuss both oxygen and hydrogen.

(b) (i) Almost every candidate recognised carbon dioxide as the compound. For full credit, candidates had to make the general point that different elements or atoms are present. It was not enough to state that carbon dioxide contains carbon and oxygen.

(ii) Candidates who were familiar with the uses of argon, usually referred to its use in some form of lighting. Any correct use of the gas gained credit.

(iii) The unreactive character of the noble gases resulting from the complete outer shell in their atoms was familiar to many candidates. One common mistake was to discuss a reactivity trend within Group VIII.

(iv) Most candidates gave a correct answer to this question realising that the total was not 100%.

Question 3

(a) (i) The formula for kinetic energy was familiar to a large number of candidates. Many correctly substituted values and gained full credit for their final answers. Some candidates omitted to find the square of the velocity even when they had correctly stated the formula. Candidates who did not state the formula usually simply divided the mass of the boat by its speed.

(ii) Most candidates found this to be a challenging question and only a small number gained full credit. It was important for candidates to realise that work done = energy transferred. This was often missed and explanations involving energy were rarely seen. Successful candidates gained credit for describing resistive forces acting on the boat and some stated that at constant speed the driving and resistive forces would be balanced.

(b) (i) Some candidates correctly referred to reflection. Many other candidates used wording such as, they bounce back, which did not gain credit.

(ii) Some candidates recognised that their knowledge of the law of reflection in the context of light needed to be applied here. Partial credit was awarded for a reflected arrow direction anywhere between an imaginary normal and the harbour wall. Full credit required the angle of reflection to look reasonably close to the angle of incidence.

Question 4

(a) (i) Almost every candidate gained this mark.

(ii) Some candidates worked through the steps in this calculation successfully and gained full credit. Two common reasons why full credit was missed were, not finding 25% of the data for nuts in the table and not correcting the final answer to two significant figures. Candidates should be advised that when the required precision of the final answer is stated, marks will be allocated for doing this correctly.

(iii) Stronger candidates tended to gain this mark. It was important to compare the high levels of protein in nuts to the lower levels in other vegetables. The mark was not awarded for the simple idea, given by many candidates, that nuts have a high protein content.

(b) (i) Most candidates gained at least partial credit for stating that both types of digestion involved the break down of food. There were several points that candidates could make to gain the second mark and all the expected options were seen. Credit was frequently missed because candidates suggested that both types of digestion involved the breakdown of molecules.

(ii) The importance of maintaining optimum conditions for stomach enzymes was understood by stronger candidates. Answers often revealed confusion about the role of hydrochloric acid in digestion. Credit was not awarded for referring to killing pathogens, or for the idea that hydrochloric acid digests food directly.

Question 5

(a) Many candidates gained full credit for completing the equation.

(b) (i) Many candidates gained at least partial credit for knowing that during an exothermic reaction, energy is released. Candidates should avoid suggesting that energy is produced or created. Candidates often had difficulty in explaining how the energy level diagrams show that the reactions are exothermic. They needed to compare the energy levels of product and reactants rather than simply making statements such as the products are low in energy. Some candidates attempted to give details of the energy changes during bond breaking and formation and some good answers were seen. Candidates often mistakenly suggested either that energy is taken in when bonds are formed, or energy is given out when bonds are broken.

(ii) Many candidates clearly identified the two differences but found it difficult to word their answers. Candidates who were familiar with the term activation energy easily gained at least partial credit. Those who were not, made suggestions such as methane takes in less energy which is not quite enough. Candidates often realised they had to state that the combustion of propane released a greater amount of energy. Some candidates did this clearly while others made suggestions such as the products of propane are lower down than methane.

(c) Some candidates were familiar with the toxic nature of carbon monoxide. Some gave excellent descriptions of the interaction of carbon monoxide and haemoglobin although this was not necessary. Candidates should be advised to use the mark allocation as a guide for how much detail to include. The most common answers that did not gain credit were global warming and air pollution.

Question 6

(a) (i) This question was answered well by many candidates. It was important to state that the normal boiling point of water is 100 °C and that the addition of salt increases, rather than simply changes, this value. Some candidates attempted to try to explain the effect rather than simply describe it and often missed credit as a result.

(ii) Some candidates wrote excellent answers but many found this to be a challenging question. The strongest candidates stated very clearly that increased intermolecular forces require more energy to break. Common answers that were insufficient included, higher forces need higher temperature, the higher the force the more difficult it is to break, higher forces take longer to break and several references to the water no longer being pure.

(b) (i) Most candidates calculated the volume of the rock.

(ii) The use of the relationship, density = mass ÷ volume was familiar to most candidates who worked through to the correct final answer. The most common mistake was to multiply the mass by the volume. An error in **(b)(i)** was allowed to be carried forward.

(iii) The majority of candidates correctly converted the mass of the rock to its weight.

(iv) Many candidates were familiar with the relationship, pressure = force ÷ area and worked through to the correct final answer and stated correct units. The two most common mistakes were to calculate mass ÷ area and to multiply force by the area. Some candidates were unfamiliar with suitable units for pressure and so could only gain partial credit. An error in **(b)(iii)** was allowed to be carried forward.

Question 7

(a) (i) Many candidates suggested structures such as lumen, artery wall, capillary and some others suggested plant structures. Only the stronger candidates realised that a tissue type was required.

(ii) A small number of candidates gained full credit. Many candidates wrote at length, describing the passage of blood around the double circulatory system without explaining the advantages. Of the candidates gaining credit, the most familiar advantage was keeping oxygenated and deoxygenated blood separate. The need for different blood pressures in the pulmonary artery and the aorta was rarely seen.

(iii) Many of the answers to this question described the passage of blood through the chambers and valves inside the heart. Only a small number of candidates discussed the contraction of muscles in the ventricles.

(b) (i) Most candidates gained this mark. Credit was awarded for the answers positive and weakly positive. Stronger candidates gave a fuller description of the increase in deaths with the number of cigarettes smoked. Insufficient answers included, weak, scattered, and best fit.

(ii) This topic was familiar to many candidates and full credit was frequently awarded. The most common suggestion that did not gain credit was that the smoke particles are trapped in the cilia with no mention of the role of mucus.

Question 8

(a) (i) The properties of the halogens were familiar to many candidates.

(ii) Candidates needed to be careful with their definition of diatomic. The best answers referred to molecules containing only two bonded atoms. Many candidates missed credit with suggestions such as diatomic means they have two molecules or diatomic means more than one atom.

(b) Many candidates answered this correctly. It was not sufficient to simply state that they are in Group VII because they have a valency of 1.

(c) Many candidates gained partial credit for knowing the order of reactivity of the halogens. For the explanation, they needed to do more than re-write the information shown in the chemical equations. Therefore, answers like chlorine reacts with potassium bromide and bromine reacts with potassium iodide did not gain credit. Stronger responses stated that a more reactive halogen, such as chlorine, will displace a less reactive halogen like bromine.

(d) (i) Most candidates gained this mark. Covalent was the most common incorrect answer.

(ii) The candidates were required to refer to the strong attractive forces between ions and some of the stronger candidates gained the mark. Some candidates mentioned that the high melting point meant that higher energy is needed to separate ions, but without reference to high attractive forces, the mark was not awarded.

Question 9

(a) (i) Many candidates drew excellent circuit diagrams and gained full credit. There were several ways that candidates could gain at least partial credit and many did. Candidates should be advised that they must draw electrical symbols accurately and so, for example, symbols for an ammeter and a voltmeter must not show connecting wire drawn through them. One mistake that occurred several times was that candidates connected the voltmeter across a central portion of the resistance wire.

(ii) Many candidates understood that when the length of the resistance wire is increased then the resistance will increase in proportion. A smaller number were familiar with the effect on resistance of reducing the diameter of the wire. These effects were marked independently which allowed many candidates to be awarded at least partial credit, provided that they had set out their working clearly.

(b) (i) A small number of candidates understood that if the potential difference across both wires is the same then the current through the 5 Ω resistance is greater than that through the 10 Ω. Some of these candidates were also able to predict that the ratio of the currents would be divided between the 5 and 10 Ω wires in the proportion of 2:1. They could then divide 3 A into two parts that had the proportions of 2:1. Most candidates found this route through the problem to be too challenging.

(ii) Some stronger candidates were familiar with the formula for calculating the combined resistance of two resistors in parallel and gained full credit. A frequent mistake was to state the formula as $R = \frac{1}{R_1} + \frac{1}{R_2}$. Candidates unfamiliar with this type of calculation often simply added the resistances.

COMBINED SCIENCE

Paper 0653/42
Theory (Extended)

Key messages

Candidates should read each question carefully and take particular note of the command word. Describe and explain require very different answers and candidates are often confused by the requirements of each command word.

Care should be taken when converting units in calculations and it should only be done when necessary, to limit the chance of errors. Numerical answers should always be given to an appropriate number of significant figures.

Candidates should be encouraged to use scientific terminology carefully and in the correct context. Answers should be as specific as possible and address the question being asked. Chemical formulae should be written carefully and should follow appropriate convention.

Candidates should ensure they draw electrical circuit symbols as they are shown in the syllabus.

General comments

Many candidates had a very good understanding of most of the syllabus and gave clear, well-organised answers. Performance across the three Science disciplines was well balanced. Candidates usually showed their working in questions requiring calculation, whether instructed to do so or not, and this is good practice. This often allows partial credit to be awarded even when an incorrect final answer is stated.

Some questions proved more challenging than others.

In Biology, details of the ethanol emulsion test, (**1(d)**), were not always complete. Some candidates seemed unsure about the kinetic reasons for the increase in enzyme activity with increasing temperature below the optimum, (**4(a)(ii)**). Many candidates were unfamiliar with the syllabus definition of ecosystem, and often had difficulty using ecological terms appropriately, (**7(a)**).

In Chemistry, not all candidates understood that the total surface area of a solid increases when it is broken into a larger number of smaller pieces, (**(5(b)).** Some candidates were unfamiliar with the way that the similarities of members of a homologous series are described in the syllabus, (**8(a)(ii)**).

In Physics, candidates often found it difficult to describe the way that the wind can be used to provide electrical energy, (**3(a)(i)**). Only the strongest candidates were familiar with the working of a liquid thermometer, (**6(b)(i)**). Many candidates did not make the connection between greater intermolecular separation and weaker intermolecular forces in gases compared to liquids as the reasons for less energy needed to increase gas temperature, (**6(b)(ii)**). Many candidates were unfamiliar with how to vary the relative positions of object lens and eye to increase magnification, (**6(c)(iii)**).

Comments on specific questions

Question 1

(a) (i) This question was answered very well. Most candidates correctly stated pollen. The most common incorrect suggestion for stigma was anthers.

(ii) Candidates needed to be very clear about the anthers of a wind-pollinated flower being positioned outside the flower or petals and on a longer filament for full credit. It was not enough to suggest that the anthers were just larger or longer. Some candidates described the differences between the pollen grains of wind or insect pollinated flowers.

(b) (i) The majority of candidates correctly identified germination.

(ii) Most candidates were awarded this mark. The expected answer, phototropism, was frequently seen. The alternative correct answers, geotropism and gravitropism also gained credit.

(c) Some candidates had learned this part of the syllabus very well and full credit was often awarded. Candidates needed to state elongation as the correct term and it was not sufficient to describe the process as growth or speed of growth. However, correct alternatives for shaded or dark such as the opposite side to the light were given credit.

(d) Many candidates were unfamiliar with the ethanol emulsion test. For those who were familiar with it, a common reason for missing credit was to omit any reference to the addition of water. One allowed alternative was the use of filter paper and the formation of a translucent area when the seed is rubbed onto it.

Question 2

(a) (i) Many candidates answered this correctly. Common mistakes were to suggest that electrons are gained or shared.

(ii) The essential two points candidates needed to make were that the seven dots represent the electrons present in the outer shell of a chlorine atom and that the cross represents an electron gained to stabilise or complete the outer shell. In this case, it was not necessary to state that the cross was an electron donated by calcium, although many did make this point. The first of these ideas was often seen but credit for the second idea was less frequently awarded.

(iii) Candidates sometimes found it difficult to express their understanding of why each calcium ion is bonded to two chloride ions. Those who approached the answer in terms of ionic charge balance or electrical neutrality were successful. Others gained the mark by describing the numbers of electrons lost and gained during the formation of calcium chloride. Weaker answers that could not be credited simply stated that's how they all get full outer shells. Many missed credit because they reversed the direction of electron transfer between calcium and chlorine.

(b) (i) Most candidates labelled the diagram correctly. The terms cation and anion were not sufficient as the names of the elements were required.

(ii) Candidates were required to refer to the presence of particles (ions) with opposite electrical charges. Some candidates wrote at length about the bonding between metals and non-metals without ever quite giving the required answer. Candidates should be alerted to the importance of wording such as 'State how the diagram shows…' or 'Use the diagram to explain…'.

(iii) This proved to be a challenging answer to express clearly and only a minority of candidates gained any credit. Some candidates made assumptions about the relative sizes of sodium and calcium ions rather than discussing the difference in stoichiometry.

Question 3

(a) (i) The two key ideas that candidates needed to include were that the wind provides kinetic energy which is used to move a turbine and/or generator. It was not essential to use the term turbine and some candidates referred to a windmill or blades that turn which were typical of accepted suggestions. Many candidates left the energy described as wind energy which was not enough. Candidates missed credit if they suggested that the wind created kinetic energy.

(ii) The majority of candidates were familiar with renewable sources of energy and any correct suggestion gained credit. Despite the wording of the question some candidates still suggested wind. Nuclear is not accepted as a renewable and the single word Sun is not interpreted as an energy source in this context.

(b) (i) The range of answers accepted was 150 to 152.5 s and the majority of candidates read this correctly from the graph.

(ii) Candidates were familiar with the use of a speed/time graph to calculate distance travelled and many gained full credit. Some gained one mark simply for demonstrating that they knew an area had to be calculated. Most candidates showed their working and candidates should always be encouraged to do this. Many gained partial credit if clear working showed one or two correct steps in the calculation even if the final answer was incorrect.

(iii) Those candidates who realised that this question involved unit conversion usually gained full credit. Some showed that the maximum speed of the bus was 28.8 km / h and others showed that 30 km / h would have been 8.33 m / s. Candidates who did not make progress with the calculation could still gain partial credit for reading 8 m / s from the graph.

Question 4

(a) (i) Almost every candidate gained this mark. Of the small number of candidates that did not gain credit, several read the value from the *y*-axis.

(ii) Some stronger candidates understood that below the optimum, rate of reaction depends on temperature and so energy gain and increasing frequency of collisions between particles are the ideas that needed to be discussed. Candidates gained credit for answers such as there is more chance of collision or there are more effective collisions or correct references to activation energy. As is usual in questions concerned with reaction kinetics, the simple statement there are more collisions does not gain credit. An incorrect idea that was seen from several candidates was that enzymes denature at temperatures below the optimum.

(b) (i) Many candidates were familiar with the role of proteases breaking down proteins to amino acids. Full or partial credit was frequently awarded for both or one of the named molecules. Appropriate use of the alternative term, polypeptide, was also accepted. A common reason for missing credit was that candidates gave general answers about digestion rather than the specific details relating to protease.

(ii) Many candidates found acceptable ways of expressing the two key ideas that the conditions in the stomach are acidic and that enzyme **A** is the only one in the diagram that has an optimum activity in acidic conditions. Partial credit was often awarded for knowing that the stomach is acidic. The most common incorrect statement was that protease or enzyme **A** is acidic.

(c) Many candidates were familiar with all of the details in the photosynthesis equation. Candidates should be advised that marks can be missed if chemical formulae are written carelessly, for example by using lower case letters as in h_2o, or writing subscripts that are too large, as in H2O.

Question 5

(a) (i) Most candidates were familiar with the use of Universal Indicator paper. For full credit, candidates needed to make clear that the paper has to make contact with the liquid from the reaction mixture. Those candidates who only wrote about using the colour of the paper to estimate pH gained only one mark.

(ii) The majority of candidates gained at least partial credit for a correct pH value or range of values of the acidic mixture at the start of the reaction. Credit for stating that the pH at the end of the reaction would be seven was not awarded quite as frequently. One common mistake was the assumption that the reaction mixture would become strongly alkaline once the acid had reacted.

(b) **S**ome candidates found it fairly challenging to interpret the information in the table and then provide explanations in appropriate detail. Full credit was infrequently awarded although many of the stronger candidates gained two or three marks. The most common incorrect experiment numbers suggested were 3 (highest) and 2 (lowest). This invariably matched the candidates' idea that large pieces of calcium carbonate would have the larger surface area, missing the information that the same mass was used each time. Candidates had to refer to collision frequency rather than number of collisions. They also needed to explain that a higher concentration of acid meant that larger numbers of acid particles would be available, rather than stating that there would be more acid.

Correct Chemistry seen in the explanations gained credit even if the experiments had not been identified correctly.

Question 6

(a) (i) and (ii) Some candidates gained both of these marks, although many reversed the answers. Conduction was slightly more familiar than convection. The other common mistake for both **(a)(i)** and **(ii)** was radiation.

(b) (i) Only a relatively small number of candidates recognised that the water temperature is indicated by the expansion of a liquid inside the thermometer.

(ii) The question guided candidates towards describing the differences in intermolecular forces and distance between gas and liquid particles. The second mark was for developing the idea that as a result of these differences less energy is needed to separate the molecules in gases. This mark was not often awarded. Many candidates described, correctly in many cases, what occurs during the change of state from liquid to gas. Answers like this did not usually make the comparison between gases and liquids.

(c) (i) The diagram of a convex or converging lens was familiar to some candidates. A large number seemed uncertain and suggested magnifying lens, glass lens and transparent lens.

(ii) Many candidates recognised that light travelling through a lens is refracted. Many other candidates were not familiar with this term.

(iii) Full credit was not frequently awarded. The most popular answer that gained partial credit for some candidates was to move the lens closer to the thermometer.

Question 7

(a) Candidates should be encouraged to learn the definitions of ecological terms. The small number who had learned a definition of ecosystem gained full credit. Many answers showed that candidates did not really understand the differences between ecosystems, populations, communities and food webs. The idea that an ecosystem contains biotic and abiotic factors was frequently missing from answers and the idea that these factors interact was rarely seen.

(b) The majority of candidates gained full credit for their food chains. If the only mistake was to reverse the arrows representing energy flow, then partial credit was awarded.

(c) (i) Candidates frequently discussed the blocking of light but to be awarded the mark, they had to also state that this prevented photosynthesis. Only a minority of candidates achieved this.

(ii) The idea that respiration by decomposers removes oxygen from the water was only seen from the strongest candidates. Reference to the lack of photosynthesis as a source of dissolved oxygen was allowed as an alternative.

(iii) This question was answered very well and many candidates understood the effect of oxygen deficiency on the food chain that included herons. Candidates needed to make clear that the heron population decreases because of lack of food. Some vague answers such as all the animals in the water die so the herons fly away did not gain full credit.

Question 8

(a) (i) The majority of candidates were awarded full credit. Any mistakes tended to be in one or both of the C_{15} formulae.

(ii) This question asked for similarities between members of an homologous series. Candidates should be advised to learn the features of members of an homologous series as specified in the syllabus. Some candidates suggested that alkanes don't have double bonds but credit is rarely awarded for stating a property that molecules do not possess unless a specific comparison is asked for. Candidates should be specific and state that alkanes have single C–C bonds or that they are saturated. Another common mistake was the suggestion that all alkanes have the same chemical

formula rather than the same general formula. Despite the wording of the question some candidates still stated that alkanes contain hydrogen and carbon.

(b) Many stronger candidates were familiar with the bromine test for unsaturation.

(c) (i) This question was generally answered very well and large numbers of candidates gave correct formulae and structures. The most common error was to omit the double bond in the structure of ethene.

(ii) Many candidates were familiar with the conditions needed for cracking. Credit was not awarded for the single word answers heat, temperature and pressure or for vague suggestions such as appropriate temperature. Several candidates seemed unclear about the meaning of the phrase, conditions for cracking, and gave answers such as the need to have a large hydrocarbon.

Question 9

(a) Many candidates gained full credit and for many others the only mistake was an incorrect circuit symbol for the variable resistor. Candidates should draw circuit symbols exactly as they are shown in the syllabus. The majority correctly showed the switch in the open position and connected the two motors in parallel with the battery.

(b) (i) Use of the relationship, current = power ÷ potential difference was familiar to many candidates who worked through to the correct final answer. The most common mistakes were to invert power and p.d. in the equation, to find the product of power and p.d. or to omit converting 24 kW to 24 000 W.

(ii) Candidates could either describe how the individual currents in the branches of a parallel circuit are combined in the main circuit or they could carry out an alternative calculation such as 48 000 ÷ 96. Or they could assume 500 A is correct and show that 500 × 96 = 48 000.

(c) Many stronger candidates were familiar with the use of Q = I × t and were awarded full credit. Of the candidates who calculated the correct numerical answer, credit was often missed because an incorrect unit was stated. A variety of units were suggested and the most common one was J. Some candidates suggested the incorrect relationship Q = I × T × p.d..

COMBINED SCIENCE

Paper 0653/43
Theory (Extended)

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

COMBINED SCIENCE

Paper 0653/51
Practical Test

Key messages

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 demonstrated a good range of practical skills, followed instructions and completed the tasks successfully.

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.

Where candidates make the same observation in two different tests, they should not be afraid to record the same observation twice.

Comments on specific questions

Question 1

(a) (i) Almost all candidates correctly calculated the percentage concentration of hydrogen peroxide and completed Table 1.1 and Table 1.2 correctly.

(ii) Most candidates completed the procedure outlined in the question and recorded times in Table 1.2. Many candidates recorded the times to the nearest second and the results showed the expected pattern. The expected pattern was that the time for the potato slice to rise to the surface of the liquid decreases as the concentration of hydrogen peroxide solution increases.

(iii) Many candidates correctly concluded that the potato rises faster in a more concentrated solution of hydrogen peroxide.

(iv) It was important for candidates to read the question carefully since in this question candidates were asked about safety precautions in Step 4. Step 4 was the task of cutting the potato cylinder into thin slices. Recognising the danger of using a sharp knife and either describing the use of a firm/flat cutting surface or ensuring that fingers remained behind the knife or that the knife was used to cut away from the body were all good answers. Some candidates mentioned the use of goggles to prevent chemicals going into eyes, which was not relevant to Step 4 of this procedure.

(v) Most candidates were able to identify two variables that needed to be controlled in this experiment. Many realised that the pieces of potato should be the same thickness or size and that the total volume of liquid in the test-tube should be kept constant. A common incorrect answer was to suggest time was controlled. In this experiment, the time for the potato to rise was the dependent variable.

(vi) Candidates could gain credit by recognising that the experiment would happen too quickly for an accurate measurement with 20% concentration of hydrogen peroxide or by suggesting that such a concentrated solution might be harmful.

(b) In this question candidates were testing the potato for the presence of protein. Candidates should always record the actual observation, in this case a blue colour, rather than just state 'no change'. Several candidates incorrectly suggested that biuret solution is used to test for the presence of starch.

(c) (i) Most candidates recognised that Step 4 in the Benedict's test is heating the mixture. A common incorrect response was to refer to starting a timer and/or waiting for several minutes.

(ii) Many candidates correctly identified one of the colours for a positive result. A common misconception was to give the colour for a positive result with the starch test, rather than the Benedict's test for reducing sugar.

Question 2

(a) Solutions **F** and **K** were the same solution and therefore candidates should have recorded the same colour for each if the test had been conducted correctly. There was evidence in candidate's answers that they were unwilling to record the same colour for solutions **F** and **K**. For example, recording red for **F** and then light red or pale red for **K**. Candidates should have the confidence to record exactly what they observe.

(b) Most candidates correctly determined the pH of the solutions.

(c) (i) Many candidates were able to use their results to put the solutions in order from most to least acidic.

(ii) Many candidates, correctly giving **F** and **K** the same pH, were able to state clearly that it is hard to decide where to place them because they have the same pH or the same colour.

(d) Almost all candidates reported effervescence or bubbles being seen. A common incorrect observation was to state that a white precipitate was seen. The reaction gives a colourless solution which candidates find harder to describe. A few candidates observed the temperature increase, noting that the test-tube became warmer.

Question 3

Candidates gained more credit when their plan covered each of the bullet points given in the question. To gain full credit, the plan must include at least one statement about each bullet point.

Candidates can include a labelled diagram. Apparatus marks can be awarded directly from the labels on the diagram. Diagrams without labels are not usually awarded credit.

Many candidates were able to identify suitable control variables, stating volume and concentration of acid or mass of sodium carbonate. Fewer candidates were able to state precisely how to process the results to draw a conclusion. Stating that the results should be plotted on a graph is insufficient to gain credit. For example, in this investigation it is necessary to state that you would plot a graph of temperature of acid against reaction time.

To gain credit for a description of the method candidates needed to identify the key processes in the investigation. The stem of the question describes the reaction between sodium carbonate and dilute hydrochloric acid. The key step in the method for this investigation is adding sodium carbonate to acid of different temperatures. A good answer states clearly that at least five different temperatures are investigated as this will give sufficient results to plot a graph and look for a pattern in the results. Repetition of the experiment at each temperature will allow anomalous results to be spotted more easily.

The best answers about safety precautions were specific and directly applicable to the investigation, so for example stating that goggles are worn to avoid acid/powder getting into the eyes is an appropriate safety precaution. Similarly, credit is awarded for mentioning specific items of apparatus necessary for the particular investigation, so in this question a thermometer (to measure temperature of acid) and stopwatch (to time the reaction) are both relevant and specific to the investigation.

Question 4

(a) (i) Almost all candidates recorded a sensible value in mm for the unstretched length of their elastic band.

(ii) This question was generally answered well, although some candidates found it hard to express a practical difficulty. Many correctly identified the difficulty in holding the elastic band against the ruler without stretching it at all.

(b) Most candidates recorded a full set of results in the two tables. When the experiment is performed carefully, candidates record a longer length of the elastic band at each mass in Table 4.2 and the final length of the elastic band at the end of the experiment is longer than the unstretched length at the start.

(c) (i) Candidates generally chose suitable scales for both axes of their graph. It is important that points are plotted neatly, using a sharp pencil, to ensure an accurate plot.

(ii) Candidates must attempt a smooth curve rather than joining their points together in a series of straight lines. Almost every candidate was careful to label the line clearly.

(iii) Most candidates were able to plot their results from Table 4.2 on the same grid.

(iv) As with **(c) (ii)**, candidates needed to attempt a smooth curve. Almost every candidate was careful to label the line clearly.

(d) Candidates were asked to show how they arrived at an estimate of the area between their two best-fit curves. To gain credit it was important that candidates included evidence on the graph of how they estimated the area. Stronger candidates counted whole squares and estimated the part squares between their two curves. Full credit was available for getting a reasonably accurate value that demonstrated good practical technique in doing the experiment.

(e) Most candidates correctly calculated that 0.15 J of energy were lost.

COMBINED SCIENCE

Paper 0653/52
Practical Test

Key messages

Drawings of apparatus and biological specimens should be two dimensional. The lines should be clear and continuous without any feathering and the drawing should not be shaded or stippled.

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 and in this case straight
- plot small, neat points to cover at least half of the grid.

Candidates should take care when describing reasons for repeating readings. Repeating readings alone does not make results more accurate. When repeats are carried out, candidates need to explain that this is to check for concordance by looking for similar results or identifying any anomalous values.

The syllabus states that the gradient of a straight line should be taken using a triangle whose hypotenuse extends over at least half of the length of the best-fit line, and this triangle should be marked on the graph. Few candidates followed this guidance.

General comments

Candidates demonstrated a good range of practical skills, followed instructions and completed the tasks successfully.

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

Comments on specific questions

Question 1

(a) (i) Candidates were generally able to identify that stirring allowed the suspension to be fully mixed, with some identifying that the cells had settled in the test-tube, so giving an equal concentration of cells in each test-tube by stirring.

(ii) Most candidates were able to record a time in seconds for each test-tube.

(iii) Candidates were expected to look for a pattern in their results. Some had difficulty in identifying this, even though most results showed that as the volume of glucose decreased the time increased (and therefore the rate of respiration decreased).

(iv) Many candidates were able to identify judging the endpoint as a difficulty, but many were not able to provide an improvement.

(b) (i) Candidates were generally able to accurately measure the length of the cell in millimetres. A few used centimetres, which was not credited as the question specifically asked for millimetres.

(ii) Most candidates were able to use the formula provided to correctly calculate the actual length of the cell.

(iii) Candidates had generally read the question carefully and included two concentric circles to denote the cell wall and included the large vacuole in a correct off-centre location. A few had not used at least half the box, which was a minimum size of 75 mm in at least one direction.

Question 2

(a) (i) Candidates were generally able to record two different temperatures to the nearest 0.5°C, with the temperature of the solution being lower than the water.

(ii) Most candidates used the information to link the decrease in temperature of the solution to an endothermic process. Credit was also given to a few candidates who had a different result to that expected.

(b) (i) Candidates were able to gain this mark by obtaining the colour expected or matching the results of the Supervisor.

(ii) Strong responses described the fact that the same colour covered a range of pH values and so was not an accurate value.

(c) (i) Most candidates correctly described the damp red litmus paper turning blue.

(ii) Many candidates used the notes for qualitative analysis to identify ammonia.

Question 3

This question was the most challenging for candidates. To gain full credit in the planning question a candidate's answer must include all the areas of the task indicated by the bullet points.

Candidates should read through the question carefully to identify the dependent and independent variables. In this case, the concentration of the nitric acid was changing (independent variable) and the time was being measured (dependent variable).

Candidates can include a labelled diagram. Apparatus marks can be awarded directly from the labels on the diagram. Diagrams without labels are not usually awarded credit.

A long list of apparatus may not be awarded credit if the items are not relevant to the procedure or are not used in the procedure. Some candidates recorded temperature or volume but omitted to name a suitable piece of apparatus, such as a thermometer or measuring cylinder.

The procedure described must be specific to the question asked. In this case, adding sodium hydrogencarbonate to at least 2 different concentrations of nitric acid. Some candidates failed to state that more than one concentration of acid was used. Additional credit was available for adding more detail, including at least 5 different concentrations and repeats at each concentration. Candidates need to make it clear whether a repeat of the procedure is at the same concentration or at a different concentration.

Many candidates gained credit for describing that the volume of the acid or the mass of the sodium hydrogencarbonate needed to be kept the same in each experiment. Common errors included the concentration of the acid or time taken being kept constant, indicating that some candidates had not read the question carefully enough.

Processing the results was challenging for some candidates. Calculating the average of repeats at the same concentration was commonly credited, with some candidates giving details of the appropriate axes for a graph that could be plotted. Stronger answers discussed how the results would be compared, for example by looking for a relationship between reaction time and concentration of acid.

Question 4

(a) (i) Most candidates were able to obtain a set of results at a wire length of 200 mm.

(ii) Many candidates had the same potential difference for all the lengths, rather than it increasing as the length increased, so were not able to gain full credit.

(iii) Few candidates were able to identify that the wire heats up if the circuit is complete. Credit was also given to candidates that realised the cell would run down.

(b) Many candidates were able to use the formula provided to correctly calculate the resistance for each length of wire.

(c) (i) The axes were already fully labelled but candidates needed to provide a sensible linear scale and use at least half of the grid. A horizontal axis of 11 cm was provided. This allowed 2 cm (10 small squares) for each 200 mm length. Some candidates chose only 1 cm for each 200 mm length, which resulted in a very small graph. Plotting data was generally good, although some candidates used an awkward scale that meant they could not easily work out the value of one small square and so incorrectly plotted their points.

(ii) Some candidates drew a curve despite the question asking for the best-fit straight line.

(iii) This question proved challenging. Partial credit was often awarded. Many candidates did not show their gradient as a clear triangle on their graph or chose a very small area on their graph.

(d) Candidates were usually able to use the formula provided to correctly calculate the cross-sectional area of the wire and round the answer to 2 significant figures. A few candidates made use of the value provided for *G* because they did not have their own value from **(c) (iii)**.

COMBINED SCIENCE

Paper 0653/61
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 (section 7.3 of the syllabus).

When candidates are asked to 'explain' or 'give a reason' for an answer, credit is generally not awarded without an explanation. For example, in **1 (a) (vii)** where the question asked for a prediction and an explanation, candidates needed to ensure they explained their prediction to gain credit.

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 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.

Comments on specific questions

Question 1

(a) (i) Almost all candidates correctly calculated the percentage concentration of hydrogen peroxide solution.

(ii) Most candidates correctly read the times and converted minutes to seconds. 354 s for **A** (an error in the interpretation of minutes and seconds) was a common incorrect answer.

(iii) Most candidates gave a correct statement linking concentration with either the time taken or the rate at which the potato slices rise to the surface.

(iv) Strong responses described keeping the blade away from fingers and/or cutting on a hard surface. Some candidates gave vague suggestions such as to 'be careful'. Some suggested using gloves. The type of gloves typically used in laboratories would be too thin to prevent injury from a sharp blade, so this did not receive credit.

(v) The most common error here was to state one or both of the variables that would be changed, i.e., the concentration of the hydrogen peroxide solution or the volume of water used. Some stated that the time would be controlled.

(vi) Strong responses used the information in the table and stated that a high concentration would result in a time which was too short to measure. Some candidates gave answers such as 'too strong' or 'too dangerous' without clearly indicating a problem arising from the high concentration.

(vii) This question asked for both a prediction and an explanation. Most candidates predicted that the time would increase but did not always explain that this was due to the increase in mass of the potato.

(b) Iodine turning blue-black was well known, but the link to starch was not always stated.

(c) (i) Most candidates recognised that Step 4 in the Benedict's test is heating the mixture. A common incorrect response was to state that Step 4 is to start a timer and/or wait for a fixed amount of time.

(ii) The colours for a positive test for reducing sugars were very well known.

Question 2

(a) Almost all candidates correctly determined the pH of the solutions.

(b) (i) Most candidates put the solutions into the correct order, however, a relatively common error was either to list the colours or the numerical pH values rather than the letters **F** to **K**.

(ii) Almost all candidates stated that the similarity in colour or pH of **F** and **K** meant it was difficult to order them in the list.

(c) Most candidates knew that hydrogen gives a squeaky pop, but fewer stated clearly that a lighted splint is used in the test. Some confused the hydrogen and oxygen tests and stated that a glowing splint pops.

(d) Limewater, to test for carbon dioxide, was very well known.

Question 3

Candidates gained more credit when their plan covered each of the bullet points given in the question. To gain full credit, the plan must include at least one statement about each bullet point.

Candidates can include a labelled diagram. Apparatus marks can be awarded directly from the labels on the diagram. Diagrams without labels are not usually awarded credit. Candidates need to practise drawing diagrams for common procedures so that they can draw them clearly, with labels and without errors.

Candidates should state how they will use each piece of apparatus, for example, use a measuring cylinder to measure the volume of acid. If a list of apparatus is given without a clear indication of how it will be used, credit may not be awarded.

Safety guidance should be specific, simply stating 'wear gloves and goggles' is not enough. Candidates need to think about the specific safety issues for the experiment and explain them clearly. Wearing goggles to make sure that harmful acid does not come into contact with the eyes is a suitable safety statement.

When describing the control of variables, candidates need to clearly state what they will change and what they will keep the same. The key step in the method for this investigation was adding sodium carbonate to acid of different temperatures. Stating 'use the same volume and concentration of acid and the same mass of sodium carbonate each time' gained credit. A good answer stated clearly that at least five different temperatures are investigated as this will give sufficient results to plot a graph and look for a pattern in the results. Repetition of the experiment at each temperature will allow anomalous results to be spotted more easily.

Some candidates omitted a description of how they would process their results. Stronger answers discussed how the results would be compared, for example by looking for a relationship when a graph of reaction time is plotted against temperature.

Question 4

(a) Most candidates correctly measured the elastic band and recorded their value in mm in the table.

(b) This was well answered. The most common correct answer was to describe the problem that the band could rebound and cause eye injury.

(c) Most candidates correctly gave the force exerted by 650 g as 6.5 N.

(d) (i) Most candidates gave appropriate scales and plotted the points accurately. Candidates were told in the question to start the graph at (0,0), not all did this, leading to a non-linear scale. Commonly the *y*-axis was labelled 0 at the origin and then 60, 80, 100... on the subsequent major gridlines. Those who did start at (0,0) did not always label the origin. Odd scales which required more complex plotting (such as rising in 30 s on the *y*-axis) almost always led to errors in plotting.

(ii) In this case the relationship was a curve. This was often accurately drawn with a single, fine line. Errors included joining plotted points with straight lines, drawing a broken, feathered line or drawing a curve which significantly drifted away from the plotted points.

(iii) Most candidates correctly read a value from their graph.

(iv) In common with **(d) (i)**, points were usually correctly plotted.

(v) In common with **(d) (ii)** most candidates drew an appropriate curve. Some candidates did not gain credit as they did not clearly label the two curves.

(e) (i) Candidates were asked to show how they arrived at an estimate of the area between their two best-fit curves. To gain credit here it was important that candidates included evidence on the graph of how they estimated the area. Stronger candidates counted whole squares and estimated the part squares between their two curves. Full credit was available for getting a reasonably accurate value that demonstrated good practical technique in doing the experiment. Many candidates attempted unnecessary and complex calculations, which did not usually come close to an acceptable value for the final answer.

(ii) Candidates found this very challenging. In this case, the idea that using smaller mass intervals would improve the quality of the curve was almost never suggested. Some gave a partially correct answer, discussing a statistical approach such as repeating with a new elastic band and finding a mean value for the energy lost.

(f) This calculation was usually completed successfully. Candidates substituted into the provided formula and gave the correct value.

COMBINED SCIENCE

Paper 0653/62
Alternative to Practical

Key messages

Drawings of apparatus and biological specimens should be two dimensional. The lines should be clear and continuous without any feathering and the drawing should not be shaded or stippled.

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.

Some questions require detail. For example, **2 (a) (ii)** asked candidates to state if the reaction was endothermic and to explain their answer. Several candidates omitted to say the reaction was endothermic having identified the temperature decrease.

The syllabus states that the gradient of a straight line should be taken using a triangle whose hypotenuse extends over at least half of the length of the best-fit line, and this triangle should be marked on the graph. Some candidates did not follow this guidance.

General comments

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

Comments on specific questions

Question 1

(a) (i) Most candidates correctly read the times and converted minutes to seconds. 325 s for test-tube **B** (an error in the interpretation of minutes and seconds) was a common incorrect answer.

(ii) This was generally well answered, though several candidates failed to give a conclusion linking the volume of glucose and reaction time, simply stating which reaction was quickest.

(iii) Successful candidates generally commented on averaging rather than finding anomalous results or outliers. Many candidates commented that repeating made the results more accurate or precise.

(iv) Most candidates successfully named one variable that is kept constant during the investigation.

(v) Those identifying the use of Benedict's solution generally linked this to it staying blue. A common incorrect reagent was iodine.

(b) Most candidates identified the use of limewater and it turning milky, though some candidates did describe using a lighted splint.

(c) (i) Candidates were generally able to accurately measure the length of the cell in millimetres. A few used centimetres, which was not credited as the question specifically asked for millimetres.

(ii) Most candidates were able to use the equation provided to correctly calculate the actual length of the cell. Some candidates left answers as fractions rather than calculating as a decimal.

(iii) Most candidates drew a diagram of a suitable size that included the cell wall. The outline was not always clear and continuous and while many drew the vacuole it was often too small or in the wrong position in the cell.

Question 2

(a) (i) Candidates were generally able to record two different temperatures to the nearest 0.5°C. Some candidates rounded the temperature of water to 21°C. Many gave the temperature of the solution as 16°C rather than 16.0°C.

(ii) Several candidates identified the temperature decrease but failed to confirm that the reaction was endothermic. A common misconception was that an endothermic reaction taking in energy would lead to an increase in temperature.

(b) (i) Most candidates correctly estimated the pH of solution **F**.

(ii) Many candidates identified the difficulty in distinguishing colours or that the pH could be between values.

(c) (i) Few candidates knew that ammonia would turn the damp red litmus paper blue.

(ii) Only the strongest candidates identified the ammonium ion.

Question 3

To gain full credit in the planning question a candidate's answer must include all the areas of the task indicated by the bullet points.

Candidates should read through the question carefully to identify the dependent and independent variables. In this case, the concentration of the nitric acid was changing (independent variable) and the time was being measured (dependent variable).

Candidates can include a labelled diagram. Apparatus marks can be awarded directly from the labels on the diagram. Diagrams without labels are not usually awarded credit.

A long list of apparatus may not be awarded credit if the items are not relevant to the procedure or are not used in the procedure. Some candidates recorded temperature or volume but omitted to name a suitable piece of apparatus, such as a thermometer or measuring cylinder.

Safety guidance should be specific, simply stating 'wear gloves and goggles' is not enough. Candidates need to think about the specific safety issues for the experiment and explain them clearly. Wearing goggles to make sure that harmful acid does not come into contact with the eyes is a suitable safety statement.

When describing the control of variables, candidates need to clearly state what they will change and what they will keep the same.

Some candidates omitted a description of how they would process their results. Stronger answers discussed how the results would be compared, for example by looking for a relationship when a graph of nitric acid concentration against reaction time was plotted.

Question 4

(a) (i) Most candidates read the meters correctly.

(ii) Few candidates knew about the wire heating as current flows, or the change in resistance.

(b) Many candidates were able to use the equation provided to correctly calculate the resistance, with most correctly rounding.

(c) (i) Most candidates were able to plot the points accurately. Axes were usually labelled but often lacked units. Several candidates did not start the scale from 0,0 and the scales were often non-linear.

(ii) Most candidates drew a suitable line of best fit.

(iii) Most candidates were able to use their line of best fit to estimate the value of *R*.

(iv) Several candidates correctly calculated the gradient of their line. Partial credit was often awarded. Many candidates did not show their gradient as a clear triangle on their graph or chose a very small area on their graph.

(d) Most candidates could use the formula provided to calculate the cross-sectional area of the wire.

COMBINED SCIENCE

Paper 0653/63
Alternative to Practical

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