COMBINED SCIENCE

Paper 0653/12
Multiple Choice (Core)

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

General comments

It is important that candidates plan their time so that all questions can be dealt with properly. It will always be the case that some questions take more time and others take less time, and candidates need to consider this in their preparation for the paper.

Candidates also need to be sure that the answer supplied is the one that the question asks for. The experience of answering past papers can lead to the recognition of a particular format or context and the assumption that a particular point is being asked for. Questions vary and a familiar context does not guarantee that the same approach is needed.

Comments on specific questions

Question 1

Most candidates answered this correctly. Some candidates incorrectly selected option **C** or **D**.

Question 2

Most candidates found this question challenging. Where candidates chose the incorrect answer, they often selected option **B**, the reverse of the correct answer.

Question 3

Many candidates selected the correct answer but a number incorrectly selected option **A**. This indicated that they thought that the test for protein was the Benedict's test.

Question 5

Most candidates found identifying the word equation for photosynthesis straightforward. However, some candidates incorrectly selected option **B**, the word equation for respiration.

Question 6

Most candidates answered this correctly. Some candidates incorrectly chose option **A**, that healthy bone and teeth development required calcium and iron.

Question 8

Most candidates answered this correctly. Sometimes candidates opted for **C** or **D**. Both of these options showed an increase in oxygen in exhaled breath when compared to inhaled.

Question 9

Some candidates incorrectly opted for **B**, where the solubility of digested food molecules was reversed, i.e., before digestion the molecules were soluble, afterwards the molecules were insoluble.

Question 10

Most candidates found this question straightforward. Some candidates incorrectly selected option **C** here.

Question 12

Several candidates incorrectly selected option **C**, secondary consumer. This may be because they did not recognise or remember the term 'tertiary consumer'.

Question 13

Most candidates found this question challenging and many incorrectly selected option **A**. This could be because they linked fossilisation to the combustion of fossil fuels rather than the fossilisation process itself, which traps carbon dioxide in the fossil.

Question 14

Most candidates understood how to interpret diagrammatic representations of molecules and selected the correct answer.

Question 18

Some candidates chose the incorrect option **A** rather than the correct answer, **C**. They are expected to know that in redox reactions oxygen is transferred from the substance being reduced to the substance being oxidised. They are also expected to know that when an acid reacts with a base, neutralisation occurs.

Question 20

Candidates chose the incorrect option **B** more often than the correct answer, **D**. They knew that copper sulfate is a blue solid and dissolves to form a blue solution. However, they did not realise that sodium chloride is soluble in water and that barium sulfate is insoluble.

Question 29

That air resistance is a force is made clear by the initial text, and the unit of force is the newton (N). More candidates selected the correct option **D** than any other, but a sizeable minority chose option **A** the unit ohm (Ω), which is the unit of electrical resistance. Very few candidates chose option **B**, which is the unit of mass.

Question 30

This question required candidates to calculate an appropriate quantity using the data supplied. It is that data that needed to be used to deduce the answer. The most obvious approach was to calculate the density of the material of which the solid object is made. This led to the correct option **A**, and this was the most frequently selected option. The other options were selected by only a small number of candidates.

Question 31

Although the correct option **C** was more commonly chosen than any of the others, in general this question was challenging for many candidates. In particular, options **B** and **D** were quite commonly selected. A football travelling vertically upwards after being kicked must be decelerating and must therefore be experiencing a resultant force. In situations such as those described in options **B** and **D**, it is often important to consider the effect of the weight of the object that is moving. It is likely that candidates who chose these answers were considering the weight rather than the resultant force, which is what was asked for.

Question 32

As the object falls through the vacuum, the increase in its kinetic energy is equal to the decrease in its gravitational potential energy and so the total energy stored by the falling object does not change. This explains why option **D** is correct. Candidates who selected option **A** were probably considering only the gravitational potential energy or had attempted to allow for air resistance; there is no air resistance in a vacuum. Likewise, option **C** was given by candidates who only considered the kinetic energy. Very few candidates selected option **B**.

Question 40

In this question the current is initially 3.1 A but then decreases to 1.0 A. Despite this, neither option **A** nor option **B** was commonly chosen. The correct answer **C** was most popular but option **D**, which suggested a fuse rating of 13 A, was chosen by several candidates. Since the cable can only safely carry a current of 10 A, the cable would be damaged by a current of a magnitude between 10 A and 13 A, but the 13 A fuse would not blow and would not offer any protection.

COMBINED SCIENCE

Paper 0653/22
Multiple Choice (Extended)

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

General comments

It is important that candidates plan their time so that all questions can be dealt with properly. It will always be the case that some questions take more time and others take less time and candidates need to consider this in their preparation for the paper.

Candidates also need to be sure that the answer supplied is the one that the question asks for. The experience of answering past papers can lead to the recognition of a particular format or context and the assumption that a particular point is being asked for. Questions vary and a familiar context does not guarantee that the same approach is needed.

Comments on specific questions

Question 1

Many candidates chose the correct answer for this question, but some candidates found this question challenging. Some incorrectly chose option **B** or **D**. Option **B** was the reverse of the correct answer and option **D** indicated that both potatoes increased in mass.

Question 2

Most candidates found this question straightforward. Some candidates incorrectly thought that enzymes were denatured by low temperatures.

Question 3

Many candidates found this question straightforward. Some candidates incorrectly chose option **A**, that healthy bone and teeth development required calcium and iron.

Question 6

Some candidates found this question challenging, with many incorrectly choosing option **C**. Alliteration may help candidates: Arteries Away.

Question 7

Many candidates selected the correct answer. Some candidates incorrectly chose option **A**. While this option is correct for oxygen, it is incorrect for carbon dioxide and water vapour.

Question 8

Many candidates found this question straightforward. Some candidates incorrectly chose option **B**. Glucose is required by the brain and muscles.

Question 11

Many candidates selected the correct answer. Several candidates opted for **B** or **C**.

Question 12

Many candidates found this question straightforward. Some candidates incorrectly chose option **C**, habitat.

Question 13

Several candidates incorrectly opted for option **A**, a decrease in the decomposition of the producers.

Question 14

Most candidates understood how to interpret diagrammatic representations of molecules and selected the correct answer.

Question 16

Some candidates found this question challenging. They are required to know the electrode products in the electrolysis of dilute sulfuric acid, and to describe the reactions at the electrodes in terms of electron gain and loss.

Question 17

Some candidates found this question challenging. Candidates are expected to be able to use ionic equations, which includes identifying ions in a reaction mixture that do not change in the reaction.

Question 18

Many candidates were able to identify the activation energy for a reaction from an energy level diagram.

Question 19

Most candidates understood how a change in temperature affects the rate of a reaction.

Question 21

Some candidates chose the incorrect option **A** rather than the correct answer, **B**. They are required to know that copper is relatively unreactive, and that carbonates react with acids to form the gas carbon dioxide.

Question 22

Candidates chose the incorrect option **B** more often than the correct answer, **D**. They knew that copper sulfate is a blue solid and dissolves to form a blue solution. However, they did not realise that sodium chloride is soluble in water and that barium sulfate is insoluble.

Question 26

Many candidates knew the adverse effect of these common air pollutants on buildings and on health.

Question 27

Candidates chose the incorrect option **D** more often than the correct answer, **C**. They are required to know that all alkenes have the same general formula, and that this shows that there are twice as many hydrogen atoms as carbon atoms.

Question 28

Using the data supplied, many candidates were able to determine the mass of the stone. However, the question asked for the reading on the balance, and this includes the mass (30 g) of the measuring cylinder. This was not taken into consideration by many candidates and so option **B** was selected by many candidates.

Question 30

Although the correct option **C** was more commonly chosen than any of the others, in general this question was challenging for many candidates. In particular, options **B** and **D** were quite commonly selected. A football travelling vertically upwards after being kicked must be decelerating and must therefore be experiencing a resultant force. In situations such as those described in options **B** and **D**, it is often important to consider the effect of the weight of the object that is moving. It is likely that candidates who chose these answers were considering the weight rather than the resultant force, which is what was asked for.

Question 34

This question tested an understanding of thermal conduction and, in particular, conduction in liquids. Only a few candidates selected options **A** or **C**, but option **B** was chosen almost as frequently as the correct answer. It is not the case that conduction cannot occur in liquids. It is just that in liquids convection is very often much more important than conduction. In this experiment, the thermal transfer of energy is downwards and so convection does not occur and it is the poor conduction property of water that explains why the rate at which energy is transferred to the ice is so small.

Question 37

This question was generally well answered and many candidates realised that the extent of the refraction is caused by the extent of the slowing down of the light. Options **B** and **C** were selected by several candidates but very few chose option **D**.

Question 39

The correct option (**B**) was most commonly selected by candidates, although all the other options were chosen by some candidates. It is possible that candidates who selected option **D**, which was the second most popular choice, were under the impression that the current is decreased by a resistor and that the current in meter **D** is either very small or perhaps zero; this is a common misunderstanding.

Question 40

In this question the current is initially 3.1 A but then decreases to 1.0 A. Despite this, neither option **A** nor option **B** was commonly chosen. The correct answer **C** was most popular but option **D**, which suggested a fuse rating of 13 A, was chosen by several candidates. Since the cable can only safely carry a current of 10 A, the cable would be damaged by a current of a magnitude between 10 A and 13 A, but the 13 A fuse would not blow and would not offer any protection.

COMBINED SCIENCE

Paper 0653/32
Theory (Core)

Key messages

Candidates who did well on this paper:
- read the questions carefully
- were familiar with the contents of the syllabus
- were able to express their answers in a clear and legible way
- showed their working in numerical answers
- were able to apply their knowledge to unfamiliar situations.

General comments

Many candidates had prepared well for the examination and produced very good answers. However, there was some evidence that other candidates were not fully aware of the contents of the syllabus. Care should be taken to ensure that candidates are familiar with the knowledge and understanding required for the examination.

The use of space on the paper was good. Very few candidates wasted space by repeating the question and the vast majority of responses were written within the allocated response lines in the paper.

Comments on specific questions

Question 1

(a) (i) This was generally answered well. The most common error seen was excretion instead of egestion.

(ii) Most candidates stated ‘mechanical’ to gain credit in this question. ‘Physical’ was also accepted.

(b) (i) The point at which the two lines of the graph cross, 49 °C, was stated by those candidates who deduced that the activity of the two enzymes was identical at this point. Many candidates found this challenging with no clear pattern in the incorrect responses.

(ii) The best way for candidates to tackle this question was to describe how the activity of the enzyme changed as the temperature increased, with the maximum activity at 80 °C. Some candidates answered the question in this way. Other candidates would have gained more credit if they had quoted the temperature of maximum activity. The question requested that data should be used.

(c) This question was generally answered well.

Question 2

(a) (i) Many candidates answered this question correctly. Others stated either that no new substance was made, or that the change was physical with a new substance made.

(ii) Many candidates found this question challenging. The equation shows one solid, magnesium, and one gas, hydrogen. Neither of these elements occur in solution, so they can be excluded. The state symbols for the sulfuric acid and the magnesium sulfate are both (aq). This means that they are both solutes in the solvent water.

(iii) The test for hydrogen gas with a lighted splint was known by many candidates. Common errors included the test for oxygen with a glowing splint, and descriptions of the wrong test altogether, for example the test for water.

(iv) Most candidates answered correctly by stating filtration.

(b) (i) The numbers of the subatomic particles in the magnesium atom were given successfully by most candidates. The most common error was stating the number of neutrons, which involved the subtraction of the number of protons from the relative atomic mass.

(ii) Many candidates found this question challenging. The most common misconceptions included the idea that the magnesium ion lost electrons, the magnesium atom gained electrons and electrons were transferred from the magnesium atom to the ion.

Question 3

(a) (i) Most candidates wrote their **X** on the steepest part of the line and gained credit for identifying the fastest speed. A minority chose the part of the line between 0 and 100 s. This part of the line was not the steepest and therefore did not represent the fastest speed.

(ii) This was usually answered well. Candidates placed their **Y** on the line of the last 50 s of the graph, the place where a gradual change is shown.

(b) (i) This was generally answered well. The graph showed that no distance is covered between 100 s and 150 s. It is during these 50 s that the student was resting.

(ii) The equation speed = distance ÷ time was used to answer this question. Most candidates used this equation correctly, substituting the total distance travelled divided by the total time. However, some candidates read the total distance incorrectly. Incorrect distances used included, 800 m, 810 m, 820 m and 850 m.

(c) (i) Successful candidates used the equation m = W ÷ g to calculate the mass of the bicycle. Other candidates applied the incorrect equation, using m = W x g, or m = W – g.

(ii) Many candidates completed the energy transfers successfully. The least-known energy transfer was the first one. The energy in the student is chemical energy, released from the breakdown of food in the body. Incorrect responses included kinetic energy and gravitational potential energy.

(iii) Many candidates found this question challenging. Some thermal energy is lost during the energy conversion in the student.

Question 4

(a) This question was generally answered well.

(b) (i) Some candidates gained credit by stating embryo. The most common error was zygote. Candidates should be reminded that the zygote is the name for the fertilised ovum, and this then divides to form the ball of cells, the embryo.

(ii) Most candidates gained full credit in this question. The most common error was vagina.

(c) (i) This was generally answered well. A few candidates used the wrong length values or used the mass values from the table. These candidates were not awarded credit.

(ii) Many candidates used the table and correctly identified when the mass of the fetus doubled. The most common incorrect answer was week 24 to week 32. The increase in this case was 2.8 times.

(iii) This question was challenging for many candidates. The main point to include in answers was that growth is a permanent increase in size. The reason to include the word permanent was to include plants in the definition. Plants can contain variable amounts of water which causes their size to vary.

(d) The equation for aerobic respiration was straightforward for those candidates who were familiar with the syllabus. Most candidates gained full credit. Answers that did not gain full credit included those with the reactants and products confused or absent.

Question 5

(a) Many candidates gained full credit for stating any two of the properties characteristic of the transition metals. Other candidates stated general properties of metals that also apply to Group I metals, for example that they conduct heat and electricity. These were not awarded credit.

(b) Most candidates stated carbon dioxide and gained credit. The most common error was carbon monoxide.

(c) (i) Most candidates knew that the term oxidised meant that the copper reacted with oxygen. The response had to be expressed in a way to indicate that oxygen had combined with the copper. This meant that mixing with, or in contact with oxygen did not gain credit. Higher level responses, which suggested for example (the copper) losing electrons, gained credit for being scientifically correct.

(ii) Many candidates chose a change that would increase the rate of reaction, usually by increasing the temperature. Some candidates just stated temperature, without giving further details about whether it was increased or decreased. These answers did not gain credit.

(d) (i) The percentage of oxygen in clean air was recalled correctly by many candidates. There was no pattern to the incorrect answers apart from a few answers which gave the percentage of nitrogen, 78%.

(ii) Argon, being a noble gas, must be in the remaining 1% of the air, if candidates knew the values of 78% for nitrogen and 21% for oxygen. Many candidates gave credible suggestions, but others gave a range of incorrect answers.

(iii) Some candidates gained credit for stating that argon is a noble gas and is therefore inert. The term unreactive was not given credit because some elements, for example copper, are unreactive. The term inert was needed to gain credit in this question, or a description that the atoms have a full outer shell.

Question 6

(a) There were some correct answers, where candidates gave the melting point of ice as 0 °C. The most common error from other candidates was 100 °C.

(b) (i) The correct answer, frequency, was stated by many candidates. Other answers, which were not awarded credit, included wavelength and radiation.

(ii) Infrared was written in the correct place by most candidates.

(c) Some candidates gained credit by stating refraction. Candidates should ensure they use the correct spelling for refraction. ‘Reflaction’ was not accepted since it was not clear that reflection was not intended.

(d) (i) The wavelength is the distance between the same point of two successive waves. Some candidates drew accurate double-headed arrows and gained full credit. Others did not take sufficient care, and their double-headed arrows fell short of the required length. These answers did not gain credit.

(ii) Many candidates gained full credit with a correct calculation and units. Other candidates used the wrong equation (frequency = 40×25) and some did not know the unit for frequency, or stated it incorrectly, for example hz.

Question 7

(a) (i) Many candidates identified a chloroplast correctly. Common errors included labels on the nucleus and the cytoplasm.

(ii) The spaces were filled in correctly by most candidates. Some candidates gave evaporation instead of transpiration in the last space.

(b) (i) Many candidates ticked the correct boxes, carnivore and secondary consumer. Full credit was not awarded to those candidates who ticked the box containing tertiary consumer, or who ticked one, or three boxes.

(ii) Many candidates gained credit in this question by stating decomposers. Incorrect responses included green plants, herbivores, and carnivores.

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

Question 8

(a) (i) Some candidates gained credit in this question by stating natural gas. Others wrote one of the remaining fossil fuels. Coal was the most common incorrect answer.

(ii) Covalent was stated by most candidates. The most common incorrect answer was ionic.

(iii) Some candidates found this question quite challenging. To gain full credit, two electrons had to be written in each of the four covalent bonds. Some candidates added extra electrons, either in the bond, or in the electron shell. Others only had one electron on the bond. Neither of these responses were awarded credit.

(iv) Many candidates knew the products of complete combustion of a hydrocarbon, in this case methane. The most common error was hydrogen instead of water.

(b) (i) Many candidates gained credit by stating that the unsaturated molecule contains a double bond. Fewer gained credit for the definition of a hydrocarbon. It was important to write that only hydrogen and carbon are present in a hydrocarbon. Therefore, answers stating that a hydrocarbon contains carbon and hydrogen were not enough to gain credit. Many organic compounds contain carbon and hydrogen, but they can contain other elements too, for example oxygen, and these are not hydrocarbons.

(ii) Most candidates found this question challenging and were unfamiliar with the term cracking. Incorrect answers included fractional distillation and combustion.

(c) Some candidates recognised the positive result for the test for an unsaturated hydrocarbon. Others had the misconception that saturated hydrocarbons gave this result.

Question 9

(a) This was generally answered well. Most candidates recognised that the lamps were in separate branches of the circuit.

(b) Leaving the switch open meant that no electricity flowed in the branch of the circuit containing lamp **P**. However, there was still a complete circuit which enabled electricity to flow through lamp **Q** and light it up. This was then a series circuit and the current at all points was the same. Therefore, the reading on ammeter 2 was 0.6 A. Some candidates gained full credit in this answer. Others did not gain credit as they stated that there was a current flowing through the ammeter, but that the lamp did not light up. If electricity flowed through ammeter 2 it must have gone through lamp **Q** and caused it to light up.

(c) The variable resistor had to be added to the main circuit, on either side of the battery, before any branching took place. A few candidates did this successfully, but many did not attempt this question.

(d) Many candidates did the calculation successfully and gained full credit. Partial credit was awarded to those candidates who only stated the equation correctly. On some occasions, an incorrect answer was given with no working. These candidates gained no credit. Candidates are reminded to show their working, including an equation used, so that partial credit can be awarded if possible.

(e) Generally, candidates were familiar with the electrical symbols needed to draw the circuit, and some candidates gained full credit for this question. Others did not realise that ammeter 1 was in the main circuit and connected it as part of the branch containing lamp **P**.

COMBINED SCIENCE

Paper 0653/42
Theory (Extended)

Key Messages

Candidates who did well on this paper:

- had learned the syllabus material thoroughly in each of the three sciences
- read the questions carefully and avoided irrelevant answers
- avoided giving answers that contained insufficient detail
- in calculations, set out the logical steps in the working clearly and included the symbolic relationship between the relevant variables.

General Comments

Many candidates demonstrated good knowledge with understanding and wrote clear, well-organised answers. Candidates tended to do better in biology and physics. Candidates very often showed their working in calculations, whether instructed to do so or not, and this is good practice. Working was sometimes set out very clearly, which made it easier to award partial credit for correct steps even when mistakes led to an incorrect final answer.

Candidates generally had no difficulty in finishing the paper in the time allowed.

In biology, candidates showed good knowledge of plant biology in **Question 1**, very good understanding of enzymes in **Question 4**, and reasonably good knowledge of the circulatory system in **Question 7**.

In chemistry, several candidates showed that they understood electrolysis at the particle level in **Question 2**. Some candidates showed that they understood what is represented in energy change diagrams in **Question 5**. Many candidates showed good knowledge of organic chemistry in **Question 8**.

In physics, many candidates were very well prepared for **Question 3**, which concerned a speed/time graph and kinetic energy calculation, and for **Question 6**, on the electromagnetic spectrum and rays. Most candidates were successful in most parts of **Question 9** on electricity. Only a few candidates presented well-organised and detailed answers to **9(b)(ii)**, which asked candidates to use information to show that the current in a circuit would have a particular value.

Comments on specific questions

Question 1

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

(ii) Candidates needed to read this question carefully and make sure that they limited their answers to features of insect-pollinated flowers that were visible in the photograph. Successful candidates therefore avoided references to colourful petals, guidelines or the scent of nectar. Many candidates gained partial credit for describing the location of reproductive organs inside the flower.

(b) Most candidates recognised that the spikes on pollen grain **Y** adapted it for insect pollination. Any reasonable attempt to describe spikes was accepted but the term ‘rough’ was not.

(c) This was answered fairly well and most candidates gained at least partial credit. Candidates needed to refer to cell elongation rather than growth or cell division, and the idea of auxin distribution, spread or concentration rather than production.

(d) (i) This was very well answered and most candidates understood that the first trophic level contains producers. Many candidates were awarded credit for references to food production, photosynthesis and that plants tend not to consume other organisms. The suggestion that producers do not rely or depend on other organisms was not accepted as an alternative to the idea of consumption.

(ii) Some candidates answered this very well and credit was frequently awarded for referring to energy used up when the plant respires. Energy losses from processes, e.g. heat losses to the surroundings, which depend directly on respiration were accepted as alternatives to respiration but not in addition to it. The suggestion 'growth' was often seen but was not credited. Candidates who discussed processes in the consumer that resulted in energy wastage needed to avoid the incorrect use of the term excretion when referring to egestion.

Question 2

(a) Most candidates correctly identified anode and cathode. A common mistake was to suggest electrode products.

(b) Many candidates were familiar with the need for mobile ions in electrolysis and that at 501 °C these exist when lead chloride melts. Candidates needed to be precise in describing the flow or movement of ions through the electrolyte. It was not enough simply to state that the ions gain energy. Some candidates suggested that the increased energy of the ions was what caused the lamp to light. Most candidates avoided the mistake of referring to the movement of electrons through the electrolyte.

(c) (i) This proved to be fairly challenging for many candidates. Of those who correctly gave the chemical formulae, only a minority also realised that lead is formed as a liquid even though they were reminded of this in the question.

(ii) This was answered very well by many candidates. Full credit was awarded to candidates who made the key points that lead ions gain electrons and so are discharged. Any wording which implied discharge was accepted. Candidates needed to avoid suggesting that lead chloride gained electrons. Some candidates gained full credit by stating the electrode equation.

Question 3

(a) (i) Candidates were awarded credit for putting **S** anywhere on the curve in the range 50 to 60 s inclusive. Almost all candidates did this. The strongest answers showed **S** either with a labelling line or with a dot.

(ii) Almost all candidates correctly placed **X.** The strongest answers showed **X** either with a labelling line or with a dot.

(iii) Almost all candidates stated the expected answer, 10 s.

(b) It was apparent that many candidates were well-prepared for this question but did not realise that the bicycle was being lifted and not driven. Many answers referred to friction or air resistance but these could not be credited. Similarly, the vague answer "some energy is lost" did not gain credit.

(c) This calculation was successfully completed by many candidates, and most gained partial or full credit. Most candidates were familiar with the formula for kinetic energy and gained credit for stating it. The two most common incorrect answers were either not finding the kinetic energy of the combined masses of bicycle and rider or combining the mass of one with the weight of the other.

Question 4

(a) Almost all candidates stated that enzymes function as catalysts.

(b) (i) Almost all candidates identified enzyme **A**.

(ii) Most candidates were awarded at least partial credit for stating that at 80 °C the enzyme would be denatured. For full credit, candidates had to use the term active site and explain that its shape would be altered so that the substrate does not fit into it. Candidates needed to be precise and state that it is the active site rather than just the enzyme that changes shape. Candidates should be advised to avoid relying on the idea of the lock and key mechanism when answering examination questions.

(c) This table was completed accurately by most candidates. Carbohydrase was accepted as an alternative for amylase and polypeptide was accepted for amino acids. A small number of candidates suggested lipids instead of lipase.

(d) Many candidates had learned that starch is used to store glucose. Any reasonable reference to storage was accepted including storage of food and storage of energy. The most common misconception was that starch provides energy directly and so answers such as “for energy” or “for food” were not accepted.

Question 5

(a) Many candidates were awarded full credit. Some other candidates reversed the solute and solvent. Other common mistakes included suggestions such as magnesium as the solute and sulfate or sulfur as the solvent. Mistakes like this were often made by candidates who generally did well in the examination overall, which suggested they were unfamiliar with the terms solute and solvent.

(b) (i) The most common answers that were awarded credit referred to energy released or that an exothermic process occurs. A small number of candidates went on to gain full credit by stating that the energy of the products (magnesium sulfate solution) was less than that of the reactants (solid magnesium sulfate). The significance of the phrase ‘overall energy change’ in the question may have been missed by many candidates who described the shape of the curve around the activation energy.

(ii) Most candidates were familiar with the term activation energy.

(iii) Some candidates correctly stated that the energy change **A** involves the breaking of bonds. The most common mistake was to suggest that bonds were being formed.

(c) Many candidates were very familiar with these acid reactions and were awarded full credit. Magnesium oxide or hydroxide were sometimes suggested for magnesium carbonate and there was some confusion over whether hydrogen or water were formed in the first and second reactions. A small number of candidates suggested acids other than sulfuric for some of the reactions.

Question 6

(a) (i) Most candidates were awarded credit here. Answers needed to state that solid turns to liquid or that melting occurs. Some candidates simply stated that liquid forms, which was not enough for credit.

(ii) Most candidates knew the melting point of water. A variety of incorrect temperatures were suggested including –5 and 100 °C.

(b) Most candidates wrote ultraviolet in the correct position in the spectrum. However, several candidates also included other parts of the spectrum in their answer and could not gain credit.

(c) Many candidates knew that light rays refract when passing across the boundary between different media. The change in light speed was less well-known.

(d) This calculation was completed successfully by many candidates. Most had learned the relationship between speed, frequency and wavelength and gained credit for stating it. The most common mistake was the inversion of the calculation of the frequency.

Question 7

(a) (i) Most candidates could identify the pulmonary artery.

(ii) Candidates needed to read this question carefully. It did not ask about the purpose of valves in blood vessels, but this was how many candidates chose to answer. Consequently, credit for answers to this question was not awarded very frequently. The answer "**D** because it is the vena cava" was accepted.

(iii) Many candidates gained partial credit for describing the route the blood takes from atrium to ventricle. Further credit for referring to contraction of heart muscle as the driving force was awarded to some candidates. Some generally well-prepared candidates wrote lengthy descriptions of the arrival of deoxygenated blood at the heart and subsequent transfer to the lungs for oxygenation without answering the question that had been asked.

(b) Many candidates gained at least partial credit for discussing the reduction in transport of oxygen due to the blockage in the coronary artery. The strongest answers stated or implied that this reduction was to the heart, preferably heart muscle. Some candidates went on to explain that a reduction in oxygen transport would have a negative impact on respiration. Candidates should be advised to avoid making statements such as "there will be no respiration". Only a relatively small number of candidates completed the answer by stating that reduced respiration would mean reduced energy available to the heart muscle.

Question 8

(a) Nearly all candidates knew that propane is an alkane.

(b) Candidates generally knew the difference between saturated and unsaturated hydrocarbons in terms of bonding. Credit was awarded for stating that saturated compounds contained only single bonds or that they contain single bonds between carbon atoms. Candidates needed to avoid statements such as "saturated compounds have single bonds". Most candidates gained at least partial credit for referring to the presence of double bonds in unsaturated molecules.

(c) (i) Most candidates used the information and answered this correctly. The question requested the formula H_2O and so the answer 'water' was not awarded credit.

(ii) Nearly all candidates could explain why ethanol is not a hydrocarbon. Any reasonable answer that referred to the presence of an element other than carbon and hydrogen was accepted.

(d) Nearly all candidates had been very well prepared to complete the dot-and-cross diagram for ethene. Inclusion of electrons in addition to those in the bonds was the most common mistake.

(e) Most candidates were familiar with the use of aqueous bromine to distinguish between saturated and unsaturated hydrocarbons. Candidates should avoid the answer "nothing happens" when propane is tested. The strongest answers for propane referred to the orange colour of bromine remaining.

Question 9

(a) Most candidates were awarded credit here. The term serial was not accepted as an alternative for series.

(b) (i) Many candidates gained full credit for this Ohm's Law calculation. Candidates should be advised that the symbol A or the word ammeter should not be used instead of current when stating Ohm's Law.

(ii) This proved to be the most challenging question on the paper and only a very small number of candidates gained full credit. Some gained partial credit for stating either 1.28 ÷ 3 = 0.43 A or 6.4 ÷ 15 = 0.43 A but answers like these were often disorganised and rarely supported by clear and correct reasoning.

(c) Many candidates answered this question very well and gained full credit. Common errors resulted from unfamiliarity with the symbol for a variable resistor, candidates placing the voltmeter in series with lamp **R** or not completing the branch of the circuit containing lamp **P**.

COMBINED SCIENCE

Paper 0653/52
Practical Test

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

COMBINED SCIENCE

Paper 0653/62
Alternative to Practical

Key messages

- Candidates need to read questions carefully and make sure that they refer to exactly what the question is asking about.
- Candidates need to look at the guidance for drawing graphs given in the syllabus. Many candidates did not label axes appropriately or choose appropriate scales.

General comments

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

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

Guidance for the requirements for the practical component can be found at the back of the syllabus. Teachers are referred to Section 4 and 5.

Comments on specific questions

Question 1

(a) (i) Candidates were asked to 'Use Fig. 1.1 and Table 1.2 to determine the clotting score….'. Those who did this judged the observations from the figure and interpreted them in terms of the numbers given in Table 1.2. This often led to full credit being awarded. However, a common error was to describe the observations in words. This involved the use of only Fig. 1.1, indicating that candidates had not read the question carefully in order to judge what to do.

(ii) In questions that ask for a relationship, it is important to look at the question and reply using the same wording. In this case, the relationship asked for was between concentration of acid and clotting score. Some candidates did not address this exactly, using more vague language such as "the more acid, the more clotting".

(iii) Only some candidates used the information provided effectively to state a conclusion. Most based their conclusion on earlier results. The strongest answers addressed the information and used it to state that as the concentration of acid increases, more protein molecules change shape and stick together. Most candidates gave vaguer answers, such as "more acid makes more molecules stick together".

(iv) Most candidates correctly read the thermometer to give a reading of 24.5 °C.

(v) It was correct to say that temperature was not a source of error, because all the test tubes were in the same water bath. Answers that suggested that temperature was a source of error because the water bath cooled during the experiment were also accepted. Many candidates stated one of these ideas, but it was common for candidates to give vaguer answers such as "temperature is not controlled" or "the experiment measures clotting scores, not temperatures".

(vi) A common answer to this question was to give an example of human error, stating that the volume or temperature was read incorrectly. No credit was awarded for this type of answer. Stronger answers recognised that there was no mention of time in the procedure, so the test-tubes may not have been left in the water bath for the same amount of time.

(b) (i) This calculation was usually completed correctly. Candidates selected the appropriate information from the table and calculated the percentage.

(ii) Most candidates answered correctly that with the increase in concentration, the mass of solid formed increases in a similar pattern to the increase in clotting score. The most common error in answers was to give a statement which was too brief to make it clear that the candidate had linked the ideas in the two questions. Answers such as "yes because it increases" were insufficient to clearly show that the two sets of results had been fully processed.

(c) (i) Almost all candidates measured line **F** correctly. A small minority incorrectly measured in cm, giving answers such as 4.7. These answers were not accepted.

(ii) Most candidates used the equation correctly and showed working of 47 / 15 000. However, many candidates were unable to handle the zeros or standard form in the decimal place value. Incorrect answers such as 3.13 were often seen. Of those who did the calculation correctly, many did not follow the instruction to 'Give your answer to two significant figures'. It is important that candidates follow instructions such as this in calculations as credit may be awarded for them.

Question 2

(a) (i) Many candidates correctly read the thermometer and correctly judged the decimal place value to give a fully correct answer of 21.0. The most common error was to miss off the '0'. Answers of 21 alone were incorrect because the thermometer can be read to 0.5 °C and there was a clear instruction above the table to record the temperature to this level of precision.

(ii) Candidates found this graph very challenging. Teachers are referred to the mathematical requirements and the presentation of data sections at the back of the syllabus in Section 5 relating to the expectations for the correct presentation of data in graphs.
While most candidates plotted the points correctly, some candidates omitted the units from the axes labels and others reversed the axes. Most candidates did not use an appropriate scale. Scales for graphs should be chosen such that the points fill more than half the available grid (in both directions) and they should increase in sensible increments such as 1, 2, 5 or 10. Credit for plotting cannot be awarded if complex scales are chosen. It is not expected that graphs always start at 0. However, whether they do or not, the origin should be clearly labelled with the values for both the x and y axis. Points should be plotted with a small cross or a dot in a circle. Large solid circles obscure the accuracy of the plot.

(iii) Best fit lines may be either a straight line or, in this case, a curve. In either case, the line should show the trend. If points are not all on the line, the line should be drawn so that points are distributed evenly either side. A common error was to draw a dot-to-dot line, which is incorrect. Other errors included ragged, double, feathered or very thick lines.

(iv) Most candidates recognised that when the volume of hydrochloric acid increased the temperature increased. Some candidates went on to say that this reaches a maximum after which the temperature decreases.

(v) When asked about stirring, many candidates said it was to ensure mixing. This was only a partial answer and was not awarded credit. Stronger answers stated clearly that this ensures that the temperature is the same throughout the mixture.

(vi) This question was challenging for many candidates. Candidates were familiar with the use of a burette to increase precision and to add aqueous solutions slowly or dropwise during titrations. However, the question asked for one advantage 'other than the precision of measurement'. The advantages included that the student does not have to keep refilling a burette as they would have to do with a measuring cylinder.

(vii) Most candidates correctly suggested insulating the reaction vessel. Some incorrectly suggested using a conical flask with a bung. This would not allow the acid to be added easily and would make stirring and the measurement of temperature with a thermometer more difficult.

(b) (i) Many candidates knew that a green precipitate indicates the presence of iron(II) ions. Those who did not know this, often chose iron(III) ions, which at least showed that they knew that a coloured precipitate is most likely to be caused by iron ions.

(ii) Many candidates had the right idea here but struggled to communicate their answers clearly. The question used the phrase "not important" and many candidates repeated this in different language saying that "the volume doesn't matter". Such answers did not add sufficiently to the question to be awarded credit. Stronger answers stated more clearly that the formation of the coloured precipitate occurs after only a few drops are added or that the formation of the precipitate is not volume dependent.

(iii) The formation of a blue precipitate by copper(II) ions was very well known.

Question 3

(a) Candidates generally recognised the idea of avoiding parallax but did not always express this well. The main point is that the eye must be level with the measurement being made. Many candidates did not fully state this, but instead gave partial answers, such as making sure that the student is "eye level with the apparatus" or "eye level with the ruler". These statements alone were not quite enough. A common error was to state that the reading needs to be made parallel (rather than perpendicular) to the bottom of the spring.

(b) (i) Most candidates correctly measured the length of the spring.

(ii) Almost all candidates calculated the spring extension correctly.

(iii) The value was usually correctly calculated, but a few candidates calculated the spring constant incorrectly by applying the formula given upside down.

(c) Most candidates spotted the anomalous value and were able to justify their choice in terms of deviation from the other values.

(d) Many candidates found this question challenging. Most candidates vaguely suggested doing repeats. Some candidates recognised that the spring is likely to deform during the experiment. These candidates had perhaps done similar experiments during their practical work, which is to be encouraged. Stronger answers suggested measuring the extension both as the loads are added and again as they are removed.

Question 4

Best practice in answering planning questions is to consider the bullet points carefully and to use these to structure answers. Weaker answers only addressed one or two of the bullet points.

- In this question, an apparatus was shown set-up. It was not necessary to describe this set-up in the answer. Most candidates addressed the first bullet point well, usually suggesting that a stopwatch and thermometer were needed.

- The method was not always clearly described. To record data, there were two possible methods for this experiment. The temperature of the liquid could be measured before and after heating for the same amount of time. Another approach was to control the temperature change and measure the time taken to achieve the same temperature change for each liquid. These ideas were not typically well explained. Common incorrect or partially correct answers discussed heating "until the liquid temperature increases", without stating that the temperature change should be the same for each liquid. Some candidates incorrectly changed all the variables at the same time, suggesting "doing it again at different values of voltage, current and time".

- Candidates should note that controlling the "amount" of a substance was not sufficient. They needed to state whether they would do this by using a constant volume (for liquids) or mass (for solids).

- Most candidates included a results table, but this was not always sufficiently well-constructed to be awarded credit. In order to record all necessary data, the table needed to include the liquids under test, a column for voltage, current and either time or temperature (depending on the method). All these values should have been accompanied by the appropriate units.

- Candidates generally found describing processing of results to draw a conclusion challenging. Some candidates suggested “calculating the energy by using the formula” without describing how this would be done. The strongest answers clearly stated that at the end of the experiment it was necessary to multiply the voltage, current and time together to work out the energy transferred.