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Paper 0653/12
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Questions 16**, **23 and 31**.

Question 32 was found to be particularly challenging.

Comments on specific questions

Question 1

Almost all the higher-scoring candidates selected the correct answer here. Many lower-scoring candidates incorrectly thought that breathing is a characteristic of living organisms. Candidates needed to recognise that organisms are not only from the animal kingdom, but include plants, bacteria and other organisms.

Question 2

Many candidates answered this question successfully. Lower-scoring candidates incorrectly thought that the function of a cell membrane is to hold the chlorophyll of the cell. This may be because they had confused chlorophyll with cytoplasm.

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Question 4

This question was challenging for candidates with many incorrectly selecting option **D** which was the graph showing the effect of pH on enzyme activity.

Question 5

Most candidates answered this question successfully. Some lower-scoring candidates incorrectly thought that Y was the cuticle and not the vascular bundle.

Question 6

Most candidates selected an option that correctly contained digestion. Almost all high-scoring candidates got the question correct. However, many lower-scoring candidates incorrectly thought that the small intestine was involved in egestion.

Question 7

Whilst most higher-scoring candidates answered this question successfully. Half of all lower-scoring candidates incorrectly opted for 4 g of water per hour. This may be because they did not read the question correctly. They may not have seen that the experiment was run for two hours, and the question asked for a rate of transpiration per hour.

Question 8

Whilst most candidates chose the correct answer, many lower-scoring candidates incorrectly chose option **B**. The question asked for the equation for respiration, not photosynthesis.

Question 9

Most candidates chose an option indicating that the heart rate increases. Many of the lower-scoring candidates incorrectly thought that frightened people's eyes narrow.

Question 10

Most candidates answered this question well. Some lower-scoring candidates incorrectly indicated that a feature of asexual reproduction is to produce genetically different offspring.

Question 11

Most candidates answered this question well. The most common incorrect answer indicated that Z was a cervix. If this were correct the label line would be touching the top part of the vagina on the diagram.

Question 13

Almost all higher-scoring candidates got this question correct. Some of the lower-scoring candidates thought that option **D** represented plants in the diagram.

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Question 15

Although this question was answered correctly by most candidates, some of the higher-scoring candidates incorrectly thought that iodine could be stretched into a wire. They needed to know that this is a property of metals, and not, as it is a non-metal, a property of iodine.

Question 30

Although the majority of candidates answered this question correctly, the most common misconception was that the speed of the car is changing when there is no resultant force acting (option **B**). Possibly these candidates equated 'no resultant force' with 'no driving force from the engine' and therefore thought that friction reduces the speed.

Question 32

The topic here was hydroelectric power. Many candidates opted for **C**, failing to identify geothermal resources as being renewable. Fewer candidates knew that hydroelectric power stations do not use steam as part of the generation process.

Question 34

A significant number of candidates believed that cool air rises from the ice cube and therefore thermometer X showed the change of reading, leading them to choose the incorrect option **A**.

Question 39

The number of candidates choosing option **C**, which is the exact opposite of the correct option **B**, suggests that they were confused about the meaning of the terms 'open' and 'closed' when applied to switches.

Question 40

It is likely that the popularity of option **C** among the lower -scoring candidates was a result of them confusing parallel and series circuits and believing that the current is the same at every point.

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Paper 0653/22
Multiple Choice (Extended)

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

General comments

Candidates performed very well on **Question 15**, **Question 16**, **Question 20**, **Question 22**, **Question 25 and Question 31**.

Questions 22 and **33** were more challenging for many candidates.

Comments on specific questions

Question 2

Some of the lower-scoring candidates, incorrectly thought that the answer was **D**. Option **D** is the reverse of the correct answer suggesting that these candidates had confused high and low water potential.

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Question 3

Some candidates found this question challenging. Although most candidates correctly identified that the enzyme at point X was not denatured. Candidates incorrectly thought that the substrate's kinetic energy at the lower temperature, at X, was higher than at Y.

Question 4

Most candidates answered this question successfully. Some candidates incorrectly thought that Y was the cuticle and not the vascular bundle.

Question 6

Whilst most higher-scoring candidates answered this question successfully, many lower-scoring candidates incorrectly opted for 4 g of water per hour. This may be because they did not read the question correctly. They may not have seen that the experiment was run for two hours, and the question asked for a rate of transpiration per hour.

Question 7

Most of the higher-scoring candidates answered this question successfully. Many candidates incorrectly thought that the role of the cilia was to trap pathogens.

Question 8

Whilst most candidates chose the correct answer, many of the lower-scoring candidates incorrectly chose option **B**. The question asked for the equation for respiration, not photosynthesis.

Question 9

Most candidates of all abilities were able to answer this question successfully. Candidates who chose the incorrect option, either indicated that auxin accumulated on the side of the plant closest to the light, or they had chosen option **A** where auxin accumulated at the tip.

Question 11

Many lower-scoring candidates chose option **A**. Whilst the amniotic fluid does have a general protective role, this question asked what protects the embryo against toxins.

Question 12

Many candidates correctly identified that humans were in the second tropic level. Incorrect responses indicated that humans were secondary consumers.

Question 13

Most higher-scoring candidates answered this question successfully. Among the lower-scoring candidates, several thought that option **D** represented plants in the diagram.

Question 23

There was evidence that many candidates had guessed at the answer. Some of the higher-scoring candidates chose the incorrect **D** rather than the correct answer, **A**. They were expected to be able to deduce the order of reactivity of metals by reference to the reactions, if any, of each metal added to aqueous ions of other metals.

Question 24

Many higher-scoring candidates chose the incorrect **C** and incorrect **D** rather than the correct answer, **A**. Candidates needed to know the reactions that occur in the blast furnace and also the order in which these reactions occur.

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Question 28

A large majority recognised that the first section of the graph represented increasing speed, but some candidates often simply multiplied the final speed of this section (2 m/s) by the time (40 s), resulting in them choosing option **C**.

Question 29

Although most answers to this question on spring constant were correct, a common mistake was to divide extension by force, leading to option **B**.

Question 31

A large majority of the candidates knew the formulae for kinetic and gravitational potential energies.

Question 32

In this question on power, several candidates neglected to convert the time into seconds and therefore opted for the incorrect **C**.

Question 33

The topic here was hydroelectric power. Many candidates opted for **C**, neglecting to identify geothermal resources as being renewable. Only a few knew that hydroelectric power stations do not use steam as part of the generation process.

Question 40

Slightly more candidates chose option **A** than the correct option **C**. This was a result of neglecting to change the time from hours into seconds.

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Paper 0653/32
Theory (Core)

Key messages

Candidates who did well in this paper
- had a good knowledge of the syllabus across all three disciplines of Biology, Chemistry and Physics
- were able to apply their scientific knowledge to unfamiliar situations successfully
- calculated numerical answers accurately, showing their working
- used legible handwriting.

General comments

The standard of candidates' work was very good overall. Others, who did not do so well in this paper would have scored better if they were more familiar with the contents of the syllabus, especially the electromagnetic spectrum and chemical analytical tests.

Regarding examination technique, candidates should be aware of the difference between the command words *describe* and *explain*. Describe, as in **1(b)(i)** is purely asking what the differences between the cells look like and not asking to explain why this has happened.

Careful reading of the stem of the question would have improved performance. Examples of this are in **5(a)(i)** and **8(b)(ii)**.

Comments on specific questions

Question 1

(a) (i) The parts of the plant cell were correctly identified by many candidates. The most common error was naming the nucleus as a chloroplast. Candidates should be aware that there are no chloroplasts in root hair cells.

(ii) The majority of candidates gave a correct answer to this question. Many of the incorrect responses described the plant cell wall as partially permeable, allowing only some molecules to pass through it. The cell wall is freely permeable.

(iii) The words to complete the pathway of water through the pant were successfully added by most candidates. The first word, *cortex*, was more of a challenge than the second word*, xylem.* There was a variety of incorrect words, including wall, hair, and transfer.

(b) (i) Candidates of all abilities found this question challenging. There were many scripts with attempts at explanation of what had happened, rather than descriptions. So, references to the loss of water were not relevant. Descriptions implying that either the cell membrane or cytoplasm had shrunk did not gain credit because it is the vacuole, which has shrunk.

(ii) The majority of candidates answered this question successfully.

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Question 2

(a) (i) The higher-scoring candidates stated the correct colour changes for the test for water. There were no common incorrect answers, with a wide variety of colours being stated.

(ii) Some candidates identified the iron(III) ion successfully. Incorrect responses included iron(II), magnesium and sodium.

(iii) There were some candidates who correctly identified the sulfate ion. Others wrote other anions, for example chloride and nitrate.

(b) (i) Most candidates used the fact that the reaction is an exothermic one, to conclude that the temperature would increase due to the release of thermal energy.

(ii) The word equation was successfully completed by many candidates. The sodium hydroxide was identified by most candidates, whereas the gas produced, hydrogen, was more challenging. Incorrect answers included oxygen and carbon dioxide.

(c) (i) This was generally answered well by the full range of candidates.

(ii) There were many correct answers to this question. Incorrect answers included drawings of the displayed formulae, and incorrect numbers of atoms in the molecule.

Question 3

(a) Most candidates completed the energy flow diagram correctly. Several candidates incorrectly stated that heat or electrical energy is in the battery.

(b) The use of the rearranged formula, speed = distance / time, enabled most candidates to gain full credit in this question. Errors arose due to using the wrong equation, for example, distance = speed / time.

(c) (i) This question was well answered by the full range of candidates.

(ii) This was well answered by most candidates. Errors were made when candidates multiplied the weight of the car and child by the gravitational force instead of dividing by it.

(iii) This question was successfully answered by most candidates. They knew that the car was travelling at a constant speed, so the forces were balanced. Therefore, an increase in the driving force would lead to acceleration. Some candidates incorrectly assumed that the car was stationary before force **S** was increased and stated that the car would start to move forward.

(iv) Many candidates did not appreciate that the application of the brakes causes an increase in the frictional forces shown by arrow **Q**, which enables the car to decelerate.

Question 4

(a) This question was well answered by candidates across the full range.

(b) The two roles of the white blood cells, phagocytosis and antibody production, were the key points in this answer, which very few candidates described. Many answers just stated, ‘to fight against the bacteria’, or ‘to prevent infection’. These responses did not gain credit.

(c) Many candidates successfully completed the sentences about the heart. Other candidates who were not so successful confused arteries and atria, or atria and ventricles.

(d) (i) Generally answered correctly.

(ii) Generally answered correctly.

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Question 5

(a) (i) While some of the higher-scoring candidates scored quite well in this question, most of the remaining candidates found this question challenging. Many of them misinterpreted the sense of the word separation and described the method of separation of a solid from a liquid by filtration instead of describing the distance between particles in a solid.

(ii) Some candidates knew that chromatography is used to separate the different coloured dyes in ink. Common errors included filtration, distillation, or fractional distillation.

(b) (i) There was a wide range of acceptable answers to this question. Most candidates managed to suggest a quantity less than 35 g. The most common incorrect answers were 35 g and 3500 g.

(ii) Some candidates answered this correctly, writing the gas chlorine. Incorrect responses included chloride, sodium, and hydrogen. Candidates are reminded that chloride ions go to the anode where they form the element chlorine.

(c) (i) Many candidates scored credit in this question by stating coal. Several incorrect responses included various fractions from fractional distillation, for example diesel and kerosene.

(ii) Fractional distillation was stated by the higher-scoring candidates, who gained credit. Common incorrect answers from other candidates stated filtration and cracking.

(iii) This question was challenging to many candidates. The question asked for a difference in **chemical** properties of saturated and unsaturated hydrocarbons. Therefore, answers describing the difference in bonding did not gain credit. Candidates should be aware that the chemical properties describe the reactions of the compounds, not the structure.

Question 6

(a) (i) Candidates found this question challenging. The two processes of *evaporation* of water molecules from the beaker, followed by *condensation* to form the cloud, were both needed to gain full credit. Evaporation was the most common correct answer in this question. Many candidates stated that one of the processes was boiling. Candidates are reminded that boiling occurs at 100°C, and the highest temperature of the water in the beaker was 90°C, so this answer did not gain credit.

(ii) Heating the water gave the water molecules more kinetic energy. Most candidates stated this correctly. Fewer candidates continued their answer to explain that the increased kinetic energy enabled more water molecules to escape from the surface of the water. Therefore, only partial credit was obtained by the majority of candidates.

(b) (i) Approximately half of the candidates stated the correct answer for this question, *frequency*. The most common incorrect answer was wavelength. Candidates should be aware that the wavelength increases beyond the infrared part of the electromagnetic spectrum and decreases beyond the ultraviolet part of the spectrum.

(ii) Some candidates identified the parts of the electromagnetic spectrum correctly. There were many incorrect answers, demonstrating that candidates were not familiar with the characteristics of the different waves making up the spectrum.

(c) Most candidates stated that since the range of hearing is from 20–20000 Hz, the sound emitted from the Bunsen burner would be audible. Credit was missed by those candidates who omitted any reference to the audible range, or who gave an incorrect range.

Question 7

(a) Candidates were generally familiar with the stigma, which receives the pollen and the anther which produces the pollen. They were less familiar with the function of the sepals. Some candidates confused the word sepals with petals, wrongly describing how they attract insects instead of protecting the bud of the flower.

(b) Most candidates interpreted the information in the stem to produce a correct food chain.

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(c) There were some excellent descriptions of the process of photosynthesis. They stated the raw materials and products of the process, and also included the conditions needed. Less successful descriptions were too vague, with statements such as 'photosynthesis is when plants make their own food'. Much more detail was needed to score credit.

Question 8

(a) (i) Some candidates described the trend in physical states correctly. Others did not gain credit because they referred to trends of reactivity, colour, or melting point. Candidates are reminded that the physical states are solid, liquid and gas, and the correct answer shows the trend going down Group VII.

(ii) Many responses stated that diatomic means two atoms of the same element. This was not enough to gain credit. The two atoms, which do not have to be the same, must be bonded in a molecule.

(b) (i) Many candidates answered this question correctly, naming the transition metals. Incorrect answers included naming individual metals, for example sodium, iron and cobalt.

(ii) There were several possible correct answers to this question covering the properties of the transition metals from the syllabus that have not already been mentioned. Many candidates wrote a correct answer. However, credit was missed due to some candidates writing high melting point or high density as a property of the transition metals. These properties have already been given in the stem of the question. Other candidates described a use of transition metals instead of a property.

(c) (i) Many candidates successfully stated a use for argon. The most widely chosen use of argon was to provide an inert atmosphere in light bulbs.

(ii) The key to the unreactive nature of Group VIII elements is the complete outer shell of electrons. Many candidates wrote this and gained credit for this point. However, further credit was available if they developed their answer further to say that this configuration is stable. Only a few answers contained this further point.

Question 9

(a) Many candidates described the purpose of a voltmeter correctly. Incorrect responses included voltmeter and volts.

(b) There were many correct calculations to find the resistance of the motor. Also, most candidates wrote the unit for resistance (Ω) correctly. Credit was missed by those candidates who used the Ohm's Law formula incorrectly, for example $R = V \times I$ instead of $R = V / I$

(c) (i) Most of the candidates successfully added a lamp in parallel with the motor in the circuit. Credit was missed by some candidates who could not recall the symbol for a lamp, though they gained some credit for placing their component in the correct position in the circuit.

(ii) Generally, candidates found this question challenging. Most were unaware that adding the lamp to the circuit in parallel reduces the resistance and therefore the current increases at the same voltage.

(d) Very few candidates gained credit for this question. The fuse rating should not be too much higher than the expected current in the circuit. The 13 A fuse allows a much larger current to go through the circuit without blowing. This means that the motor could easily be damaged at high currents below 13 A.

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Paper 0653/42
Theory (Extended)

Key messages

Candidates who did well on this paper:
- had learned the course material thoroughly in each of the three Sciences
- where appropriate, wrote answers using words and phrases that appear in the syllabus
- selected information provided in questions and used it correctly
- in calculations, included the symbolic relationship between variables as part of well-organised working.

General comments

Many candidates had very good knowledge with understanding of most of the syllabus and wrote clear, well-organised answers. Performance across the three Science disciplines was well balanced. Candidates usually showed their working in calculations, whether instructed to do so or not, and this is good practice. There was no evidence that candidates had difficulty in finishing the paper in the time allowed.

In Biology, candidates showed that they had learned the details of leaf structure as shown in **1(b)**, chemical digestion **4(a)** and osmosis **4(c)**, although the use of the term 'concentration' was sometimes ambiguous. Some candidates would have gained more credit if they had realised that smoking damage in alveoli caused a decrease in the surface area available for diffusion of gases.

In Chemistry, most candidates had sound knowledge with understanding of atomic structure **2(a)** and **2(b)(i)**, chemical tests **5(a)** and **(c)**, and organic chemistry in **Question 8**. Some candidates had difficulty in explaining electrode processes in **5(b)(ii)**. The form and use of state symbols in chemical equations was unfamiliar to many candidates **5(b)(i)**.

In Physics, most candidates successfully completed calculations, **3(b)**, **(c)** and **9(b)**, and showed good understanding of light and lenses **Question 6**. They understood the concept of balanced forces **3(a)(ii)** and could explain changes in gas volume using molecular theory **6(c)**. Although many candidates showed that they understood the action and need for fuses in electrical circuits, they found it difficult to explain the reasons why a fuse should be rated a little higher than the maximum expected current **9(c)**.

Questions **2(b)(i)** and **(ii)**, **3(b)(i)** and **3(c)(i)**, and **7(a)(i)** showed that many candidates could select and use relevant data.

Comments on specific questions

Question 1

(a) (i) Most candidates constructed correct food chains.

(ii) In order to gain full credit, candidates had to refer specifically to consumption of one organism by another. Most candidates did this. A number of candidates described details of energy losses during transfer at trophic levels but gained only partial credit because they did not mention feeding.

(b) Many candidates stated that the feature of the palisade mesophyll layer was the presence of chlorophyll. Stronger candidates correctly referred to the presence of chloroplasts which are a feature rather than a substance. Alternative answers that gained credit described the arrangement of cells or their location in the leaf.

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Stronger candidates gained credit for referring gaseous exchange in the air spaces of the spongy mesophyll. Unqualified statements such as 'for diffusion' or 'diffusion of materials' were not accepted.

Most candidates were familiar with the function of xylem tissue, referring to the transport of water, minerals or ions.

(c) Most candidates gained at least partial credit for stating that the rate of photosynthesis increases with increasing light intensity. The second mark for going on to discuss the significance of the plateau was awarded mainly to stronger candidates. Some candidates suggested that the variables were directly proportional but this is not strictly correct and so the mark was not awarded if this was the only statement made.

Question 2

(a) Most candidates identified atom **Z** as the halogen. Their explanation had to refer to seven outer shell electrons. Answers that did not gain credit included 'Z has seven electrons', 'it only needs one electron to be complete', 'it is only one electron away from being stable'. However, answers such as 'it only needs one electron to complete the octet' were credited.

(b) (i) Most candidates correctly placed element **X** in Group II. A minority suggested Group I and these candidates were awarded partial credit if they stated that **X** was a metal. Many candidates gained full credit for selecting the correct information from Fig. 2.1 and Table 2.1.

(ii) Only a minority of candidates were awarded this mark. A popular suggestion that did not gain credit was '**X** is a solid and **Y** is a gas'. This does not explain why these elements are placed in different groups. The key idea was that **X** is a metal and because **Y** is a gas or exists as single atoms, it is a non-metal. The answer '**X** is a metal and **Y** is a *noble* gas' was credited.

(iii) Helium was identified by many candidates. The answer 'one of the inert gases' was not sufficient to gain credit.

(iv) Many candidates were awarded at least partial credit for two or three correct ticks. One of the more frequent mistakes was to suggest that molecules of $\mathbf{Z}_2$ are not diatomic.

(v) At least partial credit, for identifying ions of **X** as positive and ions of **Z** as negative, was very frequently awarded. Stronger candidates gave the additional detail that ions of **X** would carry a 2+ charge and ions of **Z** would carry a single negative charge. For the explanation, credit was awarded for correct science, either a discussion of electron loss and gain, or ideas based on charge balance in $\mathbf{XZ}_2$.

Question 3

(a) (i) Most candidates gained this mark. Alternative answers included '**air** resistance' and 'drag'. The single-word answer 'resistance' was not sufficient.

(ii) Most candidates correctly stated force **Q** to be 25 (N).

(b) Most candidates were familiar with the expression for kinetic energy and many worked through to the correct numerical answer. A common mistake was to neglect to take the square of velocity even when the correct formula had been stated.

(c) (i) Most candidates were familiar with the idea that the area under a speed–time graph gives the distance moved. Many worked through to the correct numerical answer. Provided clear working was shown, partial credit was awarded for obvious attempts to calculate an area. One common mistake was made by candidates who calculated the area of the rectangle, $0.7\ (\text{m/s}) \times 4\ (\text{s})$. Some candidates correctly substituted into the expression for the area of a trapezium and gained full credit for this.

(ii) This was answered well by many candidates who were familiar with the expression for calculating acceleration. Many worked through to the correct numerical answer and stated correct units. Common incorrect units were m/s and m.

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Question 4

(a) (i) Most candidates recognised both oesophagus and pancreas. 'Food pipe' was not accepted as an alternative to oesophagus.

(ii) Stronger candidates gained full credit by explaining that saliva contains amylase which breaks down starch to simple sugars. Maltose was accepted as a named simple sugar. The wording in the question guides candidates towards an answer referring to chemical digestion but many described processes related to mechanical digestion. The term 'carbohydrate' was not accepted as an alternative to starch and 'enzymes' was not accepted as an alternative to amylase.

(b) Most candidates knew that dietary fibre prevents constipation, and answers that stated or implied this gained credit. One common idea that did not gain credit was that 'fibre helps digest food'.

(c) Most candidates knew that the red blood cell shrinks because of osmosis and many gave fully correct explanations in terms of water potential. Candidates need to take great care if they use the term 'concentration' in their answers. The idea of 'concentration of water' is often used as an alternative to water potential, and candidates must distinguish this from solute concentration. Some candidates were familiar with many of the terms used to explain osmosis but often used these terms incorrectly. There seemed to be some confusion about the idea of a 'concentration gradient' and this term often featured in answers that lost some credit.

(d) Stronger candidates had learned that thin **walls** are a key feature of the structure of capillaries and avoided answers such as 'capillaries are thin' or 'capillaries are only one cell thick'. Any wording that described efficient exchange of substances was accepted for the second mark. Credit was not awarded for vague, unqualified references to 'easy diffusion'.

Question 5

(a) Most candidates were familiar with the tests for hydrogen and oxygen. Candidates should be advised that they need to describe these tests carefully. Answers such as 'the pop test' or 'the splint test' are not acceptable alternatives to the detail of applying a flame or burning splint.

(b) (i) Only stronger candidates were familiar with the use of state symbols, and only a minority of these candidates gained full credit. The most frequently awarded mark was for recognising that the state symbol (g) should follow H_2 and O_2.

(ii) Only the strongest candidates tended to gain full credit even though candidates could have used the equations in the preceding question as a guide. Many candidates described the attractive forces between ions and the electrodes but did not go on to describe what happened at the surfaces of the electrodes. Answers in terms of oxidation and reduction were accepted.

(c) Tests for acidity were familiar to most candidates. Any correct indicator with its colour change was accepted as was the use of a pH meter giving a reading below seven.

Question 6

(a) Most candidates knew that distance **A** is the focal length of the lens. No other wording was accepted.

(b) (i) Candidates needed to avoid locating **X** at position **A**. The most common incorrect positions for **X** were to the left of **A** or above the top of the lens.

(ii) The relationship between density, volume and mass was very familiar and the great majority of candidates worked through to the correct value of the mass. The main cause of missed credit was an incorrect arrangement of the three variables at the start of the calculation.

(c) (i) Some very good answers were given by many candidates and full credit was often awarded. Candidates used the guidance in the question and many described the increase in separation between molecules with increasing temperature. Candidates needed to specify that increased temperature increases the **kinetic** energy or the speed of the molecules. Candidates should avoid

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stating that the 'motion of the molecules increases'. Some candidates attempted to explain the volume increase in terms of increased collision frequency.

(ii) Many candidates simply stated that the density decreases because the volume increases. Credit was awarded to candidates who found a way to express the idea that there is less mass, or fewer molecules in a given volume. A variety of acceptable ways to do this was seen from stronger candidates.

Question 7

(a) (i) The great majority of candidates selected the correct data from the bar graph and gave the correct final answer.

(ii) Candidates generally were very familiar with the toxic components in cigarette smoke and full credit was very frequently awarded. The least well-known answer was the connection between tar and lung cancer.

(b) Only the strongest candidates stated that smoke-damaged alveoli have a decreased surface area. The explanation of reduced gaseous exchange in terms of reduced diffusion was rarely suggested. Some candidates wrote answers which were more related to coronary heart disease and its causes.

Question 8

(a) (i) Most candidates recognised cracking.

(ii) Most candidates were clearly familiar with the conditions needed for cracking. Candidates needed to avoid one-word answers such as 'temperature' or 'pressure'. They had to specify **high** temperature or pressure. Some candidates were awarded only partial credit because of this. The need for a catalyst was very familiar. A minority of candidates were unfamiliar with the meaning of the term 'conditions' in the context of this question and suggested answers such as 'hydrocarbons are required'.

(b) Candidates needed to have two correct rows of ticks in order to gain at least one mark. This mark was frequently gained for correct first and second rows.

(c) The colour change in the bromine test for alkenes was very familiar and all candidates avoided suggesting 'clear' or 'white' instead of 'colourless'. Variations on yellow, orange or brown were allowed for aqueous bromine but red was not accepted.

(d) Stronger candidates had learned how to answer this question about homologous series and gained full credit. Credit was awarded for alternative answers that referred to a common functional group or a named type of chemical reaction. Suggestions that were not accepted included 'they all have the same chemical formula', 'they all have the same elements' and 'they all have the same properties'.

Question 9

(a) Most candidates recognised the symbol of the variable resistor. Candidates needed to explain that the purpose of the variable resistor was to control the current in the circuit. Control of the brightness of the lamps was also accepted. The statements 'to change the resistance in the circuit' or 'to limit the current' did not gain credit.

(b) This type of calculation was very familiar to most candidates and the majority worked through to the final answer. Candidates either substituted into the formula for two resistors in parallel or they noticed that they could simply calculate the value of 220 (V) ÷ (2 × 5 (A)). Partial credit was awarded to candidates who showed in their working that they had used Ohm's law to calculate the resistance of one of the lamps. Candidates who wrote the resistance of one lamp (44 Ω) on the answer line without showing any working did not gain credit.

(c) (i) These marks were infrequently awarded. Many candidates discussed, in general terms, the purpose of a fuse and what causes it to blow. Some gained at least partial credit for showing that

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they realised the current flowing through both lamps when working normally would be 10 A. The idea that current might naturally fluctuate and so increase to a value greater than 10 A was unfamiliar.

(ii) These marks were infrequently awarded. The reason why a 13 A fuse would be more suitable needed candidates to explain that the lamps could function normally and that the fuse would not blow if small increases in current occurred. Equally important, but suggested by only a small number of candidates, was the idea that a fuse rating that was too high risked damage to the lamps.

(d) The great majority of candidates were awarded this mark.

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Paper 0653/62
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental technique and to have carried out experiments similar to the ones shown in the paper. Candidates are becoming more prepared for the planning question; describing the investigation in a logical sequence would help candidates to organise what needs to be included. The bullet points in the question are there to help candidates structure their plan into the sections required. Candidates found interpreting and evaluating experiments challenging.

General comments

Candidates generally demonstrated good understanding of basic practical knowledge and techniques. The standard of graph drawing was quite high although candidates need to remember that axes need to be labelled with quantity and unit and the scale should be linear and allow the plotted points to cover at least half of the grid. If a line of best fit is a straight line then it should have a constant gradient. When citing a relationship the two variables in the question need to be used. Candidates must read the questions carefully so that they answer what is being asked by the question for example **2(c)(i).** Undertaking practical work helps the candidates to interpret and evaluate experimental methods and results.

Comments on specific questions

Question 1 – Rate of an enzyme catalysed reaction

(a) (i) Almost all candidates counted the discs correctly.

(ii) Almost all candidates counted the tally correctly.

(iii) Most candidates calculated the rates correctly, a small number multiplied by three.

(b) (i) The higher-scoring candidates drew complete graphs. However, many omitted labelling the axes, particularly the units, or reversed the axes. Some scales covered too little of the grid or used the values in the table rather than being linear. Where the axes were linear most candidates plotted the points correctly.

(ii) Candidates found the line of best fit challenging. Many drew a line which changed gradient part way or ignored many of the points in order to put the line through the origin.

(iii) The relationship was deduced by many candidates. The most common error was discussing the number of bubbles rather than the rate of reaction.

(iv) Higher-scoring candidates used their graph correctly. Some used a surface area of 24 or gave a number which didn't correlate to the graph they had drawn.

(v) Higher-scoring candidates suggested a valid improvement. A greater sample size, greater mass and more trials were common incorrect responses.

(vi) The use of a gas syringe was quite well known. Those that chose a measuring cylinder usually did not include collecting over water.

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(vii) The test for oxygen gas was not well known and a significant number omitted the question. Common incorrect responses included a lighted splint relighting, a splint relighting and the test for carbon dioxide.

Question 2 – Properties of a solid

(a) (i) Many candidates interpreted the information correctly. Common incorrect responses included 7, 10 and 8–10.

(ii) Candidates found this very challenging. Incorrect responses included the indicator giving different colours at different times, green blue is a mixture or repeating the stem of the question.

(b) (i) The test for ammonia was well known. All responses were seen with carbon dioxide being the most common.

(ii) Candidates found this very challenging. Common incorrect responses included ammonia, sodium, calcium, copper and hydrogen.

(iii) Whilst many candidates recognised a suitable safety precaution, far fewer explained in sufficient detail why the precaution should be taken. What the precaution is protecting and what it is being protected from should both be included in the answer.

(c) (i) Higher-scoring candidates appreciated that an observation was needed. Common incorrect responses included forms a gas, forms carbon dioxide, goes milky, gives a white precipitate. A significant number omitted the question.

(ii) The test for carbonates was quite well known. All responses were seen with chloride being the most common.

Question 3 – Planning question

Candidates are becoming more prepared for the style of answer required of a planning question and some are addressing the bullet points, which are there to help.

A very small number omitted the question and almost all of those who answered gained some credit.

The whole range of marks was seen and some higher-scoring candidates gave detailed answers gaining full credit.

Apparatus was quite well known with many including a form of heating. Whilst many candidates discussed measuring mass and volume, few included a balance or syringe.

Methods tended to lack the detail needed, for example heat and weigh with no amplification. Many heated and passed the gas into limewater or collected the carbon dioxide and weighed it. The method needs to address the variables in the relationship being investigated. Whilst many gave a safety precaution, few explained why it was necessary.

Many used only one mass of magnesium carbonate or discussed the amount of carbon dioxide made rather than its volume.

Many candidates omitted including a table for the results. Those that were drawn usually did not include units.

Candidates continue to find processing results and drawing conclusions very challenging. Many cited a conclusion rather than explaining how the results could be used to find the conclusion or omitted this altogether.

If a graph is to be drawn then the quantities on each axis need to be given.

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Question 4 – Calculation of work done

(a) (i) The majority of candidates measured the height correctly. Common incorrect responses included 6.1 and 6.2.

(ii) The majority of candidates measured the length correctly. Common incorrect responses included 16.4, and 16.5.

(iii) Most candidates multiplied by ten, a small number divided by 10.

(b) The majority of candidates calculated the value correctly. A significant number did not give the value to 2 significant figures.

(c) Most candidates calculated the value correctly, rounding proved challenging for a significant number.

(d) (i) Most candidates named an appropriate piece of apparatus. A small number gave ‘clock’ unqualified or ‘timer’.

(ii) The majority of candidates chose the correct anomalous result and the higher-scoring candidates explained their choice. Others discussed it being the odd one out without specifying how they knew this.

(iii) Candidates found this very challenging. They needed to give a reason why the value was higher than expected. Common incorrect responses included parallax, incorrect reading, poor timing, started timing too late, stopped timing too early and reaction time.

(iv) Few candidates appreciated that the anomalous result should not be included in the average or that the answer should be quoted to the same number of significant figures as the data in the table. The most common incorrect response was 3.242.

(e) Candidates found this very challenging and a significant number omitted the question. Common incorrect responses included two people timing, using a more accurate stopwatch and repeating to take an average.

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