COMBINED SCIENCE

Paper 0653/11
Multiple Choice

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

Comments on specific questions (Biology)

Question 3

This question demanded a three-step thought process before arriving at the correct answer. First, there was the need to appreciate that enzymes are proteins, then to know that the biuret solution is used to test for protein and finally what colour indicates a positive result. Those candidates who performed well on the test as a whole were largely those who successfully arrived at the correct response.

Question 6

Candidates are reminded that they need to read question stems carefully. A misreading of 'anaerobic' for 'aerobic' may have accounted for many of those who opted for an equation that did not show oxygen being used. A substantial number of candidates thought that glucose is produced during respiration.

Question 7

Many candidates gave the answer **A,** suggesting that those candidates believe that the bicuspid valve closes when the left atrium contracts.

Question 8

This proved to be the easiest of the biology questions with candidates clearly secure in their knowledge of the form in which water enters and leaves a plant.

Comments on specific questions (Chemistry)

Question 17, **22 and 27** were the most accessible, with the majority of the candidates answering these questions correctly.

Candidates found **Question 19** the most challenging. The distractor A was chosen by a large proportion of the candidates. Candidates need to be made aware that air can be separated by fractional distillation, albeit after cooling to a sufficiently low temperature to turn gaseous air into a liquid mixture.

Question 15

Many candidates chose **C**, an electrolyte, rather than the key, **A**. The question stem states that a solid X is placed in the circuit. Electrolytes do conduct electricity, but must be a liquid or in solution.

Question 16

Most candidates realised that in exothermic reactions heat energy is given out, but some candidates chose option C, indicating that they did not understand that in a compound the elements bonded together are difficult to separate.

Question 18

Many candidates chose distractor **A**.

Question 21

Many candidates chose distractor **B.** Candidates need to be aware that NaC*l* does not conduct electricity in the solid state.

Question 25

A good proportion of candidates incorrectly thought that transition metals have low melting points and are not used as catalysts. Candidates need to be aware of the properties of transition metals as listed in the specification.

Question 26

Answers indicate that many candidates think that iodine gas is brown.

Comments on specific questions (Physics)

Question 30 was the best-answered in the physics section, with candidates finding **Questions 32** and **35** the most difficult.

Question 32

Many candidates opted for the distractor **C** in this question on change of state. These candidates needed to understand that the temperature of the ice stays constant as it is melting.

Question 33

This question involved applying knowledge of thermal energy transfer in a novel situation. Those candidates who knew that only radiation occurs in a vacuum coped well.

Question 35

This question involved refraction of a ray of light through a parallel-sided glass block. Many candidates chose distractor **A**. Candidates needed to use the fact that the emergent ray follows a path parallel to, but not a continuation of, the path of the incident ray.

Question 36

Candidates need to be aware of common applications of electromagnetic waves. A large proportion of candidates did not know that satellite television links are by microwave, and they also believed that terrestrial television communication was by infrared.

Question 39

Many candidates appeared to believe that opposite charges would repel.

COMBINED SCIENCE

Paper 0653/12
Multiple Choice

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

Comments on specific questions (Biology)

Candidates found no questions particularly easy. Candidates found three of the questions (**Questions 8**, **11** and **13**) more challenging.

Question 8

It is important that candidates know the differences between xylem and phloem.

Question 11

This question tested knowledge of reproductive terminology as well as the knowledge of a fundamental feature of sexual reproduction. Candidates found this question very challenging with even some of the better candidates confused the terms *haploid* and *diploid*.

Question 12

This question tested the knowledge that proteins are made from amino acids. Many candidates answered the question correctly but there was evidence of guesswork in the answers submitted by many others.

Comments on specific questions (Chemistry)

Candidates found **Question 17**, **22**, and **24** the easiest to answer correctly.

There were no items on this paper that candidates found particularly challenging.

Question 15

Many candidates chose **C**, an electrolyte, rather than the key, **A**. The question stem states that a solid X is placed in the circuit. Electrolytes do conduct electricity, but must be a liquid or in solution to do so.

Question 16

Most candidates realised that in exothermic reactions heat energy is given out, but some candidates chose option **C**, indicating that they did not understand that in a compound the elements bonded together are difficult to separate.

Question 19

Many candidates chose distractors **B** and **D**. Reacting an excess of an insoluble base (e.g. CuO) with an acid (e.g. H_2SO_4), followed by filtration to remove the excess solid and evaporation to crystallising point, is an expected laboratory experience for candidates.

Question 20

To answer this question correctly, candidates need to be able to differentiate between laboratory and industrial scale purification processes.

Question 23

Many candidates incorrectly identified electrode Y as the anode (distractor **B**). Candidates need to know that an anode is positively charged, how to identify the positive anode from the cell/battery symbol and that metal ions are positively charged and are attracted to the negative, not the positive, electrode.

Question 25

Many candidates chose distractor **D**. Candidates need to know that water turns copper sulphate from white to blue.

Question 26

Many candidates chose distractors indicating that they think that the combustion of methane is an endothermic process.

Comments on specific questions (Physics)

Question 31 was found the easiest in the physics section. Although **Question 32** was found quite difficult, no one question proved to be extremely challenging.

Question 28

In this question candidates had to appreciate that the unbalanced force would cause the rock to change speed and direction; a significant number chose distractors indicating that they believed that only the direction would change.

Question 32

Many candidates opted for the distractor **C** in this question on change of state. These candidates needed to understand that the temperature of the ice stays constant as it is melting.

Question 35

This question involved refraction of a ray of light through a parallel-sided glass block. Many candidates chose distractor **A**. Candidates needed to use the fact that the emergent ray follows a path parallel to, but not a continuation of, the path of the incident ray.

Question 36

This was a simple recall question on the electromagnetic spectrum. Many candidates gave incorrect answers. Candidates need to be able to the types of electromagnetic radiation ordered by frequency or wavelength.

Question 39

Candidates need to know that the correct positioning of a fuse in the domestic circuit shown is such that it will cut the connection between the live wire and an appliance if a fault develops.

COMBINED SCIENCE

Paper 0653/13
Multiple Choice

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

Comments on specific questions (Biology)

Candidates found two of the questions (**Questions 4** and **9**) to be challenging.

Question 4

This question demanded a three-step thought process before arriving at the correct answer. First, there was the need to appreciate that enzymes are proteins, then to know that the biuret solution is used to test for protein and finally what colour indicates a positive result. Those candidates who performed well on the test as a whole were largely those who successfully arrived at the correct response.

Question 7

Candidates found this the most accessible of the biology questions, with candidates clearly secure in their knowledge of the form in which water enters and leaves a plant.

Question 9

The most commonly chosen distractors (**A** and **B**) suggested that many candidates believe that the left atrium and left ventricle contract simultaneously.

Comments on specific questions (Chemistry)

Question 14, **19**, **21 and 26** were the most accessible, with the majority of the candidates answering these questions correctly.

Candidates found **Question 20** the most challenging. The distractor **A** was chosen by a large proportion of the candidates. Candidates need to be made aware that air can be separated by fractional distillation, albeit after cooling to a sufficiently low temperature to turn gaseous air into a liquid mixture.

Question 17

Candidates are correct in associating salt with electrical conductivity, but need to realise that a salt which is solid (as specified in the question) will not be a conductor; it must be either molten or dissolved in water to conduct electricity.

Question 18

Many candidates chose distractor **A**, indicating that these candidates do not associate rusting with moisture / water and oxygen.

Question 22

Candidates need to understand that they can expect only metals (solid or molten), aqueous ionic solutions, or graphite to conduct electricity.

Question 23,

A good proportion of candidates incorrectly thought that transition metals have low melting points and are not used as catalysts. Candidates need to be aware of the properties of transition metals as listed in the specification.

Question 24

Many candidates chose distractor **A**. Candidates need to appreciate concurrent oxidation and reduction in redox reactions.

Comments on specific questions (Physics)

Candidates found **Question 29** the most accessible and **Questions 33**, **34** and **36** the most challenging.

Question 33

This question concerned change of state. Candidates need to understand that the temperature of the ice stays constant as it is melting.

Question 34

Candidates need to be aware of common applications of electromagnetic waves. A large proportion of candidates did not know that satellite television links are by microwave, and they also believed that terrestrial television communication was by infrared.

Question 36

This question involved refraction of a ray of light through a parallel-sided glass block. Many candidates chose distractor **A** or distractor **D**. Candidates needed to use the fact that the emergent ray follows a path parallel to, but not a continuation of, the path of the incident ray.

Question 37

Whilst the majority of candidates knew the relationship between pitch and frequency, a good proportion either failed to link loudness to amplitude.

Question 40

Candidates need to be familiar with the simple circuit used to determine resistance using a voltmeter and an ammeter.

COMBINED SCIENCE

Paper 0653/21

Core Theory

Key Messages

Pictures are often used as prompts to set a question within a context. However, they are not a substitute for the question. When candidates are asked to describe an experiment, prompted by a picture of the apparatus in use at some point in that experiment, they should describe the whole of the experiment and not simply limit themselves to the content of the picture.

Candidates should be encouraged to pay particular attention to words in heavy print in the question stems and also to the number of marks allotted to a question.

General Comments

There were some very good performances in this paper, with several candidates showing a good understanding of the core content of the syllabus. Candidates are reminded that they cannot receive credit for questions that they have not attempted to answer.

There was no evidence that candidates had a problem in completing the paper in the available time.

Candidates are reminded that a triangle of variables is not an equation or formula. Candidates who give a triangle of variables when asked for a formula will not gain that mark.

Comments on Specific Questions

Question 1

(a) (i) This was quite well answered across the ability range. Some candidates gave words which were similar to the correct answer, but not correct, such as *nucleon*, *nuclear*, and *nuclease*.

(ii) Many candidates gained the mark for the atom **B**. However, of these candidates, many went on to explain that the number of protons should be added to the number of electrons. Some candidates only wrote 8 + 8 = 16. This did not gain the mark, since they had not explained the origin of the numbers.

(iii) There were two marks for this question, but many candidates gave only one answer. *'The number of protons and electrons is the same'* was correct but not sufficient. Similarly, *'electrons are negative and protons are positive'* was correct but not sufficient.

(b) (i) This was quite well answered by the higher scoring candidates. However, many candidates gave *'ionic'* rather than the correct answer *'covalent'.*

(ii) This proved a challenging question. Many candidates suggested that, since helium is a noble gas, it did not need to bond. This was not sufficient.

(c) This was quite well answered. The best candidates described the relative reactivity of zinc and hydrogen as the reason for the reaction. Some candidates described at length what was happening in the picture without explaining why. Some candidates referred to the production of oxygen and that it relights the splint but made no comment about relative reactivity, as specified in the stem.

Question 2

(a) (i) This was quite well answered across the ability range. Some candidates gave an answer referring to an energy, such as gravitational potential energy. The question asks for a force.

(ii) Most candidates made a good attempt at the question; some confused the situation and wrote that kinetic energy was changed to gravitational potential energy.

(b) Almost all candidates attempted this question and many gained at least 1 mark.

(c) This was very well answered by the great majority of the candidates.

Question 3

(a) Almost all candidates attempted this question and gained at least 1 mark, most commonly for the water lily being a *producer*. Many candidates placed ticks in only one of the boxes for the other organisms, whilst there needed to be two ticks for heron and water snail.

(b) (i) **T**he most commonly seen correct answer was *'toxin'.* Many other candidates referred to *'the lack of oxygen'.* Very few referred to *'eutrophication' or 'the growth of algae'.* Most candidates wrote at length. Descriptions of the dirt and germs in the water did not gain marks.

(ii) Many candidates found this a challenging question, describing methane as '*poisonous'* or *'smelling bad'*. Other candidates incorrectly stated that methane damages the ozone layer, linking this damage to global warming. Methane is a greenhouse gas, but does not damage the ozone layer. There were also many answers stating that methane causes acid rain.

Question 4

(a) (i) Many candidates gained the mark for showing two carbon atoms bonded together. However some did not then draw the six hydrogen atoms correctly bonded. Some candidates drew two methane molecules, whilst others added an extra hydrogen atom between the carbon atoms.

(ii) Only a few of the higher scoring candidates gained the mark for '*methane'.* Most candidates gave nitrogen as their answer.

(b) (i) The question proved difficult for most, excepting the higher scoring candidates. Some omitted the word *'fractional',* whilst others described the process which was happening, without given the name of the process *'fractional distillation'.*

(ii) Many candidates found this question challenging. However, many candidates did gain one mark. Individually, both correct compounds were seen quite frequently, but the correct answer, *'water'* was often given alongside a fuel. When *'carbon dioxide'* was give, carbon monoxide was often the other answer.

(c) (i) This was found challenging across the ability range. Many answers simply described the conditions in the Earth's crust and did not gain the mark. The best answers stated that *'the compounds are much more stable'.*

(ii) Some higher scoring candidates gave very full answers to this question. Other candidates referred to *'atoms'* or '*ions'* being transferred, instead of the correct particle, *'electrons'.* Some candidates gave the incorrect charge for the ions produced.

Question 5

(a) This question required very careful reading of the data in the table and candidates across the ability range gave the incorrect answer of protein, rather than the correct *calcium.* Candidates needed to look at the units used for each row in tandem with the numbers.

(b) The correct answer here is '*water'.* Some candidates referred to the energy content and others to vitamins.

(c) This was well answered by the higher scoring candidates. Many other candidates stated that the colour showed the alkaline pH of milk.

(d) This proved a challenging question for many candidates.

(e) Any inclusion of calcium in a candidate's answer disallowed the mark.

(f) This was well answered across the ability range. Candidates, who stated that buffalo milk contains more protein and calcium, either of which was partially correct, gained only one mark. The question required that the candidate explain how these were better for a person's health. For calcium, the importance of calcium for *'healthy bones and/or teeth'* was required. For protein, the importance to *'growth and/or repair'* was required.

Question 6

(a) (i) This was quite well answered across the ability range. However some candidates missed the mark by stating that more force is required to lift the bags higher.

(ii) Most candidates knew the correct answer here, although the spelling was varied.

(iii) This was answered correctly by the higher scoring candidates.

(iv) Many candidates did not gain the first mark because they used the triangular relationship between *D*, *M* and *V*. In many cases this then lead to the incorrect manipulation of mass and volume. Others used weight rather than the correct term, *'mass',* in the formula and did not gain the mark. Of those who had produced the correct fraction, *5000/5500,* some then went on to abbreviate this to 0.90. Several answers were allowed, *0.91, 0.9, 0.90 recurring*, but 0.90 is incorrect.

(b) (i) There was a mark given for working in this question. Most candidates who gained it, gave the formula of $D = S \times T$; an indication that the area under the graph was being considered would also have earned this mark. Many candidates had problems identifying the correct value of the time *240s.*

The higher scoring candidates usually gained both marks.

(ii) This was quite well answered. Lower scoring candidates made some errors made in reading the graph and in the manipulation of the two numbers.

(iii) This was well answered by the higher scoring candidates. Some other candidates, having identified **C** as the correct boy, did not then refer to the graph in the explanation of their choice.

Question 7

(a) This was quite well answered across the ability range and particularly by the higher scoring candidates. Many answers referred to the elements by name; this was allowed. Some candidates gave CO as an element. Another incorrect answer referred to the number of atoms, 6.

(b) This proved a challenging question for most candidates. Many candidates described in detail what was shown in the diagram, but did not relate this to the observation that they were asked to explain.

(c) (i) Most candidates gained the mark for the numerical value of 7. However, despite there being two marks for the question, many did not note that this was a *decrease* in temperature.

(ii) This proved a difficult question for most candidates. Many did not give a response. Most gave exothermic.

(d) This was quite well answered by the higher scoring candidates. Many others did not give a response. Some candidates who attempted the second part of question referred to the increase in surface area but did not explain how the increased area would change the reaction rate.

Question 8

(a) The first part was well done, but many candidates gave incorrect answers such as *'bronchi'* or *'bronchials'* to the second part.

(b) (i) This a challenging question for many candidates. Most candidates gave the correct answer, *1,* for the noble gases.

(ii) This was quite well answered by the higher scoring candidates. Other candidates gave answers relating to other gases in the air, for example, nitrogen.

(iii) Candidates needed to state that the oxygen was used in the body and that carbon dioxide is a waste product. Many of the higher scoring candidates used the correct term *'respiration'.* A few candidates also explained the diffusion process successfully.

(iv) Candidates found this question very challenging. Many used the space to give an extended explanation of the previous question rather than answering the question posed.

Some of the higher scoring candidates gave very full answers, with labelled drawings of apparatus.

(c) (i) Most of those who wrote about the runner's use of more energy did not include a reference to the rate of energy used, or rate of work done and so missed the second marking point.

(ii) This question was well answered. It was not sufficient to write that the runner uses or needs more air; reference needs to be made to *'the volume of air in each breath increasing'.* Some of the higher scoring candidates made successful references to the data in the graph.

(iii) This was well answered by the higher scoring candidates generally. Other candidates referred to other aspects of the runner's body, such as sweating and being tired; the question asks how her breathing will change.

Question 9

(a) This was quite well answered.

(b) Most candidates gained the first marking point, usually for showing the correct symbols for voltmeter, ammeter and lamp.

Many candidates placed the ammeter correctly in series with the lamp, but some of these candidates did not place the voltmeter in parallel with the lamp, so did not gain the fourth marking point.

(c) This was a challenging question for most candidates. Candidates needed to state that metals *'contract when cold'.* Many answers used terms such as *'shrink'* and these were not considered sufficient.

Some of the higher scoring candidates also successfully referred to the possibility of *'cables breaking and damaging pylons'.*

COMBINED SCIENCE

Paper 0653/22

Core Theory

Key Messages

Many candidates wrote long answers to extended questions. It is beneficial for candidates to read through these answers after completing them, to make sure that they have used the correct terms in their sentences.

General Comments

There were some very good performances in this paper, with several candidates showing a good understanding of the core content of the syllabus. Candidates are reminded that they cannot receive credit for questions that they have not attempted to answer.

There was no evidence that candidates had difficulty in completing the Paper in the available time.

Candidates are reminded that a triangle of variables is not an equation or formula. Candidates who give a triangle of variables when asked for a formula will not gain that mark.

Colleagues should read this report in conjunction with the Marking Scheme which is available from the Examination Board.

Comments on Specific Questions

Question 1

(a) (i) This was quite well answered with the correct answer *hydrogen.* However many gave answers relating to the metals in the column, for example, *lithium*.

(ii) The majority of higher scoring candidates showed they knew of the *'increase in reactivity down the group'.* Some candidates gave a description of the reaction.

(b) (i) This was not as well answered. Many candidates found it challenging to translate the physical state of the elements into their relative melting points.

(ii) This proved a very difficult question for most candidates. Reference was often made to *'a change in colour*', but not to the actual colours involved. Candidates also often wrote that a reaction would happen, but did not go on to say that '*bromine was produced'.*

(c) (i) This was quite well answered.

(ii) A good portion of the higher scoring candidates showed an excellent understanding of the construction of formulae and a few gained both marks, using diagrams in some cases. Others referred to the pH of phosphorus being 4. Many candidates did not attempt the question.

Question 2

(a) (i) Many candidates struggled with this question, giving answers relating to the force which was causing the motion, rather than friction, which opposes the motion.

(ii) This was a well answered; the most common incorrect answer being *Joules*.

(iii) The second marking point was often gained, with either *thermal or sound.* However many candidates gave the two answers in the first sentence, the wrong way round. The correct answer is that *gravitational potential* energy transfers to *kinetic* energy.

(iv) This was well answered, with very few candidates quoting the triangle rather than the correct formula *speed = distance / time.*

(b) This was quite well answered by higher scoring candidates. Many others used the extra information given in the question, such as the speed of the tree trunk or the mass of the elephant.

(c) (i) Candidates needed to state that the human lower threshold frequency is about 20Hz to gain the second mark.

(ii) This question was answered well by the higher scoring candidates. Other candidates referred to *'how often'* something happens, rather than giving a definition relating to *'number per second'*.

Question 3

(a) Most candidates gained at least one mark in this question, usually by stating something similar to *'seeds need warmth and water'.* Very few stated that *'light is not needed'.*

In several cases, candidates gave the correct conditions for growth, but mistakenly also stressed the need for light.

Many candidates only gave one set of seeds, very often one of the correct pair, but both pairs were needed for the mark.

(b) (i) This proved quite a challenging question across the ability range. Of the two correct answers, *geotropism* and *sensitivity,* candidates usually gained a mark for the latter.

(ii) This proved another challenging question for many candidates. A large number of candidates referred to the extra sunlight that would be gained by the plant, which would aid photosynthesis. This did not gain a mark, as the question asked about sexual reproduction. Similarly, those who explained how the seeds could be better dispersed after pollination could not gain a mark. Answers such as *'it is easier for flowers to attract pollinating insects'* gained two marks.

Question 4

(a) (i) Many candidates were able to gain the first marking point by recognising that the word *thermal* is required for the first and second spaces. Fewer candidates noted the information in the stem that refers to solid food, meaning that the words *conduction* and *radiation* could not be options for the third space.

(ii) Many candidates gave examples of the heating effect of microwaves and these did not gain marks as they are too similar to the example given in the stem. *'Mobile phones'* and '*satellite TV*' did gain marks.

(b) This was very well answered; a few candidates failed to ensure that all their drawn particles were touching, and so lost credit.

Question 5

(a) (i) This was quite well answered by higher scoring candidates.

Marks were lost by other candidates for referring to elements, rather than atoms within an element, as being all the same and referring to compounds as mixtures, whilst not adding that the atoms/elements in a mixture are chemically combined. Very few gave answers referring to elements being in the Periodic Table of the Elements.

(ii) This proved a challenging question for all candidates.

(iii) This was a well answered question. A few candidates appeared to be distracted by the term *fossil* in the question and gave *bones* as their answer.

(iv) This was well answered by the higher scoring candidates. Most candidates gained a mark for *carbon dioxide*. However, many candidates also gave incorrect answers such as *hydrogen*, *oxygen*, *alkanes*, or types of energy for the other product.

(b) (i) This was well answered throughout the ability range.

(ii) This was quite well answered and the candidates who gained two marks described both the correct transfer of electrons, as well as the correct charge on the ions. Some candidates, although they referred to the transfer of particles from magnesium to oxygen, talked about *ions* or *atoms* being transferred, rather than *electrons.*

Question 6

(a) (i) Many candidates gave the answer *chloroplast* rather than the correct answer *chlorophyll.* Candidates need to be aware of the difference between chloroplasts and chlorophyll.

(ii) This question was quite well answered, particularly by the higher scoring candidates. Many candidates across the ability range gained a mark for *water.* However, many gave *sunlight* as the other raw material, rather than the correct answer, *carbon dioxide.*

(iii) This was well answered and the majority gave the correct answer *oxygen.* A few candidates said that carbon dioxide was released.

(b) This was well answered.

(c) This was not very well answered. Most marks were gained for stating that protein was needed for *'growth and repair'.* Some candidates referred to proteins *'making you strong'*; this was not specific enough to gain credit.

(d) (i) This proved an extremely challenging question for all candidates. The '*diffusion of oxygen from the lungs into the blood',* is the only process which does not use energy. Most candidates only ticked one box.

(ii) This was also a challenging question for candidates across the ability range. Many candidates wrote lengthy answers, but lost marks by using phrasing that was too ambiguous or too general.

Examples of phrases that did gain credit are *'eating fat gives your body heat energy by respiration'* (marking points 4 and 5) and *'more fat layers under your skin insulates your insides from the cold'*, (marking points 6 and 7).

Question 7

(a) (i) This was a very well answered question. Most candidates gained 3 marks. A few candidates referred to the first symbol as a light and did not gain that mark.

(ii) This was also a very well answered question across the ability range. A few candidates did not draw a complete circuit.

(b) (i) The question was well answered. Some candidates missed the mark by writing *'hydro energy'*, whereas the correct term, *hydroelectric*, was required. Similarly, several candidates wrote water energy, rather than specifying *'wave energy',* or *'tidal energy'.* The most commonly given answer was *'wind energy'.*

(ii) This question was quite well answered. However many candidates wrote fossil fuels, whilst the question had asked for **one** fuel and they could not receive the mark. Some candidates wrote batteries.

(iii) Many candidates struggled to give an acceptable answer to this question. The requirement for conduction, that is, a *medium* or *particles* did not appear to be well understood. Some candidates said that conduction would be too slow, whilst others said that the Earth's temperature would get too high.

(c) Across the ability range, this was well answered. Some candidates gave acute as their first answer. There were also some who referred to the reflected ray, rather than the correct *'reflected angle'* or '*angle of reflection'.* In almost all cases, the numerical answer for the angle was correct.

Question 8

(a) Candidates were able to say which reaction gives off hydrogen gas, but were unable to say which reaction produces a blue solution. Only some candidates were able to say which reaction releases carbon dioxide.

(b) (i) This was well answered by the higher scoring candidates. However some other candidates gave answers above 14.

(ii) This proved a challenging question for most candidates. Many described the colour changes of an indicator, rather than the value of the pH, which would have been displayed on the screen as *pH 7.*

(iii) Many candidates chose the acid **C,** and gave as their reason that it took the largest volume.

(iv) This was quite well answered by the higher scoring candidates only.

(v) Candidates across the ability range often gave one of the correct products, *water.* Only some of the higher scoring candidates gave the other correct product, *salt.*

Question 9

(a) (i) This question proved challenging for the whole ability range. Many candidates did gain one mark, giving either *'it does not contain a nucleus'* or '*it is smaller'* or '*it contains haemoglobin'.* Candidates then gave answers which did not contain sufficient detail to be awarded the second mark, such as *'they have a different shape'*, or *'they have a different function'* or *'a different colour'*.

(ii) This was quite well answered. Across the ability range most candidates gained one mark, usually for the correct statement *'transports oxygen'.* Candidates who gained full credit then went on to explain where the oxygen was carried to.

(b) This proved a challenging question for all abilities. Some candidates gained one mark for the correct answer of either '*protects against disease'* or *'destroys invading bacteria'.* Very few candidates gave an answer referring to *phagocytosis.*

(c) Most candidates gained the mark for *adrenaline.* However, many described the nutrients as *insoluble*. Others incorrectly identified where the nutrients entered the blood as the stomach, rather than the correct place, *'small intestine'.*

COMBINED SCIENCE

Paper 0653/23

Core Theory

Key Messages

Pictures are often used as prompts to set a question within a context. However, they are not a substitute for the question. When candidates are asked to describe an experiment, prompted by a picture of the apparatus in use at some point in that experiment, they should describe the whole of the experiment and not simply limit themselves to the content of the picture.

Candidates should be encouraged to pay particular attention to words in heavy print in the question stems and also to the number of marks allotted to a question.

General Comments

There were some very good performances in this paper, with several candidates showing a good understanding of the core content of the syllabus. Candidates are reminded that they cannot receive credit for questions that they have not attempted to answer.

There was no evidence that candidates had a problem in completing the paper in the available time.

Candidates are reminded that a triangle of variables is not an equation or formula. Candidates who give a triangle of variables when asked for a formula will not gain that mark.

Comments on Specific Questions

Question 1

(a) (i) This was quite well answered across the ability range. Some candidates gave words which were similar to the correct answer, but not correct, such as *nucleon*, *nuclear*, and *nuclease*.

(ii) Many candidates gained the mark for the atom **B**. However, of these candidates, many went on to explain that the number of protons should be added to the number of electrons. Some candidates only wrote 8 + 8 = 16. This did not gain the mark, since they had not explained the origin of the numbers.

(iii) There were two marks for this question, but many candidates gave only one answer. *'The number of protons and electrons is the same'* was correct but not sufficient. Similarly, *'electrons are negative and protons are positive'* was correct but not sufficient.

(b) (i) This was quite well answered by the higher scoring candidates. However, many candidates gave *'ionic'* rather than the correct answer *'covalent'.*

(ii) This proved a challenging question. Many candidates suggested that, since helium is a noble gas, it did not need to bond. This was not sufficient.

(c) This was quite well answered. The best candidates described the relative reactivity of zinc and hydrogen as the reason for the reaction. Some candidates described at length what was happening in the picture without explaining why. Some candidates referred to the production of oxygen and that it relights the splint but made no comment about relative reactivity, as specified in the stem.

Question 2

(a) (i) This was quite well answered across the ability range. Some candidates gave an answer referring to an energy, such as gravitational potential energy. The question asks for a force.

(ii) Most candidates made a good attempt at the question; some confused the situation and wrote that kinetic energy was changed to gravitational potential energy.

(b) Almost all candidates attempted this question and many gained at least 1 mark.

(c) This was very well answered by the great majority of the candidates.

Question 3

(a) Almost all candidates attempted this question and gained at least 1 mark, most commonly for the water lily being a *producer*. Many candidates placed ticks in only one of the boxes for the other organisms, whilst there needed to be two ticks for heron and water snail.

(b) (i) **T**he most commonly seen correct answer was *'toxin'.* Many other candidates referred to *'the lack of oxygen'.* Very few referred to *'eutrophication' or 'the growth of algae'.* Most candidates wrote at length. Descriptions of the dirt and germs in the water did not gain marks.

(ii) Many candidates found this a challenging question, describing methane as '*poisonous'* or *'smelling bad'*. Other candidates incorrectly stated that methane damages the ozone layer, linking this damage to global warming. Methane is a greenhouse gas, but does not damage the ozone layer. There were also many answers stating that methane causes acid rain.

Question 4

(a) (i) Many candidates gained the mark for showing two carbon atoms bonded together. However some did not then draw the six hydrogen atoms correctly bonded. Some candidates drew two methane molecules, whilst others added an extra hydrogen atom between the carbon atoms.

(ii) Only a few of the higher scoring candidates gained the mark for '*methane'.* Most candidates gave nitrogen as their answer.

(b) (i) The question proved difficult for most, excepting the higher scoring candidates. Some omitted the word *'fractional',* whilst others described the process which was happening, without given the name of the process *'fractional distillation'.*

(ii) Many candidates found this question challenging. However, many candidates did gain one mark. Individually, both correct compounds were seen quite frequently, but the correct answer, *'water'* was often given alongside a fuel. When *'carbon dioxide'* was give, carbon monoxide was often the other answer.

(c) (i) This was found challenging across the ability range. Many answers simply described the conditions in the Earth's crust and did not gain the mark. The best answers stated that *'the compounds are much more stable'.*

(ii) Some higher scoring candidates gave very full answers to this question. Other candidates referred to *'atoms'* or '*ions'* being transferred, instead of the correct particle, *'electrons'.* Some candidates gave the incorrect charge for the ions produced.

Question 5

(a) This question required very careful reading of the data in the table and candidates across the ability range gave the incorrect answer of protein, rather than the correct *calcium.* Candidates needed to look at the units used for each row in tandem with the numbers.

(b) The correct answer here is '*water'.* Some candidates referred to the energy content and others to vitamins.

(c) This was well answered by the higher scoring candidates. Many other candidates stated that the colour showed the alkaline pH of milk.

(d) This proved a challenging question for many candidates.

(e) Any inclusion of calcium in a candidate's answer disallowed the mark.

(f) This was well answered across the ability range. Candidates, who stated that buffalo milk contains more protein and calcium, either of which was partially correct, gained only one mark. The question required that the candidate explain how these were better for a person's health. For calcium, the importance of calcium for *'healthy bones and/or teeth'* was required. For protein, the importance to *'growth and/or repair'* was required.

Question 6

(a) (i) This was quite well answered across the ability range. However some candidates missed the mark by stating that more force is required to lift the bags higher.

(ii) Most candidates knew the correct answer here, although the spelling was varied.

(iii) This was answered correctly by the higher scoring candidates.

(iv) Many candidates did not gain the first mark because they used the triangular relationship between *D*, *M* and *V*. In many cases this then lead to the incorrect manipulation of mass and volume. Others used weight rather than the correct term, *'mass',* in the formula and did not gain the mark. Of those who had produced the correct fraction, *5000/5500,* some then went on to abbreviate this to 0.90. Several answers were allowed, *0.91, 0.9, 0.90 recurring*, but 0.90 is incorrect.

(b) (i) There was a mark given for working in this question. Most candidates who gained it, gave the formula of $D = S \times T$; an indication that the area under the graph was being considered would also have earned this mark. Many candidates had problems identifying the correct value of the time *240s.*

The higher scoring candidates usually gained both marks.

(ii) This was quite well answered. Lower scoring candidates made some errors made in reading the graph and in the manipulation of the two numbers.

(iii) This was well answered by the higher scoring candidates. Some other candidates, having identified **C** as the correct boy, did not then refer to the graph in the explanation of their choice.

Question 7

(a) This was quite well answered across the ability range and particularly by the higher scoring candidates. Many answers referred to the elements by name; this was allowed. Some candidates gave CO as an element. Another incorrect answer referred to the number of atoms, 6.

(b) This proved a challenging question for most candidates. Many candidates described in detail what was shown in the diagram, but did not relate this to the observation that they were asked to explain.

(c) (i) Most candidates gained the mark for the numerical value of 7. However, despite there being two marks for the question, many did not note that this was a *decrease* in temperature.

(ii) This proved a difficult question for most candidates. Many did not give a response. Most gave exothermic.

(d) This was quite well answered by the higher scoring candidates. Many others did not give a response. Some candidates who attempted the second part of question referred to the increase in surface area but did not explain how the increased area would change the reaction rate.

Question 8

(a) The first part was well done, but many candidates gave incorrect answers such as *'bronchi'* or *'bronchials'* to the second part.

(b) (i) This a challenging question for many candidates. Most candidates gave the correct answer, *1,* for the noble gases.

(ii) This was quite well answered by the higher scoring candidates. Other candidates gave answers relating to other gases in the air, for example, nitrogen.

(iii) Candidates needed to state that the oxygen was used in the body and that carbon dioxide is a waste product. Many of the higher scoring candidates used the correct term *'respiration'.* A few candidates also explained the diffusion process successfully.

(iv) Candidates found this question very challenging. Many used the space to give an extended explanation of the previous question rather than answering the question posed.

Some of the higher scoring candidates gave very full answers, with labelled drawings of apparatus.

(c) (i) Most of those who wrote about the runner's use of more energy did not include a reference to the rate of energy used, or rate of work done and so missed the second marking point.

(ii) This question was well answered. It was not sufficient to write that the runner uses or needs more air; reference needs to be made to *'the volume of air in each breath increasing'.* Some of the higher scoring candidates made successful references to the data in the graph.

(iii) This was well answered by the higher scoring candidates generally. Other candidates referred to other aspects of the runner's body, such as sweating and being tired; the question asks how her breathing will change.

Question 9

(a) This was quite well answered.

(b) Most candidates gained the first marking point, usually for showing the correct symbols for voltmeter, ammeter and lamp.

Many candidates placed the ammeter correctly in series with the lamp, but some of these candidates did not place the voltmeter in parallel with the lamp, so did not gain the fourth marking point.

(c) This was a challenging question for most candidates. Candidates needed to state that metals *'contract when cold'.* Many answers used terms such as *'shrink'* and these were not considered sufficient.

Some of the higher scoring candidates also successfully referred to the possibility of *'cables breaking and damaging pylons'.*

COMBINED SCIENCE

Paper 0653/31
Extended Theory

Key Messages

In many cases, candidates who had clearly worked hard for the examination lost marks through simple mistakes in examination technique. Some candidates may have scored a higher mark if they had:

- avoided repeating or rephrasing the words given in the question instead of bringing new information to their explanations,
- given more explanatory detail of points that they may have thought too obvious to mention.

General Comments

Some excellent scripts were seen from candidates who had mastered all aspects of the syllabus, and who demonstrated good examination technique. There were a number of very low marks and it is probable that entry to Paper 2 may have been a better choice for these candidates. Candidates usually wrote answers of appropriate length although colleagues should continue to stress to candidates that the number of marks and the space allocated for answers is a guide to the length and detail required.

The numerical answers to most calculations require the correct physical units to be stated. In general, candidates entering this year seemed to be more aware of this than in some previous years.

Comments on specific questions

Question 1

(a) (i) Candidates had to make it clear that the nucleon number is calculated by adding the numbers of protons and neutrons. Answers such as *'nucleon number is its protons and neutrons'* are insufficiently detailed.

(ii) Many candidates had mastered the idea of the balance between negative electrons and positive protons. Answers such as '*electrons and protons cancel each other out'* contained insufficient detail to gain credit in the extended theory paper.

(b) (i) Large numbers of candidates gained credit for a correctly drawn covalent bonding diagram of a hydrogen molecule. Only a minority gained full credit for a description that was not supported by a diagram. Colleagues might wish to advise candidates that when space is left for them to draw a diagram then it is always a good idea to try to do so.

(ii) The best answers referred to the lack of reactivity and / or the filled outer shell of the helium atom; it was not sufficient for candidates simply to state that helium is a noble gas or that it occurs in Group 0. A minority of candidates suggested that helium contains eight outer electrons and so could not be credited.

(c) Candidates from across the ability range made the mistake of writing lengthy answers that did little more than describe the diagram. Credit could be gained for stating that the gas test showed hydrogen and that this is produced because zinc reacts with dilute hydrochloric acid. The question was designed to suggest to candidates that they needed to consider the reactivity series and hydrogen's position in relation to zinc and/or silver. Many simply stated that the experiment showed that zinc is more reactive than silver, for which limited credit was given.

Question 2

(a) (i) The best candidates were alert to the context of the question and realised that the required answer would be half of the total calculated distance of 320 m. Candidates generally were able to state and use the relationship *distance = speed x time*.

(ii) Substantial numbers of candidates could state the relationship *frequency = velocity / wavelength*. Many could also use the relationship correctly having realised that they needed to use the value of wave velocity given in the previous question. Candidates were less secure in giving the correct units of frequency and many suggested λ rather than Hz.

(b) (i) Candidates need to be careful that they do not give vague or unscientific answers to questions concerning the environment and renewable energy sources. Answers that did not gain credit included: '*they cause no pollution'; 'they are environmentally friendly'; 'they can be used over and over again'; 'they give infinite energy'; 'they do not have to be extracted'; 'they are much cheaper'.*

(ii) This was an unfamiliar context but there were a large number of statements candidates could make to gain credit. Candidates needed to separate the functions of the turbine and the generator; suggestions that kinetic energy would be converted to electrical in the turbine could not gain credit. Some other candidates assumed that sea water would flow through the turbine, but even if they did it was perfectly possible to gain credit for any other correct energy transfers identified.

(c) (i) This was a very straightforward question and most candidates answered it correctly. The answer, *liquid* was not allowed in this particular context.

(ii) This was a very straightforward question and most candidates gained credit. A minority incorrectly suggested *boiling*.

Question 3

(a) Most candidates showed some knowledge of the causes of acid rain. One common mistake was to suggest that acidic liquids already on the Earth's surface, evaporate, condense and fall as acidic rain. Another inaccurate wording was to refer to burning fossil fuels releasing sulfur or carbon into the air. In an extended Chemistry examination candidates must try to use correct compound names. It was also important for candidates to make it clear that the rising polluting gases react with water (in some form) in the atmosphere.

(b) Some candidates had learned the main processes occurring in eutrophication and went on to gain full credit for some well-expressed answers. There were many statements for which marks were awarded and the better answers avoided vague ideas or relevant points that were spoiled by misconceptions. For example, it was frequently suggested that the fertiliser formed the opaque surface layer rather than algal growth. Many confused ideas concerning dissolved oxygen levels were seen. Some candidates stated that the layer of algae prevented oxygen from dissolving at the surface. Others stated that large populations of water plants beneath the surface would use up oxygen during photosynthesis.

(c) Most candidates understood how to answer this question, but others did not gain full credit because their explanation simply repeated the words in the question. An example of this is '*if trees are cut down there will be less photosynthesis and so carbon dioxide levels will rise'.* The additional logical connection was required that consequently '*less carbon dioxide would be absorbed'* from the air. Candidates should be advised that simply repeating a point or information given in a question stem is unlikely to gain credit.

Question 4

(a) This was answered correctly by many candidates, but was clearly very unfamiliar to many others.

(b) Many candidates had obviously read the question carefully and used the guidance it contained to produce excellent answers that gained full marks. Some candidates gained credit for correct statements involving molecular size, intermolecular force and boiling point but then assigned these incorrectly to materials at positions **B** and **C**. This part of the Chemistry syllabus has been tested many times in recent years and the quality of candidates' answers continues to improve.

(c) (i) Candidates from across the ability range recognised that all that was required was some reference to the highly reactive nature of sodium and chlorine. A general reference to reactivity was required and so answers such as *'because they would react with each other'* did not gain credit on this occasion. Another frequent suggestion that did not gain credit was the statement that *'chlorine is a gas and so would not be present on the Earth'.*

(ii) Candidates generally do very well in questions involving bonding theory. Very many fully correct responses were seen from candidates across the total mark range.

Question 5

(a) (i) Candidates who read the table very carefully and took note of the units shown in the left-hand column, realised that the correct answer was *calcium*. Many candidates from across the ability range suggested the answer *protein*.

(ii) A very wide range of incorrect answers were suggested including *vitamins, iron and glucose*.

(iii) Many candidates gave the expected answer, *calcium*, and correctly explained its importance in maintaining healthy teeth and bones. Credit was also given to those candidates who suggested *protein,* although for full credit they had to give a specific rather than general use of protein.

(iv) Many candidates gained credit for stating calcium, but only a minority were able to explain why this does not need to be digested. They needed to refer to or imply the small size of calcium particles which means that calcium does not need to be or cannot be broken down into anything smaller before it can be absorbed. Answers such as '*calcium because it can go straight into the blood'* do not explain why direct absorption is possible. Some candidates showed that they had not learned that fats, carbohydrates and proteins need to be digested.

(b) (i) Full credit could only be given for answers that referred to the *enzyme* activity that causes lactose to convert to lactic acid. Many candidates wrote answers that would have been fully correct had they used the word *enzyme* rather than *bacteria.* Only a minority of the more-able candidates referred to enzyme activity.

(ii) Candidates were not penalised twice if they also answered this question in terms of bacteria rather than the enzymes they provide. It was not appropriate to credit answers such as *'to kill the bacteria'* since this would not occur at the temperature stated in the question.

(iii) Candidates from across the ability range correctly referred either to increased acidity or more directly to the increase in lactic acid.

Question 6

(a) (i) Many candidates were able to state either the relationship *'work = force x distance'* or *'work = weight x height'*. Full credit was given to candidates who showed that the work done by **Y** was 100 J and that done by **X** was 120 J. Only a minority of candidates gave correct numerical answers. Large numbers used the mass rather than the force (weight) in their calculations, and others overlooked that fact that worker **X** lifted three bags.

(ii) Many candidates knew that the speed of working is related to power, but simply stated that **X** used more power because they worked more quickly. Credit was gained if candidates made it clear that more power is exerted when the same amount of work is done in a shorter time or more quickly. The simplest way to gain this mark was to state the relationship *'power = work/time'*. Quite a large minority of candidates from across the ability range thought that **Y** must be using more power because they had to bear the weight of the bag for a longer time. This suggests they had not learned or understood the concept of power as it is used in Physics.

(iii) Most candidates could state and use the relationship *'density = mass / volume'*. The most common mistake was to use 5 kg rather than 5000 g in the calculation.

(b) (i) Most candidates were able to interpret the graph and gained full credit for some working or explanation together with the numerical answer of 288 m. Full credit was not given if the unit was missing or incorrectly stated, e.g. *M*.

(ii) Most candidates gave the correct answer of 240 s.

(iii) This was another question where many candidates did not gain credit because they did nothing more than repeat the information given in the question. Thus answers such as *'**C** because his speed gradually decreased'* did not score any marks. Candidates needed to refer directly to the graph for boy **C** or to make use of data taken from the graph.

Question 7

(a) Candidates generally recognised that the test-tube of limewater meant that the expected gas was carbon dioxide. In this particular context they did not need to state that the limewater would turn cloudy but most did so. The more common incorrect gases that were suggested were hydrogen and chlorine.

(b) (i) Most candidates correctly identified where the **X** should be placed on the graph.

(ii) This proved to be a very challenging question for the majority of candidates. Full credit was given to those who showed that the temperature during the reaction *decreased* by 7 °C. Many candidates made simple mistakes in reading the temperature scale and very many did not realise that the duration of the reaction was shown only by the part of the graph that was descending. Thus a very common answer was that the temperature had decreased by 3.5 °C, which gained partial credit.

(iii) This question was also challenging and full credit was given to only a minority of candidates. Large numbers of candidates described the process occurring in the reaction tube as an endothermic reaction that later became exothermic. This misconception then led to incorrect statements about the transfer of thermal to chemical energy.

(c) Usually, candidates do well in questions that ask them to deduce ionic charge. In this case the context of sodium hydrogencarbonate, $NaHCO_3$, proved too unfamiliar. Many simply did not attempt to answer and other candidates spent valuable time attempting to work out the charge on the hydrogencarbonate ion by breaking it into its constituent elements. Many gained partial credit for recognising that sodium ions have a single positive charge.

Question 8

(a) Most candidates correctly labelled the trachea. They had to be careful that their second labelling line went to a bronchus and not to a bronchiole.

(b) The large surface area of alveoli was very well known and many candidates correctly referred to thin walls. Vague answers such as '*they are one cell thick'* were not uncommon. No credit was given for *'thin membranes'*. Discussion of a good blood supply was often attempted and candidates who gained credit for this point avoided reference to both arteries and veins and correctly wrote about capillaries.

(c) Full credit was gained by those candidates who described how specific air-borne hazards such as bacteria or dust were trapped by mucus which is then swept away from the lungs by cilia. Some candidates were confused over these two essential stages in preventing invasion of the lungs. A common mistake was to state that the cilia trapped out materials with mucus taking no active part in the process.

(d) (i) The most common incorrect response was 1, 2 and 6.

(ii) Only the very best candidates scored full credit for their answers. Better answers avoided vague statements about harmful substances getting into the lungs and causing smoker's cough. A number of answers did not make any reference to smoke-related cancers and fewer named bronchitis and emphysema as possible smoking-related diseases. Many stated that damage to goblet cells would result in no mucus being produced.

Question 9

(a)(i) This was a relatively straightforward circuit to draw and full credit was only given for carefully-drawn circuits that did not contain breaks. Fully correct circuit symbols were required including both cell symbols. The correct symbol for the variable resistor was quite often omitted altogether or drawn incorrectly. Candidates were not penalised if they included a switch in the circuit.

(ii) In general, candidates were able to state and use the relationship *'resistance = voltage / current'*. As usual, credit for the formula was not given if incorrect symbols for the variables were used. The most commonly seen examples of incorrect symbols were A or C used to represent current. If there is any doubt about which symbols to use then candidates are advised to write the formula using words.

(b) The context used in this question seemed unfamiliar to large numbers of candidates. The question gave guidance to focus candidates' thoughts towards temperature effects and most of the candidates who attempted the question realised this. Partial credit was given for recognising that metals contract when the temperature decreases. Many candidates suggested that the cables needed to be slack so that they did not over-tighten when the temperature increased.

COMBINED SCIENCE

Paper 0653/32
Extended Theory

Key Messages

Candidates are reminded to read the stem of the question carefully to ensure their answers address the question asked.

When interpreting graphical information, candidates are reminded that credit is given for using numerical information from the graph to illustrate their answers.

General Comments

There were some excellent scripts from candidates who had mastered all aspects of the syllabus, and who demonstrated good examination technique. There was no evidence that candidates had difficulty in completing the paper in the required time.

The majority of candidates used the available space on the examination paper appropriately, showing good examination technique. Handwriting was readable in the majority of scripts; a few candidates needed to write more legibly so that their use of key words could be demonstrated beyond doubt.

Responses to the physics calculations generally included the correct formulae. Care should be taken to provide *either* symbols *or* words and not a combination of both when writing equations for these questions. Circuit diagrams should be carefully drawn, with no spaces between connecting wires and components.

Candidates should provide a balanced symbolic equation, not a word equation, when requested in biology and chemistry questions.

It is recommended that this report and the published mark scheme are read together.

Comments on Specific Questions

Question 1

(a) (i) This question was answered well by the higher-scoring candidates. Incorrect responses from other included explanations in terms of reactivity of the groups or electron transfer during reactions. A more careful reading of the stem of the question may have led these candidates to the answer required.

(ii) As in part **(a)(i)** this question also required careful reading of the question. The response needed a melting point trend down the respective group, and a statement of whether the melting points were higher or lower than the elements in the rest of the group. Trends of reactivity were not relevant to the question so were not given credit.

(b) (i) A few candidates correctly gave a chemical test for water along with its positive result. Candidates need to provide the complete colour change in their description, for example, '*cobalt chloride paper changes from blue to pink*'. Descriptions of electrolysis, or physical tests such as boiling point and melting point determination were not given credit.

(ii) Many candidates answered this question correctly and gained full credit. Incorrect responses included the use of PbO_2 as the formula for lead oxide instead of PbO. Careful reading of the stem would have shown candidates the correct formula, PbO.

(iii) This question was well answered by the better-scoring candidates who compared the reactivity of hydrogen with calcium to assess whether a displacement reaction was possible. Incorrect responses included the comparison of the reactivity of calcium with lead or carbon.

Question 2

(a) (i) Generally well answered. Candidates correctly gave the formula and the calculation including the correct units.

(ii) The majority of candidates obtained full credit for this question. The most common error was the failure to square the velocity.

(b) This was well answered by candidates who supplied the correct formula, calculation and units.

(c) (i) The majority of candidates correctly suggested a suitable frequency for infrasound, along with a correct explanation.

(ii) Most candidates correctly defined frequency.

(iii) Although many candidates knew that ultrasound had a higher frequency than infrasound, full credit was only given if they explained the frequency had to be above the limit of human hearing.

Question 3

(a) (i) Very few candidates correctly identified this response as geotropism. Phototropism was the most commonly given incorrect response.

(ii) Some candidates answered this question correctly and made reference to the elevated position of the flowers. General statements about better photosynthesis did not gain credit.

(b) There were some excellent responses by candidates who successfully interpreted the information on the graph. The highest scoring responses included those who took numerical information from the graph to illustrate their responses.

Question 4

(a) (i) Some candidates answered this question well. Candidates are reminded that microwaves increase the kinetic energy of the water and fat molecules causing an increase in their thermal energy. This thermal energy is then transferred to the rest of the solid food by conduction.

(ii) There were many correct responses referring to the use of microwaves for communication. Some candidates misinterpreted the question, giving other uses of a microwave oven, for example defrosting frozen food.

(b) The best candidates scored full credit on this question. Partial credit was gained for the use of the equation energy = power x time. The inclusion of the voltage in calculations was the most common error in candidates' responses.

(c) Many candidates correctly explained that the reduction of combustion of fossil fuels in power stations causes a reduction in carbon dioxide emission into the atmosphere. Some incorrect responses included the idea that light bulbs themselves give out carbon dioxide.

Question 5

(a) Many of the best candidates scored full credit for this question providing a good explanation of ionic bond formation. Candidates are reminded of the ionic bonding between a metal and non-metal. Most incorrect answers referred to descriptions of covalent bonding.

(b) (i) Most candidates correctly described the glowing splint test for oxygen.

(ii) This question was answered well by many candidates who correctly calculated the rate of hydrogen production, including the correct units.

(iii) The best candidates gave a correct description of the gain of electrons by the hydrogen ions at the cathode. Commonly seen incorrect answers included a description of hydrogen ions donating positive electrons to the cathode.

(iv) Candidates generally found this question challenging. Most candidates correctly stated that the greater current produced a larger volume of hydrogen. Fewer candidates made the connection between the fact that electric current is a flow of electrons and the use of those electrons to convert hydrogen ions to hydrogen gas at the cathode.

Question 6

(a) Many candidates produced a good description of photosynthesis. Candidates are reminded that the role of chloroplasts is to trap light energy, not just to 'help' the process of photosynthesis. An explanation that chemical energy is stored in the glucose produced during photosynthesis would have enabled some candidates to gain more credit, as this was omitted in many answers. Descriptions of the food chain and the energy changes related to the consumers in the chain were not relevant to the question and so could not gain credit.

(b) Most candidates correctly identified a cause of energy loss from the food chain.

(c) (i) Many candidates correctly stated the correct equation, therefore gaining full credit.

(ii) The main emphasis of this response was to describe the greater need for heat energy release from food by respiration to maintain body temperature. The best answers gave explanations referring to the greater loss of heat energy due to the cold climate requiring more heat energy to be released within the body. gained more credit than candidates who did not mention heat energy at all.

Question 7

(a) Many candidates obtained full credit for this question. Candidates should be aware that circuit diagrams should contain no gaps between components, and they should contain exactly those components described by the question.

(b) Both a renewable and a non-renewable energy resource were needed to gain the mark.

(c) (i) Most candidates gained full credit for this question. Candidates who did not gain full credit used incorrect symbols in the formula. Candidates are reminded not to use the equation for resistors in parallel when analysing a series circuit.

(ii) Many candidates gained full credit for this question, either by explanation or by using the equation for resistors in parallel.

Question 8

(a) Generally well answered. Some lower-scoring candidates only provided one response to each observation. Candidates are reminded that when the information in the stem specifies that more than one answer was allowed for each observation, they should bear this in mind when responding.

(b) (i) The best answers provided a description of the trends of pH change over different volumes of the added acid. A general statement about the pH decreasing was not acceptable since more detail was required.

(ii) Many candidates correctly identified the given volumes of the acids needed to produce a pH value of 7.

(iii) The best responses correctly identified acid **A** as the stronger acid because it needed a smaller volume for neutralisation compared with acid **B**. Candidates are reminded that the X-axis described the volume of acid added, and not the time of reaction. Therefore the many responses describing **A** neutralising the alkali faster than acid **B** did not gain credit.

Question 9

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

(ii) Most candidates correctly described the role of the red blood cell in carrying oxygen to the body tissues. Candidates are reminded that oxygen is picked up by the red blood cell at the lungs and then carried around the body. Only a few candidates mentioned this.

(b) Most candidates correctly identified cell **B** as being involved in defence against disease. Candidates should be aware that this cell is a phagocyte, not a lymphocyte, and therefore defends the body by phagocytosis of invading microorganisms, not by producing antibodies.

(c) (i) The best answers described the consequence of lack of oxygen for the heart muscle; many candidates correctly stated that coronary heart disease affects the coronary arteries in the heart.

(ii) Many candidates provided two correct responses to gain full credit. Candidates needed to give enough detail to make the point. The simple phrase *'eating fat'* was not awarded credit, as some fat is necessary in the diet. The phrase *'eating too much fat'* was acceptable.

COMBINED SCIENCE

Paper 0653/33
Extended Theory

Key Messages

In many cases, candidates who had clearly worked hard for the examination lost marks through simple mistakes in examination technique. Some candidates may have scored a higher mark if they had:

- avoided repeating or rephrasing the words given in the question instead of bringing new information to their explanations,
- given more explanatory detail of points that they may have thought too obvious to mention.

General Comments

Some excellent scripts were seen from candidates who had mastered all aspects of the syllabus, and who demonstrated good examination technique. There were a number of very low marks and it is probable that entry to Paper 2 may have been a better choice for these candidates. Candidates usually wrote answers of appropriate length although colleagues should continue to stress to candidates that the number of marks and the space allocated for answers is a guide to the length and detail required.

The numerical answers to most calculations require the correct physical units to be stated. In general, candidates entering this year seemed to be more aware of this than in some previous years.

Comments on specific questions

Question 1

(a) (i) Candidates had to make it clear that the nucleon number is calculated by adding the numbers of protons and neutrons. Answers such as *'nucleon number is its protons and neutrons'* are insufficiently detailed.

(ii) Many candidates had mastered the idea of the balance between negative electrons and positive protons. Answers such as '*electrons and protons cancel each other out'* contained insufficient detail to gain credit in the extended theory paper.

(b) (i) Large numbers of candidates gained credit for a correctly drawn covalent bonding diagram of a hydrogen molecule. Only a minority gained full credit for a description that was not supported by a diagram. Colleagues might wish to advise candidates that when space is left for them to draw a diagram then it is always a good idea to try to do so.

(ii) The best answers referred to the lack of reactivity and / or the filled outer shell of the helium atom; it was not sufficient for candidates simply to state that helium is a noble gas or that it occurs in Group 0. A minority of candidates suggested that helium contains eight outer electrons and so could not be credited.

(c) Candidates from across the ability range made the mistake of writing lengthy answers that did little more than describe the diagram. Credit could be gained for stating that the gas test showed hydrogen and that this is produced because zinc reacts with dilute hydrochloric acid. The question was designed to suggest to candidates that they needed to consider the reactivity series and hydrogen's position in relation to zinc and/or silver. Many simply stated that the experiment showed that zinc is more reactive than silver, for which limited credit was given.

Question 2

(a) (i) The best candidates were alert to the context of the question and realised that the required answer would be half of the total calculated distance of 320 m. Candidates generally were able to state and use the relationship *distance = speed x time*.

(ii) Substantial numbers of candidates could state the relationship *frequency = velocity / wavelength*. Many could also use the relationship correctly having realised that they needed to use the value of wave velocity given in the previous question. Candidates were less secure in giving the correct units of frequency and many suggested λ rather than Hz.

(b) (i) Candidates need to be careful that they do not give vague or unscientific answers to questions concerning the environment and renewable energy sources. Answers that did not gain credit included: '*they cause no pollution'; 'they are environmentally friendly'; 'they can be used over and over again'; 'they give infinite energy'; 'they do not have to be extracted'; 'they are much cheaper'.*

(ii) This was an unfamiliar context but there were a large number of statements candidates could make to gain credit. Candidates needed to separate the functions of the turbine and the generator; suggestions that kinetic energy would be converted to electrical in the turbine could not gain credit. Some other candidates assumed that sea water would flow through the turbine, but even if they did it was perfectly possible to gain credit for any other correct energy transfers identified.

(c) (i) This was a very straightforward question and most candidates answered it correctly. The answer, *liquid* was not allowed in this particular context.

(ii) This was a very straightforward question and most candidates gained credit. A minority incorrectly suggested *boiling*.

Question 3

(a) Most candidates showed some knowledge of the causes of acid rain. One common mistake was to suggest that acidic liquids already on the Earth's surface, evaporate, condense and fall as acidic rain. Another inaccurate wording was to refer to burning fossil fuels releasing sulfur or carbon into the air. In an extended Chemistry examination candidates must try to use correct compound names. It was also important for candidates to make it clear that the rising polluting gases react with water (in some form) in the atmosphere.

(b) Some candidates had learned the main processes occurring in eutrophication and went on to gain full credit for some well-expressed answers. There were many statements for which marks were awarded and the better answers avoided vague ideas or relevant points that were spoiled by misconceptions. For example, it was frequently suggested that the fertiliser formed the opaque surface layer rather than algal growth. Many confused ideas concerning dissolved oxygen levels were seen. Some candidates stated that the layer of algae prevented oxygen from dissolving at the surface. Others stated that large populations of water plants beneath the surface would use up oxygen during photosynthesis.

(c) Most candidates understood how to answer this question, but others did not gain full credit because their explanation simply repeated the words in the question. An example of this is '*if trees are cut down there will be less photosynthesis and so carbon dioxide levels will rise'.* The additional logical connection was required that consequently '*less carbon dioxide would be absorbed'* from the air. Candidates should be advised that simply repeating a point or information given in a question stem is unlikely to gain credit.

Question 4

(a) This was answered correctly by many candidates, but was clearly very unfamiliar to many others.

(b) Many candidates had obviously read the question carefully and used the guidance it contained to produce excellent answers that gained full marks. Some candidates gained credit for correct statements involving molecular size, intermolecular force and boiling point but then assigned these incorrectly to materials at positions **B** and **C**. This part of the Chemistry syllabus has been tested many times in recent years and the quality of candidates' answers continues to improve.

(c) (i) Candidates from across the ability range recognised that all that was required was some reference to the highly reactive nature of sodium and chlorine. A general reference to reactivity was required and so answers such as *'because they would react with each other'* did not gain credit on this occasion. Another frequent suggestion that did not gain credit was the statement that *'chlorine is a gas and so would not be present on the Earth'.*

(ii) Candidates generally do very well in questions involving bonding theory. Very many fully correct responses were seen from candidates across the total mark range.

Question 5

(a) (i) Candidates who read the table very carefully and took note of the units shown in the left-hand column, realised that the correct answer was *calcium*. Many candidates from across the ability range suggested the answer *protein*.

(ii) A very wide range of incorrect answers were suggested including *vitamins, iron and glucose*.

(iii) Many candidates gave the expected answer, *calcium*, and correctly explained its importance in maintaining healthy teeth and bones. Credit was also given to those candidates who suggested *protein,* although for full credit they had to give a specific rather than general use of protein.

(iv) Many candidates gained credit for stating calcium, but only a minority were able to explain why this does not need to be digested. They needed to refer to or imply the small size of calcium particles which means that calcium does not need to be or cannot be broken down into anything smaller before it can be absorbed. Answers such as '*calcium because it can go straight into the blood'* do not explain why direct absorption is possible. Some candidates showed that they had not learned that fats, carbohydrates and proteins need to be digested.

(b) (i) Full credit could only be given for answers that referred to the *enzyme* activity that causes lactose to convert to lactic acid. Many candidates wrote answers that would have been fully correct had they used the word *enzyme* rather than *bacteria.* Only a minority of the more-able candidates referred to enzyme activity.

(ii) Candidates were not penalised twice if they also answered this question in terms of bacteria rather than the enzymes they provide. It was not appropriate to credit answers such as *'to kill the bacteria'* since this would not occur at the temperature stated in the question.

(iii) Candidates from across the ability range correctly referred either to increased acidity or more directly to the increase in lactic acid.

Question 6

(a) (i) Many candidates were able to state either the relationship *'work = force x distance'* or *'work = weight x height'*. Full credit was given to candidates who showed that the work done by **Y** was 100 J and that done by **X** was 120 J. Only a minority of candidates gave correct numerical answers. Large numbers used the mass rather than the force (weight) in their calculations, and others overlooked that fact that worker **X** lifted three bags.

(ii) Many candidates knew that the speed of working is related to power, but simply stated that **X** used more power because they worked more quickly. Credit was gained if candidates made it clear that more power is exerted when the same amount of work is done in a shorter time or more quickly. The simplest way to gain this mark was to state the relationship *'power = work/time'*. Quite a large minority of candidates from across the ability range thought that **Y** must be using more power because they had to bear the weight of the bag for a longer time. This suggests they had not learned or understood the concept of power as it is used in Physics.

(iii) Most candidates could state and use the relationship *'density = mass / volume'*. The most common mistake was to use 5 kg rather than 5000 g in the calculation.

(b) (i) Most candidates were able to interpret the graph and gained full credit for some working or explanation together with the numerical answer of 288 m. Full credit was not given if the unit was missing or incorrectly stated, e.g. *M*.

(ii) Most candidates gave the correct answer of 240 s.

(iii) This was another question where many candidates did not gain credit because they did nothing more than repeat the information given in the question. Thus answers such as *'**C** because his speed gradually decreased'* did not score any marks. Candidates needed to refer directly to the graph for boy **C** or to make use of data taken from the graph.

Question 7

(a) Candidates generally recognised that the test-tube of limewater meant that the expected gas was carbon dioxide. In this particular context they did not need to state that the limewater would turn cloudy but most did so. The more common incorrect gases that were suggested were hydrogen and chlorine.

(b) (i) Most candidates correctly identified where the **X** should be placed on the graph.

(ii) This proved to be a very challenging question for the majority of candidates. Full credit was given to those who showed that the temperature during the reaction *decreased* by 7 °C. Many candidates made simple mistakes in reading the temperature scale and very many did not realise that the duration of the reaction was shown only by the part of the graph that was descending. Thus a very common answer was that the temperature had decreased by 3.5 °C, which gained partial credit.

(iii) This question was also challenging and full credit was given to only a minority of candidates. Large numbers of candidates described the process occurring in the reaction tube as an endothermic reaction that later became exothermic. This misconception then led to incorrect statements about the transfer of thermal to chemical energy.

(c) Usually, candidates do well in questions that ask them to deduce ionic charge. In this case the context of sodium hydrogencarbonate, $NaHCO_3$, proved too unfamiliar. Many simply did not attempt to answer and other candidates spent valuable time attempting to work out the charge on the hydrogencarbonate ion by breaking it into its constituent elements. Many gained partial credit for recognising that sodium ions have a single positive charge.

Question 8

(a) Most candidates correctly labelled the trachea. They had to be careful that their second labelling line went to a bronchus and not to a bronchiole.

(b) The large surface area of alveoli was very well known and many candidates correctly referred to thin walls. Vague answers such as '*they are one cell thick'* were not uncommon. No credit was given for *'thin membranes'*. Discussion of a good blood supply was often attempted and candidates who gained credit for this point avoided reference to both arteries and veins and correctly wrote about capillaries.

(c) Full credit was gained by those candidates who described how specific air-borne hazards such as bacteria or dust were trapped by mucus which is then swept away from the lungs by cilia. Some candidates were confused over these two essential stages in preventing invasion of the lungs. A common mistake was to state that the cilia trapped out materials with mucus taking no active part in the process.

(d) (i) The most common incorrect response was 1, 2 and 6.

(ii) Only the very best candidates scored full credit for their answers. Better answers avoided vague statements about harmful substances getting into the lungs and causing smoker's cough. A number of answers did not make any reference to smoke-related cancers and fewer named bronchitis and emphysema as possible smoking-related diseases. Many stated that damage to goblet cells would result in no mucus being produced.

Question 9

(a)(i) This was a relatively straightforward circuit to draw and full credit was only given for carefully-drawn circuits that did not contain breaks. Fully correct circuit symbols were required including both cell symbols. The correct symbol for the variable resistor was quite often omitted altogether or drawn incorrectly. Candidates were not penalised if they included a switch in the circuit.

(ii) In general, candidates were able to state and use the relationship *'resistance = voltage / current'*. As usual, credit for the formula was not given if incorrect symbols for the variables were used. The most commonly seen examples of incorrect symbols were A or C used to represent current. If there is any doubt about which symbols to use then candidates are advised to write the formula using words.

(b) The context used in this question seemed unfamiliar to large numbers of candidates. The question gave guidance to focus candidates' thoughts towards temperature effects and most of the candidates who attempted the question realised this. Partial credit was given for recognising that metals contract when the temperature decreases. Many candidates suggested that the cables needed to be slack so that they did not over-tighten when the temperature increased.

COMBINED SCIENCE

Paper 0653/04

Coursework

(a) Nature of tasks set by Centres.

Several Centres submitted coursework for the June examination. Some have provided coursework in previous years.

In most Centres all the tasks set were appropriate to the requirements of the syllabus and the competence of the candidates. The standard of candidates work was comparable with previous years with candidates covering the whole mark range.

(b) Teacher's application of assessment criteria.

In all Centres the assessment criteria were understood and applied well for all of their activities. No Centre tried to assess both skills C1 and C4 in the same investigation.

(c) Recording of marks and teacher's annotation.

Centres are being encouraged to annotate candidates' scripts with the levels at the point where they are awarded. There is room for improvement here. Many Centres made a brief note at the end to justify mark given.

(d) Good practice.

Some Centres were well organised, producing a folder with information given to candidate and marking criteria specific to the skills being assessed.

COMBINED SCIENCE

Paper 0653/51

Practical Test

Key message

- When plotting graphs, it is important to use as much of the grid as possible while still avoiding awkward scales, as these introduce errors when gradients and intercepts are required.

General comments

Candidates were able to complete this paper in the time available and generally the exercises were carried out well. The amount of information provided by Supervisors varied enormously. Centres are reminded that it is important that Supervisors record results for all questions so that candidates are not disadvantaged.

Comments on specific questions

Question 1

Most candidates were able to make a suitably large and neat pencil drawing of the flower but not all could label the stamen and carpel correctly and male and female labels were sometimes confused. In some cases, poor answers to part **(a) (iii)** were the result of a bad cut. In others, poor answers were due to poor labelling and many candidates wrongly assumed the question was looking for xylem and phloem.

The drawings for part **(b)** were usually satisfactory but fewer candidates than expected scored the mark for part **(b) (iii)** because they did not realise that the colours in the Benedict's test can vary and therefore did not appreciate that yellow could indicate sugars.

Question 2

Most candidates performed well in obtaining a set of results. Although calculating values of 1/x proved to be a simple task, the main error was incorrect rounding. The ability to round numbers correctly is an essential skill.

Graphs were usually plotted adequately, although some candidates made it more difficult by choosing awkward scales. Many candidates lost marks by not showing on the graph how the gradient was calculated. Some candidates counted squares to calculate the gradient rather than using the scales on the axes. The instruction in part **(c)** to record the mass to two significant figures was often missed.

Question 3

This experiment produced consistent results which were analysed suitably. A common error was not recording times to the nearest second.

There was often inconsistent rounding of the 1/t values. The mark scheme was generous in allowing only two decimal places for 1/t values, as those candidates who used two decimal places found the graph much easier to plot. The graphs were well plotted but a significant number of candidates did not understand the term *origin*.

The most common answer to part **(c)** was *'the rate increases as **A** increases'*; very few candidates used the word *proportional*. The question asks how the *rate of reaction* depends on the volume of reactant **A** used, so answers in terms of time were not accepted.

COMBINED SCIENCE

Paper 0653/52

Practical Test

Key message

- When plotting graphs, it is important to use as much of the grid as possible while still avoiding awkward scales, as these introduce errors when gradients and intercepts are required.

General comments

Candidates were able to complete this paper in the time available and generally the exercises were carried out well. The amount of information provided by Supervisors varied enormously. Centres are reminded that it is important that Supervisors record results for all questions so that candidates are not disadvantaged.

Comments on specific questions

Question 1

Careful preparation of the samples for **Question 1** was essential and this was done in the majority of cases. The experiment worked well for the candidates that followed instructions. Many candidates gained full credit in part **(a)**, the most frequent omission being the veins on the leaves. A small number of candidates drew with a pen rather than pencil. Although it was usually clear where the strips of black paper had been, the labelling of diagrams was sometimes poor or non-existent. Answers to part **(b)** and **(c)** were generally satisfactory. Responses to part **(d)** were good but some were derived from theoretical knowledge rather than the results of the experiment.

Question 2

In parts **(a)** and **(b),** instructions were given regarding the level of accuracy required. Many candidates missed the instruction to record their times to the nearest second; some others missed the instruction to record values of T^2 to 2 decimal places. A significant number of candidates did not derive the period T from the time for 20 oscillations, possibly thinking they had to time one swing.

Graph plotting was generally good although some candidates made it more difficult by choosing awkward scales. Many candidates did not show on the graph how the gradient was calculated. It is good practice to do this as it is easier to double check values.

Question 3

Many candidates lost marks through the use of imprecise language. *'Milky'* and *'cloudy'* are not acceptable alternatives for *'precipitate'*; *'clear'* does not have the same meaning as *'colourless'*. For example, copper sulfate solution is blue and clear whereas hydrochloric acid is colourless and clear. In this experiment, *'no change'* was not the same as *'no reaction'*, because, in part **(a) (iii),** the addition of copper sulfate solution to **C** changed a colourless solution to a blue solution by mixing; although there was no reaction there *was* a change in colour.

Generally, observations were well presented in the grid and the experiment gave the expected results. When credit was not awarded, it was usually for the reasons mentioned above. A small number of candidates could not differentiate between **A** and **B** with copper sulfate, perhaps because they added too much copper sulfate.

In parts **(b) (ii)** to **(iv)**, a variety of explanations were allowed; a significant number did not gain credit due to incorrect or vague references to the reactions.

COMBINED SCIENCE

Paper 0653/53

Practical Test

Key message

- When plotting graphs, it is important to use as much of the grid as possible while still avoiding awkward scales, as these introduce errors when gradients and intercepts are required.

General comments

Candidates were able to complete this paper in the time available and generally the exercises were carried out well. The amount of information provided by Supervisors varied enormously. Centres are reminded that it is important that Supervisors record results for all questions so that candidates are not disadvantaged.

Comments on specific questions

Question 1

Most candidates were able to make a suitably large and neat pencil drawing of the flower but not all could label the stamen and carpel correctly and male and female labels were sometimes confused. In some cases, poor answers to part **(a) (iii)** were the result of a bad cut. In others, poor answers were due to poor labelling and many candidates wrongly assumed the question was looking for xylem and phloem.

The drawings for part **(b)** were usually satisfactory but fewer candidates than expected scored the mark for part **(b) (iii)** because they did not realise that the colours in the Benedict's test can vary and therefore did not appreciate that yellow could indicate sugars.

Question 2

Most candidates performed well in obtaining a set of results. Although calculating values of 1/x proved to be a simple task, the main error was incorrect rounding. The ability to round numbers correctly is an essential skill.

Graphs were usually plotted adequately, although some candidates made it more difficult by choosing awkward scales. Many candidates lost marks by not showing on the graph how the gradient was calculated. Some candidates counted squares to calculate the gradient rather than using the scales on the axes. The instruction in part **(c)** to record the mass to two significant figures was often missed.

Question 3

This experiment produced consistent results which were analysed suitably. A common error was not recording times to the nearest second.

There was often inconsistent rounding of the 1/t values. The mark scheme was generous in allowing only two decimal places for 1/t values, as those candidates who used two decimal places found the graph much easier to plot. The graphs were well plotted but a significant number of candidates did not understand the term *origin*.

The most common answer to part **(c)** was *'the rate increases as **A** increases'*; very few candidates used the word *proportional*. The question asks how the *rate of reaction* depends on the volume of reactant **A** used, so answers in terms of time were not accepted.

COMBINED SCIENCE

Paper 0653/61

Alternative to Practical

Key Message

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper, to have used standard laboratory apparatus and be able to read the values from measuring cylinders, thermometers stopwatches etc.

General comments

Candidates from many Centres demonstrated their practical knowledge and techniques; others showed a poorer appreciation of the principles and practice of practical science, especially in **Questions 2** and **5**.

Other general points include the drawing of graphs. These are usually drawn very well but candidates should ensure that they use up as much of the grid provided as possible without using awkward scales.

A further general point is the use of significant figures or decimal places in calculations. Often, the number of significant figures required is specified in the question; at other times, when completing a table for instance the candidate should follow the precedent set in the values already there. Sometimes a candidate may have to choose the appropriate value themselves. Figures quoted to the nine or ten decimal places shown on a calculator indicate a lack of uncertainty far greater than most school experiments can justify. Another problem that some candidates have is rounding. An answer of 56.7777… for instance should be recorded as 57, 56.8 or 56.78 and never 56 or 56.7.

Comments on specific questions

Question 1

This question investigated the role of sugar in the pollination of a flower.

(a) Most drawings seen were satisfactory, although some candidates needed to make a better use of the space available.

(b) Some weaker candidates suggested that the reagent to be used was iodine but most knew that Benedict's solution or reagent had to be added to the petal. Few candidates stated that heat was required.

Most candidates were aware that the function of the petals is to attract pollinators, but were unable to interpret the results of the Benedict's test and how the results helped this function. The petal turned red at the very base of the petal, after the test, showing that sugar (nectar) is present there. This means that the insect, attracted by the sugar will burrow its way to the base of the petal, following the guide lines, with the pollen subsequently adhering to its body.

Question 2

(a) The labels on the components in the photographs were covered and the connecting wires deliberately coiled in order that candidates considered the photograph carefully before drawing a circuit diagram. Weaker candidates often drew the apparatus rather than use the correct circuit diagram symbols; most candidates connected the pieces by straight lines, removing the coils.

As there is no symbol for an orange, candidates came up with their own symbol, or drew an orange or a cell. All of these responses gained credit. Most candidates gave *'the lamp lights'* and a reading on one or both meters as an observation.

The reading of the diagrams of the scales of the voltmeters gave some candidates problems. A few gave 1.525 V for the second reading, although the scale cannot be read to this accuracy, a value of 1.52 V or 1.53 V was expected.

(b) Candidates had to draw up a table recording the results given in the text. Many candidates found this challenging. Colleagues are reminded that candidates should be given the opportunity to design tables for recording the results of practical work during the course.

(c) Some candidates tried to place two metals at each position while others had copper as more reactive than magnesium.

Question 3

This question was about an investigation to see how the concentration affects the rate of reaction.

(a) An experiment was outlined and the candidate asked to read two stop clocks and record the values to the nearest second in a table. Despite this instruction a number of candidates wrote 17.3 and 1.05.

(b) Candidates were expected to follow the pattern in the table and record their values to three decimal places.

The grid size given for the graph was selected so that a correctly chosen scale would use the entire grid. Candidates should be reminded that they need to select non-awkward scales to fill as much of the grid as possible.

(c) Many candidates correctly stated that the rate of reaction increases as the volume of potassium iodate increases. Candidates that gave answers in terms of time were unable to be awarded credit as they were not answering the question asked.

Candidates were then asked for an observation that showed iodine was formed when potassium iodate was reduced; candidates were expected to realise that the observation that the iodine solution turns a blue-black colour could be found in the experimental details given at the start of the question.

Finally, candidates had to explain why different volumes of water were used in each experiment. Candidates whose answer was either *'to keep the volume of liquid constant'* or *'to vary the concentration'* gained credit.

Question 4

A study of pectinase and its role in producing fruit juice was investigated in this question.

(a) Most candidates correctly read the volumes of fruit juice depicted.

The best candidates labelled the axes with units; candidates should be reminded that almost all graphs require labelled axes with units. The optimum pH value was 5 (or where the candidate's maximum was drawn). Many candidates realised that this value could only be an estimate as no values of the pH were tested between pH 5 and pH 6. Vague answers such as *'has not tried all pHs'* or *'has only tested between 3 and 7'* did not give sufficient detail to be awarded credit.

(b) The best candidates described a control experiment that would prove that the enzyme was responsible for the production of fruit juice as one with all factors the same but using water instead of the pectinase or leaving out the enzyme.

(c) The candidate was asked to suggest a different method to increasing the rate of reaction, explaining why it would work. As the enzyme is a biological catalyst, candidates who suggested '*a catalyst*' could not gain credit; this is not another method. Candidates were expected to give one of three answers: increasing temperature (as the frequency of collisions increases), increasing concentration (collisions again) or to make the pieces of apple smaller to increase the surface area. Candidates should be reminded to give an explanation when asked as a few candidates simply suggested that the 'temperature could be changed'; these were unable to be awarded credit as a change in temperature could mean cooling or heating.

Question 5

In this question candidates were asked to draw the apparatus for four experiments. It was expected that the pieces were joined up and arranged as they would be in use. Diagrams needed to be reasonably accurate and labelled. Some candidates produced well thought-out diagrams and scored highly. A number of candidates drew impossible apparatus. Colleagues are reminded that candidates should be made familiar with common laboratory apparatus through practical work during their lessons.

(a) Both a filter funnel and filter paper were required here, along with a receiving vessel.

(b) A piece of filter paper suspended in a solvent was required. In this case 'before' and 'after' drawings were acceptable.

(c) The collection of gas must be by gas syringe as the gas, ammonia, is highly soluble in water.

(d) A simple distillation was all that was required but the many candidates who drew a fractionating column and a condenser also gained credit.

(e) A written description of fractional distillation was required in the final part.

Question 6

In this question candidates were finding the value of an unknown mass by balancing it against a range of known masses.

(a) The best candidates used the information given in the instructions and diagrams on how the unknown *x* is measured. Candidates who gave answers of 77.9 and 75.5 were not creditworthy. These figures are far from the others in the table, and candidates should be reminded that if their answers look 'odd', they should check their work to ensure that they are following instructions correctly.

Candidates were then required to calculate the reciprocal of *x* for each value and record the answers to three decimal places. A number of candidates did not follow this instruction and were not awarded full credit.

(b) The axes for this graph were already labelled; most candidates had little problem plotting the graph and drawing the best straight line. Those candidates that had entered incorrect values into the table were unable to draw a straight line and, in some cases, needed to extend the graph to include values off the grid. Where axes are given, candidates whose answers 'do not fit' should check that they have not made a mistake in their answers.

Many candidates showed how to calculate a gradient, with a 'triangle' below the line; others were simply using small dots on the line. The instruction states that candidates should show *clearly* how the gradient is calculated.

(c) The mass was generally correctly calculated by candidates who had worked out the gradient.

(d) The answer *'It's difficult to measure'* was insufficient to gain credit; it does not add extra information to that given in the question stem.

COMBINED SCIENCE

Paper 0653/62

Alternative to Practical

Key Message

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper, to have used standard laboratory apparatus and be able to read the values from measuring cylinders, thermometers stopwatches etc.

General comments

Candidates from many Centres demonstrated their practical knowledge and techniques; others showed a poorer appreciation of the principles and practice of practical science, especially in **Questions 3** and **6**.

Other general points include the drawing of graphs. These are usually drawn very well but candidates should ensure that they use up as much of the grid provided as possible without using awkward scales.

Another general point is the use of significant figures or decimal places in calculations. Often, the number of significant figures required is specified in the question; at other times, when completing a table, for instance, the candidate should follow the precedent set in the values already there. Sometimes a candidate may have to choose the appropriate value themselves. Figures quoted to the nine or ten decimal places shown on a calculator indicate a lack of uncertainty far greater than most school experiments can justify. Another problem that some candidates have is rounding, an answer of 56.7777… for instance should be recorded as 57, 56.8 or 56.78 and never 56 or 56.7.

Comments on specific questions

Question 1

This question investigated photosynthesis.

(a) The first part of the question required candidates to label the different areas on Fig. 1.2 to show the colours expected after each leaf was tested with iodine. This was often missed by candidates. Correct labelling was all brown for leaf **A** and a brown band in the middle of a black leaf for **B**.

(b) The leaf was placed in hot water to kill or soften it. The alcohol removes the chlorophyll, not the chloroplasts, so the colour of the iodine can be seen clearly.

(c) It is suggested that the black paper may have prevented gas exchange as well as blocking light, therefore photosynthesis was not taking place because of a lack of carbon dioxide. This suggestion could have been tested by covering the other parts of the leaf with a transparent material, thus allowing light to get to the leaf, but having the same effect on gas exchange as the black paper. A second modification of using different leaves on the same plant would remove the variable of having different plants which may have different photosynthesis rates etc. Few candidates appreciated this.

(d) Unfortunately, many answers involved killing a leaf, by boiling it then removing the chlorophyll with alcohol and then comparing it with a growing leaf. An answer using a variegated leaf was expected. This could be named or described.

Question 2

In this experiment a candidate is investigating the period of a simple pendulum.

(a) After reading two stopwatches candidates had to record the values then calculate the time of a single swing (by dividing by 20) and then squaring the answer. Most managed this with few problems.

(b) The axes for this graph were already labelled; most candidates had little problem plotting the graph and drawing the best straight line. Those candidates that had entered incorrect values into the table could not draw a straight line and, in some cases, needed to extend the graph to include values off the grid. Where axes are given, candidates whose answers 'do not fit' should check that they have not made a mistake in their answers.

Many candidates showed how to calculate a gradient, with a 'triangle' below the line; others simply used small dots on the line. The instruction states that candidates should show *clearly* how the gradient is calculated.

Reading the intersect on the vertical axis proved difficult for some candidates, who gave 2.5 instead of 2.05.

Question 3

This question tested the candidates' knowledge of chemical qualitative tests.

(a) Candidates need to know that the Universal Indicator turns purple in alkaline solutions and red or pink in acids.

(b) Candidates need to know that when silver nitrate solution is added to dilute hydrochloric acid (a chloride) a white precipitate forms.

(c) When barium chloride solution is added to dilute hydrochloric acid nothing happens. Candidates were instructed to answer 'no change'.

(d) Candidates need to know that when copper sulfate solution is added to aqueous sodium hydroxide a blue precipitate is formed. When aqueous ammonia is used the blue precipitate will dissolve in excess producing a dark blue solution.

(e) Candidates need to know that hydrogen is evolved when magnesium is added to acid but there is no reaction when magnesium is added to alkali.

Question 4

A study of osmosis in dandelion stalks.

(a) Values of 10 mm and -11 mm should have been entered in the table, fitting in to the established trend. A smooth curve was produced on the graph when the correct points were plotted. The few candidates that had made mistakes in the measuring found that far from a smooth curve was produced, with lines going up and down like a rollercoaster.

Candidates were then asked to measure the curvature of the stalk before immersion in any solution. Many measured correctly, giving 6 mm as their answer; wrong answers varied from 0 mm to 12 mm.

(b) This was answered very well by a number of candidates. Many weaker candidates thought that sucrose entered the cells.

Question 5

This question looks at electrolysis and copper plating.

(a) Candidates were given a list of electrical components and asked to draw a circuit diagram. A number of candidates did not know the correct symbols for the components indicated, or what was meant by *'a circuit diagram'*.

Most candidates were able to read the balance windows and plot the graph accurately. Candidates were then asked to continue the line to the horizontal axis and find the time at this point. Some candidates did not extend their lines or continued them to an intersect off the grid; these candidates were unable to gain credit.

(b) Only the best candidates knew that the colour of the copper chloride solution changes due to copper ions being removed from the solution.

(c) Candidates had to explain why aqueous copper chloride conducted electricity but solid copper chloride does not. Many candidates gave answers in terms of moving electrons. The better candidates realised that the current was due to the movement of the charge on the ions.

Question 6

This question looked at various aspects of gases.

(a) The candidate was supplied with a number of words and phrases and asked to construct a table showing the gas with its test and the positive result that identifies it. Many candidates found this challenging. The construction of tables was poor and a number of candidates were unable to connect the tests with the correct gas. Colleagues are reminded that candidates should be given opportunity to design and construct tables during practical exercises.

(b) This was generally answered well. Some candidates named sodium hydroxide as the acid and the carbonate was often left blank.

(c) The candidate had to draw the apparatus required to react an acid and carbonate together to produce and measure the carbon dioxide evolved. It was expected that the pieces were joined up and arranged as they would be in use. Diagrams needed to be reasonably accurate and labelled. Some candidates produced good well thought-out diagrams. A number of other candidates drew impossible apparatus. Colleagues are reminded that candidates should be made familiar with common laboratory apparatus through practical work during their lessons.

(d) Finally, candidates had to name a metal that reacts with an acid to produce hydrogen safely. Most candidates chose magnesium or zinc; a few candidates named sodium or potassium, ignoring the description *'safely'*.

COMBINED SCIENCE

Paper 0653/63
Alternative to Practical

Key Message

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper, to have used standard laboratory apparatus and be able to read the values from measuring cylinders, thermometers stopwatches etc.

General comments

Candidates from many Centres demonstrated their practical knowledge and techniques; others showed a poorer appreciation of the principles and practice of practical science, especially in **Question 6**.

Other general points include the drawing of graphs. These are usually drawn very well but candidates should ensure that they use up as much of the grid provided as possible without using awkward scales.

Another general point is the use of significant figures or decimal places in calculations. Often, the number of significant figures required is specified in the question; at other times, when completing a table, for instance, the candidate should follow the precedent set in the values already there. Sometimes a candidate may have to choose the appropriate value themselves. Figures quoted to the nine or ten decimal places shown on a calculator indicate a lack of uncertainty far greater than most school experiments can justify. Another problem that some candidates have is rounding, an answer of 56.7777… for instance should be recorded as 57, 56.8 or 56.78 and never 56 or 56.7.

Comments on specific questions

Question 1

This question investigated the effect of temperature on the rate of yeast respiration.

(a) Most candidates followed the instruction to give the answer to the nearest whole number.

(b) A grid was provided for candidates to plot a graph of the average number of bubbles per minute against temperature. Candidates were told to join the points with straight lines (as you cannot have a fraction of a bubble). Some candidates used only a fraction of the grid. The size of grid provided is chosen so that candidates, choosing the most appropriate non-awkward scale, can use the maximum area for a clear large graph.

(c) Most candidates realised that this is due to the molecules having more energy at 40 °C or that the rate of collisions between particles had increased. Most were also aware that at 80 °C the enzyme would be denatured or the yeast killed.

(d) The candidate then had to explain the reasons behind three experimental details. The majority of candidates explained the first two points well. Some candidates gave confused answers to the final experimental point, missing the fact that the yeast would be killed and so unable to be used again.

(e) Many candidates suggested using limewater as a test for carbon dioxide.

(f) Some candidates appeared to misunderstand what is meant by ‘a control experiment’. The best candidates explained that the experiment should be repeated without yeast or with dead yeast.

Question 2

In this question a candidate is investigating a converging lens.

(a) Candidates had to measure the focal length of the lens with a ruler. Some answers suggested that those candidates did not have a ruler.

(b) This diagram was a scaled down drawing so candidates had to multiply their measurements by ten before filling in the table. Candidates should have noted that other values given in the table were given to one decimal place and therefore the answer 24.0 was required. Some candidates had difficulty in calculating the other required figures in the table. Error carried forward was applied if the candidate had only made one error.

(c) The axes for this graph were already labelled; most candidates had little problem plotting the graph and drawing the best straight line. Those candidates that had entered incorrect values into the table could not draw a straight line and, in some cases, needed to extend the graph to include values off the grid. Where axes are given, candidates whose answers 'do not fit' should check that they have not made a mistake in their answers.

Many candidates showed how to calculate a gradient, with a 'triangle' below the line; others were simply using small dots on the line. The instruction states that candidates should show *clearly* how the gradient is calculated.

(d) Candidates who had calculated an incorrect gradient could not give the expected answer of *'half life-size'*. They gained credit, however, if they managed to calculate a relationship between their incorrect gradient and the diagram length.

Question 3

This question was about an investigation to see how the rate of reaction between magnesium and an acid is affected by the surface area of the solid.

(a) Most candidates followed the instructions and entered correct values into the table. A few candidates did not subtract the ten seconds.

(b) Most candidates noted that the greater the length of the magnesium strip, the faster the reaction and the greater the surface area the faster the reaction. Unfortunately, many candidates made calculation errors and were unable to gain any credit for the calculation in part **(i)**. Few candidates noticed that if you compare the times for 1 cm and 2 cm the teacher's statement is true, but if the times for 2 cm and 4 cm are compared the statement is false.

(c) There were many varied and valid suggestions as to why the candidate waited ten seconds before adding the acid, including the difficulty of adding the acid and starting the clock at the same time.

(d) Most knew the test for hydrogen.

Question 4

A study of pectinase and its role in producing fruit juice was investigated in this question.

(a) Candidates were expected to notice that, after incubation, tubes **1** and **2** had become lighter or less cloudy with a bigger effect in tube **3**, due to the increased temperature increasing the rate of reaction.

(b) The test for starch was reasonably well known and many candidates were able to name an appropriate enzyme to break it down. Candidates were less comfortable with ideas to modify the experiment to produce clear fruit juice. Examiners were expecting descriptions that included some experimental detail, for example, '*a tube is set up with both pectinase and <named> enzyme along with the apple paste and incubated at a set temperature e.g. 40 °C*'. Credit was awarded for those candidates who gave some idea of control or stating the volumes involved. Candidates are reminded that the number of marks awarded for an answer is often a guide to the amount of detail expected.

Question 5

This question looked at acceleration in a test run of a motor car.

(a) Candidates were shown a test track and two diagrams showing the position of a car after 5 and 7 seconds. By studying the scales, most candidates were able to correctly fill the table.

Most candidates were able to use the results to plot a graph with a smooth curve to show that the car was accelerating. Many candidates found it more challenging to correctly calculate the average speed of the car.

(b) Run **C** shows the car coming to a stop at **X** as the distance does not change over time; this could have been caused by a crash or some mechanical failure. Many candidates thought that the flat line meant that the car was now travelling at a constant speed.

Question 6

In this question candidates had to construct a table of anions and then 'make' some copper sulfate crystals.

(a) The candidate was supplied with a number of words and phrases and asked to construct a table showing the anions with their tests and the positive result that identifies them. The best candidates ignored the 'dummy' phrases included in the diagrams and presented well-constructed tables. Many candidates found this exercise challenging, with poorly constructed tables that did not connect the tests with the correct anion. Colleagues are reminded that candidates should be given opportunity to design and construct tables during practical exercises.

(b) The question states that a candidate is preparing a solution of copper sulfate from sulfuric acid and powdered copper oxide. The question then asks how the solution is prepared using these chemicals. Many candidates ignored the information given in the stem and started with copper sulfate that was either reacted in some way or simply dissolved in water. The term evaporation and the colour blue were reasonably well known.

(c) When asked to name the group of chemicals to which the compounds copper sulfate, barium chloride and silver nitrate belong, few candidates gave the name 'salts'.