

CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice

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

General Comments: Biology

Candidates generally performed well on the biology questions.

Comments on Specific Questions: Biology

Question 1

A significant number of candidates confused the terms respiration and breathing. Candidates should be reminded that respiration is the process in which energy is obtained from food.

Question 6

Only the most able candidates chose vasodilation – the result of muscular relaxation, a totally passive process. Many candidates incorrectly chose option **A**, which as an active process requires energy.

Question 7

Only the most able candidates knew the difference between the pulmonary artery and the pulmonary vein.

Question 8

Many candidates incorrectly chose option **B**, revealing a misunderstanding of the function of adrenaline. While it is correct that the blood would be pumped faster; and oxygen would be delivered faster to the respiratory surface, the *level* of oxygen in the blood remains similar. What does significantly increase is the concentration of blood sugar (as glucose is released from the converted glycogen in the liver).

Question 11

Candidates should be able to name and identify the parts of a flower.

Question 13

This proved to be the easiest of the biology questions, with the vast majority of the candidates selecting the correct answer.

General Comments: Chemistry

Questions 14, 19, 20, 22, 27 and 28 were the easiest for the candidates.

Comments on Specific Questions: Chemistry

Question 14

The use of chromatography in the separation of coloured compounds is specified and is generally well known.

Question 16

Some candidates would benefit from additional guidance for the deduction of formulae from information given.

Question 17

This question showed evidence of guessing, with similar numbers of candidates incorrectly choosing an incorrect option as those who chose the key **C**. Candidates had either confused the tests for oxygen and hydrogen gases, or, had confused the electrodes that oxygen and hydrogen are produced at.

Question 20

A tiny minority of candidates were confused over the effects of larger and smaller surface areas on the rate of reaction.

Question 23

A small number of candidates incorrectly thought that metallic oxides are acidic, rather than basic.

Question 24

While most candidates knew that potassium is more reactive than sodium, a significant minority were too unfamiliar with bromine or its position within Group VII to understand its reactivity in comparison to chlorine.

Question 25

Similar numbers of candidates incorrectly chose option **D** as those who chose the key **C**. Candidates knew the common names for calcium carbonate and calcium oxide, but were confused in their recollection of what lime is used to neutralise.

Question 27

This was an easy question for the majority of candidates.

General Comments: Physics

Candidates performed very well on **Questions 28** and **29**, but had difficulty with **Questions 30** and **37**.

Comments on Specific Questions: Physics

Question 29

Only a tiny minority of candidates divided the mass by the area of the base, instead of by the volume.

Question 30

This question concerned energy resources and whether they originally derived from the Sun's energy. Many candidates were unable to identify the **error** in the table as option **B** (hydroelectric energy), most choosing option **C** or **D** instead. Candidates should be made aware of the link between the water cycle and hydroelectric energy.

Question 33

Only a significant minority of candidates incorrectly chose option **B**, appearing to believe that convection would transfer thermal energy downwards to the toast.

Question 34

This question required recall of the measurement representing the amplitude of a wave. Although a large majority of candidates could do this, a significant proportion of them used the 'peak to trough' value instead.

Question 35

A significant minority of candidates incorrectly chose option **A**. These candidates apparently were unaware that dispersion begins at the first air/glass boundary.

Question 36

Many candidates forgot to halve the time taken for the sound to return to the source when calculating the distance to the building.

Question 37

There was evidence of widespread guessing in this question on a test for a magnet; only if repulsion occurs must both the objects be magnets.

Question 38

Candidates are reminded that two different resistors in series across the same voltage (power) supply will divide that voltage up unequally. The potential drop across each resistor can be calculated from $V = IR$.

Question 39

Candidates should be aware that when **both** the current direction and the magnetic field direction are reversed, the direction of the force remains unchanged.

CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice

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

General Comments: Biology

Candidates generally performed well on the biology questions.

Comments on Specific Questions: Biology

Question 1

While 'irritable' responses by plants would not have been familiar to many candidates, the majority correctly chose the key **D**.

Question 4

A significant number of candidates forgot that at high temperatures, enzymes are destroyed, and thus no starch would have been digested.

Question 5

Candidates showed that they understand the biochemistry of large food molecules – particularly of proteins.

Question 8

Only the most able candidates knew the difference between the pulmonary artery and the pulmonary vein.

Question 9

Candidates should be reminded that when describing reflex action, the brain does not direct the response.

General Comments: Chemistry

Questions 14, 18, 19, 20, 21 and 27 were the easiest for the candidates.

Comments on Specific Questions: Chemistry

Question 14

The use of chromatography in the separation of coloured compounds is specified and is generally well known.

Question 15

Candidates clearly understand that covalent compounds are ‘non-metal only’, but not distinguish between high and low volatility as options **C** or **D** were chosen in numbers.

Question 18

The vast majority of candidates understand the term exothermic.

Question 20

Most candidates knew which change would increase the speed of the reaction.

Question 24

While most candidates knew that potassium is more reactive than sodium, a significant minority were too unfamiliar with bromine or its position within Group VII to understand its reactivity in comparison to chlorine.

Question 27

This was an easy question for the majority of candidates.

General Comments: Physics

Candidates found **Questions 29 and 30** the easiest.

Comments on Specific Questions: Physics

Question 29

The vast majority of the candidates correctly calculated the density.

Question 33

A significant minority of candidates incorrectly chose option **B**, appearing to believe that convection would transfer thermal energy downwards to the toast.

Question 34

This question required recall of the measurement representing the amplitude of a wave. Although a large majority of candidates could do this, a significant proportion of them used the 'peak to trough' value instead.

Question 35

A significant minority of candidates incorrectly chose option **A**. These candidates apparently were unaware that dispersion begins at the first air/glass boundary.

Question 38

Many candidates appeared uncertain with the concept that the current at all points in a series circuit is the same.

Question 39

Many candidates knew which pattern would be produced by the magnetic field.

CO-ORDINATED SCIENCES

Paper 0654/13
Multiple Choice

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12	D	32	D
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19	D	39	D
20	D	40	A

General Comments: Biology

Candidates generally performed well on the biology questions.

Comments on Specific Questions

Question 2

A significant number of candidates confused the terms respiration and breathing. Candidates should be reminded that respiration is the process in which energy is obtained from food.

Question 5

Only the most able candidates chose vasodilation – the result of muscular relaxation, a totally passive process. Many candidates incorrectly chose option **A**, which as an active process requires energy.

Question 7

Only the most able candidates knew the difference between the pulmonary artery and the pulmonary vein.

Question 9

Many candidates incorrectly chose option **B**, revealing a misunderstanding of the function of adrenaline. While it is correct that the blood would be pumped faster; and oxygen would be delivered faster to the respiratory surface, the *level* of oxygen in the blood remains similar. What does significantly increase is the concentration of blood sugar (as glucose is released from the converted glycogen in the liver).

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This question showed evidence of guessing, with similar numbers of candidates incorrectly choosing an incorrect option as those who chose the key **C**. Candidates had either confused the tests for oxygen and hydrogen gases, or, had confused the electrodes that oxygen and hydrogen are produced at.

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A tiny minority of candidates were confused over the effects of larger and smaller surface areas on the rate of reaction.

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A small number of candidates incorrectly thought that metallic oxides are acidic, rather than basic.

Question 25

While most candidates knew that potassium is more reactive than sodium, a significant minority were too unfamiliar with bromine or its position within Group VII to understand its reactivity in comparison to chlorine.

Question 26

This was an easy question for the majority of candidates.

General Comments: Physics

No questions on this paper were found particularly easy, but **Questions 31, 34, 38** and **39** caused problems.

Comments on Specific Questions: Physics

Question 28

Only a tiny minority of candidates divided the mass by the area of the base, instead of by the volume.

Question 31

This question concerned energy resources and whether they originally derived from the Sun's energy. Many candidates were unable to identify the **error** in the table as option **B** (hydroelectric energy), most choosing option **C** or **D** instead. Candidates should be made aware of the link between the water cycle and hydroelectric energy.

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A significant minority of candidates incorrectly chose option **B**, appearing to believe that convection would transfer thermal energy downwards to the toast.

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Many candidates forgot to halve the time taken for the sound to return to the source when calculating the distance to the building.

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This question required recall of the measurement representing the amplitude of a wave. Although a large majority of candidates could do this, a significant proportion of them used the 'peak to trough' value instead.

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A significant minority of candidates incorrectly chose option **A**. These candidates apparently were unaware that dispersion begins at the first air/glass boundary.

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Candidates are reminded that two different resistors in series across the same voltage (power) supply will divide that voltage up unequally. The potential drop across each resistor can be calculated from $V = IR$.

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Candidates should be aware that when **both** the current direction and the magnetic field direction are reversed, the direction of the force remains unchanged.

Question 39

There was evidence of widespread guessing in this question on a test for a magnet; only if repulsion occurs must both the objects be magnets.

CO-ORDINATED SCIENCES

Paper 0654/21
Core Theory

Key Message

Candidates are reminded that if using the word 'it' or 'they' when answering questions it needs to be made clear what is being referred to. Credit cannot be awarded if Examiners are unable to work out what the 'it' or 'they' refers to.

General Comments

Most candidates were able to attempt most questions, gaining some credit for their answers. Sometimes it appeared that candidates knew the answers to the questions, but their answers were too vague to be awarded credit.

Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided. Similarly formulae consisting of a mixture of words, symbols or units should also be avoided. The idea of using the triangle consisting of three variables is a valuable tool to answering calculation questions but is not acceptable as a formula.

There was evidence of some candidates running short of time to complete the examination.

Performance depended not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

Comments on Specific Questions

Question 1

- (a) (i) Most candidates knew that electrons are *shared* in covalent bonds, gaining credit. Fewer knew *electrons are transferred* when ionic bonds are formed. A common incorrect answer was 'ions are lost'.
- (ii) This was poorly answered with few candidates being able to explain why it was covalent bonding. Only the most able candidates suggested that it was the presence of two non-metals or the fact that carbon dioxide was a gas and therefore covalent.
- (b) (i) Many candidates knew the correct test and result. The test and result for hydrogen was a common wrong answer.
- (ii) Many candidates correctly explained why a chemical change had occurred, but had difficulty in explaining the physical change (where solid carbon dioxide turned to gas).
- (c) (i) The gas was often incorrectly identified as carbon dioxide.
- (ii) and (iii) A number of candidates predicted metals that were not given in the question. Only the most able candidates related the rate of bubbling to the reactivity of the metals.

Question 2

- (i) The most common incorrect answer was respiration.

- (ii) A significant number of candidates either put carbon dioxide and oxygen on the wrong sides of the equation or wrote the respiration equation.
- (b)(i) Most candidates referred to a decrease in their answer. Some quoted values (using the information given).
 - (ii) There were many vague references to 'nutrients' rather than mineral ions/nitrates.
- (c)(i) Only the most able linked their answer to photosynthesis.
 - (ii) The expected answer was carbon dioxide. Many candidates suggested sunlight which was creditworthy.
- (d) Again, many candidates referred to nutrients rather than mineral ions/nitrates.

Question 3

- (a)(i) and (ii) The majority of candidates gave the correct answer, however a common wrong answer to part (ii) was 45 m/s.
 - (iii) This part was well answered.
- (b)(i) Most candidates correctly calculated the volume of the block.
 - (ii) A significant number incorrectly put volume divided by mass. A few carried out an incorrect calculation with correct unit **or** the correct calculation and with an incorrect unit.
- (c)(i) Most referred to a point rather than a temperature and a few referred to melting, rather than the change from solid to liquid.
 - (ii) Only the most able drew the particles in an irregular formation but still usually touching other particles. Many candidates drew a very regular arrangement with the particles slightly separated.

Question 4

- (a)(i) While a wide range of both gaseous and liquid fuels, and their uses, were creditworthy, very few candidates were awarded credit. Helium was a common wrong answer.
 - (ii) *Exothermic* was quite well known but a significant number of candidates gave made up words (often with a link to thermal).
- (b) Candidates gained credit for 'acid rain' only when they stated what the acid rain would do. Very few references to the damage to the respiratory system were seen. Many gave incorrect answers referring to the ozone layer/global warming etc.
- (c)(i) The gas was often incorrectly identified as oxygen.
 - (ii) Many candidates incorrectly suggested that the dust would have a smaller surface area.
 - (iii) Most candidates were awarded credit for the idea of the 'explosion risk' but few mentioned ignition (by a spark) or the idea of the reduction of oxygen (or increase of carbon dioxide). Some referred to damage of the lungs but did not link this to inhaling the dust.

Question 5

- (a)(i), (ii) and (iii) Few candidates got any of these parts correct. Only the most able candidates were aware that a force acts on a current-carrying conductor in a magnetic field and the effect of reversing the current.
- (b)(i) Very few candidates mentioned electrons. Many of those who did were confused about the charge on electrons, and were not able to explain why the balloon gained a negative charge.
 - (ii) Only the most able candidates were able to explain that like charges repelled.

- (c) Most candidates explained that all the lamps could operate independently, but few understood that all the lamps would receive the full mains voltage.
- (d) Few candidates knew the purpose of a fuse or how a fuse worked. Vague responses such as 'to protect the worker' were not creditworthy.

Question 6

- (a) There were few correct responses. Many candidates referred to 'who eats who', which is not creditworthy.
 - (b) Most candidates completed the food chain correctly.
 - (c) Many candidates did not use the food web given in Fig. 6.1. Only the most able candidates correctly identified organisms to match the terms in the question.
 - (d) Most candidates understood that photosynthesis was involved but only a few explained that photosynthesis uses energy from the Sun.
- (e)(i) and (ii) Many candidates did well here, but some did not use the food web given.

Question 7

- (a) A significant minority of candidates thought that electrons are found in the nucleus.
- (b)(i) Most candidates knew that chlorine was added to water to kill microorganisms, but few were able to explain the reason for this.
 - (ii) In this question it was important to distinguish between iodide and iodine and chloride and chlorine, with only a few candidates being awarded full credit.
- (c)(i) The majority of the candidates knew the term *electrolysis*.
 - (ii) and (iii) Few candidates were able to deduce that electrolyte was copper chloride solution, and go on to link the orange substance to copper. Many simply rewrote information given in the question.

Question 8

- (a)(i),(ii) and (iii) Most candidates gave correct answers for parts (i) and (ii), however only a few gave 'kinetic' for part (iii), with wind being a common incorrect answer.
- (b) Few candidates were able to do this. Many candidates had a single energy transfer from thermal to electrical, with no mention of water, steam, turbines or generators.
- (c)(i) This part was not understood. Vague answers such as 'radiation monitor' were often seen.
 - (ii) and (iii) These parts were well answered.

Question 9

- (a) Vague answers such as 'holding the baby' were seen.
- (b)(i) A significant number of candidates stated the time of menstruation between day 5 and day 28, (which was when the lining increased), therefore indicating a misunderstanding of the process.
 - (ii) The likely day of ovulation was deduced by many candidates.
 - (iii) A large majority of candidates knew the reason for the uterus lining becoming thicker.
- (c) Ovary was not well known. Common incorrect answers were ovule and brain.

- (d)(i) Vague answers such as 'meeting' or 'getting together' were seen rather than the gametes 'joining together' or 'fusing'.
- (ii) Only the most able drew a line increasing from day 26/27. A significant number drew a straight line or curve across the whole of the graph.
- (iii) While most candidates gave the correct answer for part (b)(ii), they were unable to explain why the lining needs to **remain** thick, if an egg has been fertilised (and implants).

Question 10

- (a) Candidates were more likely to get the correct answers for light than for sound. Few candidates knew that light travels through a vacuum and sound does not.
- (b)(i) This was not well known, particularly the lowest frequency audible to humans.
- (ii) Many candidates gave answers lower than the values given in part (i).
- (iii) Most candidates successfully completed the calculation, showing good data handling skills. A few did not quote a formula or show their working.

Question 11

- (a) Most candidates gained partial credit with very few candidates knowing all three structures.
- (b) There were many incorrect answers, some referring to helping digestion or the secretion of bile.
- (c) This was not well known. There were many incorrect references about insulin.
- (d)(i) A number of candidates correctly referred to movement into the blood, but few referred to movement of digested food molecules through the walls of the intestine.
- (ii) The small intestine and the large intestine were common correct answers here. The liver was a common wrong answer.
- (iii) Many candidates confused assimilation with elimination.

Question 12

- (a)(i) Most candidates knew that metals were good conductors of heat and electricity.
- (ii) There were lots of vague answers which just repeated information given in the question.
- (b)(i) Many candidates referred to low pH rather than *lowest* pH and some confused alkaline with acidic.
- (ii) Many candidates incorrectly chose mixture **Z**, possibly because it was neutral.
- (c) Only the most able candidates could explain their predictions correctly. For test-tubes **1** and **3** candidates often referred to what was present rather than what was missing, without explaining why rust would not form. For test-tube **2** only a few candidates referred to the presence of iron with oxygen and water.

CO-ORDINATED SCIENCES

Paper 0654/22
Core Theory

Key Message

Candidates are reminded that if using the word 'it' or 'they' when answering questions it needs to be made clear what is being referred to. Credit cannot be awarded if Examiners are unable to work out what the 'it' or 'they' refers to.

General Comments

Most candidates were able to attempt most questions, gaining some credit for their answers. Sometimes it appeared that candidates knew the answers to the questions, but their answers were too vague to be awarded credit.

Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided. Similarly formulae consisting of a mixture of words, symbols or units should also be avoided. The idea of using the triangle consisting of three variables is a valuable tool to answering calculation questions but is not acceptable as a formula.

There was evidence of some candidates running short of time to complete the examination.

Performance depended not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

Comments on Specific Questions

Question 1

- (a) Many candidates gained full credit.
- (b)(i), (ii) and (iii) All three parts were quite well answered. There were no common incorrect answers.
- (c) (i) The term *electrolysis* was well known.
- (ii) Few candidates were awarded full credit. In this question it was important to distinguish between chloride and chlorine.

Question 2

- (a) Only the most able candidates gained full credit for their graph. Many candidates did not use sensible scales for the axes or finished their graph at 55 seconds rather than 50 seconds.
- (b) Most candidates successfully completed the calculation, showing good data handling skills. A few did not quote a formula or show their working.
- (c) (i) Kinetic (energy) was well known. Potential energy was a popular incorrect answer.
- (ii) Potential energy was well known. Gravitational potential energy was accepted but not gravitational energy.
- (iii) This was less well answered. *Joule* was the commonest answer given but a number of candidates gave the symbol as *j* rather than *J*.

Question 3

- (a) Sensitivity or movement were well known characteristics of living things.
- (b)(i) This was not well known. Many candidates confused the motor and the sensory neurones. A number of candidates were not awarded marks because it was impossible to work out what the label line was referring to.
- (iii) Only the most able candidates were able to give an advantage of having the reflex arc going through the central nervous system.
- (c) Many candidates were able to explain that the response described was not automatic or that it was consciously controlled gaining credit.
- (d) Many candidates explained that a reflex action might protect a young animal from danger, only a suggested that a reflex action did not need to be learned.

Question 4

- (a)(i) Only the most able candidates gained full credit, but most candidates were awarded credit for explaining either an element or a compound.
- (ii) Answers such as oil or gas are too vague to be creditworthy.
- (iii) *Fractional distillation* was not well known. Cracking was a common incorrect answer, and a few candidates just gave distillation.
- (iv) While there were many possible correct answers, very few candidates were awarded credit.
- (b)(i) *Cracking* was not well known.
- (ii) This part was very poorly answered, while candidates knew that it had something to do with single or double bonds, they were unable to explain it sufficiently clearly.
- (iii) While ethene and propene are both alkenes, only the most able candidates wrote both molecules to gain full credit. Many candidates only wrote one.
- (iv) Few candidates were able to show that they knew that ethene had a double carbon–carbon bond, and that an ethene molecule contains 2 carbon atoms and 4 hydrogen atoms.

Question 5

- (a) The correct answer was that the candidate would observe the magnet moving towards the piece of iron. The idea of attraction was accepted. However, many candidates used incorrect words such as contract, distract etc. instead of *attract*, and were unable to gain credit.
- (b)(i) and (ii) Although many candidates gave correct responses, again candidates used inaccurate words instead of *attract* and *repel*.
- (iii) Few candidates used the term *pole* in their answer. Instead they used terms such as 'side' which is too vague to be awarded credit. A significant number of candidates confused poles with charges.
- (c)(i) Most candidates realised that the current was going to be the same all the way round the circuit.
- (ii) Candidates needed to use $R = V/I$ to reach an answer of $3\ \Omega$. Too many candidates are still using the symbol A for current in quoted formulae. A number of candidates calculated either the voltage or current.
- (iii) Many candidates calculated the resistances in series and showed their working. A few attempted $3 \times 3 \times 3$ and gave their answer as $27\ \Omega$.

Question 6

- (a) (i) Candidates needed to be very careful that they were referring to how the rate of clearing changed. Some candidates were careless in their use of data.
- (ii) Most candidates gained credit, many using their awareness of environmental problems.
- (b) (i) A significant number of candidates did not mention photosynthesis, and many found it difficult to explain that there would be fewer trees absorbing the carbon dioxide.
- (ii) Most candidates correctly referred to greenhouse gases and global warming, although some also incorrectly referred to damage caused to the ozone layer.
- (c) Many candidates gained credit for one of the many possible answers.
- (d) Many candidates gained full credit for stating two different uses for trees. However, some were unable to gain full credit as they repeated their first answer by stating another example of the same use.

Question 7

- (a) Candidates needed to state that 'an isotope is where an element has the same number of protons but a different number of neutrons' in order to gain credit. Many candidates were far too brief; giving responses such as 'same protons different neutrons'.
- (b) (i) Despite being a syllabus term very few candidates had any idea how to respond to this question. Very few mentioned natural ionising radiation or where this might come from.
- (ii) This was poorly answered. Many candidates drew a curve below the original line or drew a line above the original which crossed the original line at the top and bottom. Only the most able candidates drew a line which stayed above the original line for the whole of the graph, although a line drawn 50 counts per second above the original line was rarely seen.
- (c) A significant number of candidates drew four lines, despite the instruction to draw only three lines.
- (d) (i) Most candidates gained partial credit.
- (ii) Radio waves was a common incorrect answer.
- (e) Electron transfer was not well known. Many candidates referred incorrectly to positive electrons.

Question 8

- (a) Most candidates stated photosynthesis gaining credit, but very few could give a further use of water by a plant.
- (b) (i) Leaves or stomata was the most common correct response.
- (ii) Soil was a common correct answer.
- (c) (i) There were some good descriptions of how the rate of transpiration changed within the time range specified. A number of candidates were careless in their reading of the scales.
- (ii) 15.00 was acceptable as was 3.00 pm but not 3,00 am.
- (iii) and (iv) A number of candidates gave two contradictory conditions for each part and therefore were unable to be awarded credit. Humidity was the condition that caused the greatest confusion. Many candidates thought either that high humidity would cause more transpiration **or** that low humidity would cause less transpiration.

Question 9

- (a) (i) There were lots of nucleons, proton and neutrons for **L** – the nucleus. There were lots of outermost shells for **M** – electron.
- (ii) Many candidates rearranged the question as their answer and were unable to be awarded credit.
- (b) (i) Although most candidates suggested covalent bonding candidates needed to explain why the substance had to be covalent to be awarded credit. Few managed to do this. Many suggested that it was because the atoms were sharing electrons, while this in itself is a perfectly acceptable description of covalent bonding it does not explain why this structure had to be covalently bonded.
- (ii) The important point here was to suggest that it had something to do with the *rain water*. Many candidates simply stated that ‘sulfur dioxide got into the lake and made it acidic’, and were unable to be awarded credit.
- (c) (i) Many candidates mentioned conditions. However less suggested whether the change in the condition was an increase or a decrease.
- (ii) Both magnesium sulfate and hydrogen were quite well known. However, only the most able candidates gave both.

Question 10

- (a) (i) Some candidates referred to respiration and some referred to sugar being a source of energy. Candidates needed to answer carefully to ensure that their answer did not suggest that energy was being created.
- (ii) Few candidates gave the expected answer about dental decay. However, many referred to obesity and diabetes, and as these are part of the supplement material in the syllabus, credit was awarded for appropriate responses.
- (b) (i) Many candidates knew this. Some suggested using biuret or iodine.
- (ii) Few candidates knew about roughage and preventing constipation. There were many vague answers about helping with digestion or excretion.
- (iii) Vitamin C and prevention of scurvy were well known.
- (c) Starch was the only suitable large molecule suggested by the candidates.

Question 11

- (a)(i) and (ii) Convex and focal length were well known answers. Focus length was a common response that was not accepted.
- (iii) Some candidates knew where the principal focus was located. Some candidates simply wrote the letter **P** somewhere near their idea of the position of the principal focus, without making it clear where the principal focus was.
- (b)(i) and (ii) Candidates are reminded to take care when labelling diagrams. Candidates need to be very accurate with the measurement for showing the wavelength. A double headed arrow placed between two waves and pointing to both waves was usually not sufficient. The arrowheads needed to point to *identical* points on two consecutive waves. Some candidates correctly labelled the wavelength and the amplitude but forgot to indicate which was which.
- (c)(i) and (ii) Most candidates correctly identified trumpet and piano. A common incorrect answer to both parts was violin.
- (iii) The highest frequency was better known than the lowest frequency. Many candidates gave answers of 30 Hz and 4190 Hz, which was based on the data in Table 11.1.

- (d) Most candidates successfully completed the calculation, showing good data handling skills. A few did not quote a formula or show their working. The unit for density was quite well known.

Question 12

- (a) (i) There was some confusion with pesticides. Replacing nutrients was the most popular answer.
- (ii) Potassium and phosphorus were well known.
- (iii) Common incorrect answers were 4, 5 or 7.
- (b) (i) This was not well answered. Many candidates simply repeated the question. Only the most able candidates referred to ammonia being released. Many suggested that the sodium hydroxide had caused the litmus to change colour.
- (ii) Some candidates gave creditworthy answers. Many tried to link the question to the previous part and described what would happen to litmus paper when placed in the reaction mixtures.
- (c) (i) A few candidates suggested that the answer was about soil acidity, but only the most able explained how the calcium carbonate was used to reduce the soil acidity. A few suggested that calcium carbonate contained calcium.

CO-ORDINATED SCIENCES

Paper 0654/23
Core Theory

Key Message

Candidates are reminded that if using the word 'it' or 'they' when answering questions it needs to be made clear what is being referred to. Credit cannot be awarded if Examiners are unable to work out what the 'it' or 'they' refers to.

General Comments

Most candidates were able to attempt most questions, gaining some credit for their answers. Sometimes it appeared that candidates knew the answers to the questions, but their answers were too vague to be awarded credit.

Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided. Similarly formulae consisting of a mixture of words, symbols or units should also be avoided. The idea of using the triangle consisting of three variables is a valuable tool to answering calculation questions but is not acceptable as a formula.

There was evidence of some candidates running short of time to complete the examination.

Performance depended not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

Comments on Specific Questions

Question 1

(a) (i) and (ii) Most candidates gained partial credit for knowing either an advantage or a disadvantage.

(iii) Kinetic (energy) was not well known. Many candidates wrote down wind energy.

(b) Few candidates were able to do this. Many candidates had a single energy transfer from thermal to electrical, with no mention of water, steam, turbines or generators.

(c) Very few candidates realised that this question was about expansion and contraction. Many wrote about wind damage.

(d) (i) and (ii) Many candidates answered these parts well.

(iii) Most candidates successfully completed the calculation, showing good data handling skills. A few did not quote a formula or show their working. The unit for resistance was quite well known.

Question 2

(a) Photosynthesis was quite well known.

(b) The term for tissue X, *mesophyll* was only known by the most able candidates.

(c) Full credit was gained by drawing a rectangular cell and correctly labelling four structures of the cell. Candidates were not awarded credit for incorrect labelling or where the structures were placed in an impossible position.

- (d)(i) The vascular bundles were usually correctly identified.
- (ii) Xylem and phloem were well known.
- (iii) Only the most able candidates could describe two functions of a vascular bundle.

Question 3

- (a)(i) Some candidates were able to describe an alloy as a mixture of metals.
 - (ii) The term *malleability* was not well known.
 - (iii) Many incorrect substances were suggested.
- (b) Few candidates were able to do this. Full credit was given for discussing the gain and loss of electrons or the resulting charges on the ions.
- (c)(i) A significant number of candidates managed this, however many candidates did not use the information given in the question.
- (ii) Only the most able candidates knew that a non-metal oxide would be acidic, and give a correct colour change or explanation.

Question 4

- (a) Most candidates gained partial credit for this part. However a common error was to replace artificial with natural in the first gap.
- (b)(i) Many candidates correctly identified the two sheep breeds suitable for crossing.
- (ii) Most candidates were able to give at least one suitable characteristic.
- (c) Few candidates were able to explain that the sheep would use their food for making meat/muscle rather than being used in making wool.
- (d) Many candidates explained correctly that the female sheep are kept for breeding and/or milk production. A number of candidates suggested that male sheep were bigger, which was not accepted.

Question 5

- (a)(i) Few candidates used the term *po/e* in their answer. Instead they used terms such as 'side' which is too vague to be awarded credit. A significant number of candidates confused poles with charges.
- (ii) Gravity was the only force commonly mentioned. A few candidates attempted to explain about the Earth's magnetic field, without suggesting that it was the Earth's magnetic field referring vaguely to a 'magnetic pull'.
- (b)(i) In this part it was essential that candidates referred to charges.
- (ii) Many candidates knew about electron transfer, but few explained why there was electron transfer.
- (c) Many candidates successfully completed the calculation, showing good data handling skills. A few did not quote a formula or show their working.

Question 6

- (a) (i) A number of candidates knew that the number of electrons was six but few could explain why.
- (ii) Although most candidates suggested covalent bonding, candidates needed to explain why the substance had to be covalent to be awarded credit. Few managed to do this. Many suggested that it was because the atoms were sharing electrons, while this in itself is a perfectly acceptable description of covalent bonding it does not explain why these structures are covalently bonded. This was all to do with both atoms being non-metals.
- (iii) Some candidates could correctly explain why molecule **P** was carbon dioxide.
- (iv) Burning a carbon fuel was quite well known. However, responses such as driving were considered too vague to be awarded credit.
- (b) (i) The limewater test was not well known.
- (ii) A number of candidates correctly suggested that the mass would decrease. Very few could explain why.

Question 7

- (a) (i) and (ii) Some candidates were able to use the information in the question and their knowledge to answer these parts correctly.
- (b) (i) and (ii) Many candidates showed a good knowledge of wave property terms.
- (c) A number of candidates gained some credit but few were able to fully describe what was happening to the particles.
- (d) Some candidates successfully completed the calculation, showing good data handling skills. A few did not quote a formula or show their working. A small number forgot to divide the distance by two.

Question 8

- (a) (i) The term *gamete* was known better than the term *genotype*.
- (ii) Most candidates deduced that the dominant allele was **G**/green.
- (b) Few candidates were able to explain that yellow was recessive or that there was no green allele present.
- (c) Many candidates were able to work through this part, gaining credit.
- (d) Chlorophyll was quite well known as the substance which gave the green seeds their colour.

Question 9

- (a) (i) Very few candidates identified nitrogen as the main gas in air and state its percentage.
- (ii) Many candidates correctly named a gas that causes air pollution, however, only a few could describe a harmful effect of that gas.
- (b) (i) The test for hydrogen gas was not well known.
- (ii) Only the most able candidates deduced the name of the product for the reaction as magnesium chloride.
- (c) (i) The term *exothermic* was quite well known.
- (ii) A number of candidates correctly stated that reaction had stopped.

Question 10

- (a) Many candidates gained partial credit. The commonest correct connection was between X-rays and airport security scanners.
- (b) Candidates are reminded to take greater care with their labelling. Candidates need to be very accurate with the measurement for showing the wavelength. A double headed arrow placed between two waves and pointing to both waves was usually not sufficient. The arrowheads need to point to *identical* points on two consecutive waves.
- (c) (i) Many candidates knew this.
- (ii) and (iii) These parts were not well answered. Many candidates put the radiations in reverse order.
- (iv) Very few candidates were able to describe radioactive decay.

Question 11

- (a) (i) and (ii) A significant number of candidates were able to identify the gases. A common incorrect answer for part (ii) was oxygen.
- (b) Diffusion was not well known.
- (c) (i) Red blood cell was well known.
- (ii) and (iii) These parts were not well known. There were no common wrong answers.
- (d) This was very poorly answered. Very few candidates identified where the oxygen concentration was the lowest or went on to explain why this was important in terms of oxygen diffusion.

Question 12

- (a) (i) Most candidates correctly gave the answer 3.
- (ii) Many candidates correctly identified the compound molecule.
- (b) (i) and (iii) The term transition metal was not well known, and only a few candidates were able to suggest any properties of transition metals.
- (iii) Many candidates gained some credit, usually for a correct use of aluminium. However, many uses listed were very vague and only few candidates could explain why aluminium had the use they had stated.
- (c) (i) and (ii) These were quite well known.

CO-ORDINATED SCIENCES

Paper 0654/31
Extended Theory

Key Message

The most successful candidates were able to apply the fundamental principles to explain phenomena in all branches of the subject. They used particle collision theory to explain factors affecting the working of enzymes and the burning of charcoal. They described energy transfers in electricity generation and combustion.

Many candidates tailored their answers to the requirements of the questions, discriminating between terms such as *state*, *describe* and *explain*. Candidates should be able to quote definitions as stated in each area of the syllabus.

General Comments

Extended answers were generally well organised and presented with care. Some responses could have been improved by making reference, as directed, to the data in tables, graphs and diagrams to support explanations. Candidates were often able to apply their knowledge to unfamiliar contexts.

The mathematical processes required for the calculations were handled well by the majority. Some candidates found the rearrangement of learned formulae a challenge.

Candidates should be reminded to use key words provided in the question, e.g. *energy* for energy transfer, and *particle* in collision theory.

Comments on Specific Questions

Question 1

- (a) Most candidates described covalent bonding as electron sharing and ionic bonding as electron transfer.
- (b) The majority of candidates appreciated that double bonds were involved, and correctly completed the dot-and-cross diagram of the carbon dioxide molecule.
- (c) (i) Most placed the metals in the correct order of reactivity, although a sizeable number reversed the order. This suggested a misconception, repeated in part (ii), that the displacing metal was less reactive than the displaced metal.
- (ii) Some of the candidates who placed the metals in the correct order made the correct general statement that a more reactive metal displaces a less reactive metal. They applied this principle when using the results of the experiment to explain the relative reactivity's.
- (iii) Most candidates knew that redox reactions involved the transfer of electrons. Credit was awarded when the movement of electrons between the Mg atoms and Ag⁺ ions were described respectively as oxidation and reduction.

Question 2

- (a) Most candidates correctly identified the stigma and sepal.
- (b) Many candidates correctly stated the function of the anther as producing pollen; only a few stated releasing pollen.

- (c) Most candidates correctly named the ovary. The most common incorrect response was ovule.
- (d) Petals were often suggested as a way in which flowers were adapted for insect pollination. When the petals were described it was sometimes unclear whether petals, or a feature of petals, that was the adaptation. Some correctly stated that anthers and the stigma were inside an insect pollinated flower. Some candidates gave vague descriptions about their length or relative positions.
- (e) The lack of petals was often suggested as a way in which flowers were adapted for wind pollination. Some stated that anthers and the stigma were outside a wind pollinated flower. Again some vague were seen.
- (f) (i)(ii) Many could suggest reasons for removing the stamens and covering the flower with a bag in the genetic experiment. Correct reasons included prevention of self-pollination or pollination by a plant other than **B**.

Question 3

- (a) (i) Valid explanations of how the graph showed the relative deceleration of the trucks referred to the graph in terms of gradient or the time taken to stop. The use of terms such as *slower deceleration*, or reading times from the axis without comparison, were not sufficient to gain credit.
 - (ii) Most knew the formula for acceleration and obtained the correct answer. Candidates had to indicate that it was the *change in* speed to gain full credit.
 - (iii) Most knew the formula, $F = ma$, and obtained the correct answer with appropriate units.
- (b) Most knew the formula, $d = m/V$, but some made mistakes in rearranging the formula.
- (c) Those who knew the formula for heat energy transfer in terms of specific heat capacity, could often manipulate the expression to obtain the correct answer.

Question 4

- (a) (i) While some candidates gave the name of a gaseous fuel and stated a use, many suggested a liquid fuel. Candidates are reminded to check that their responses answer the question asked.
 - (ii) The vast majority of candidates knew the term *exothermic*.
- (b) Many responses suggested that the combustion products caused acid rain, but did not always describe their possible harmful effects. Very few references to the damage to the respiratory system were seen. Common misconceptions were that the oxides of sulfur and nitrogen were greenhouse gases, and that they damaged the ozone layer.
- (c) (i) Many candidates stated that the rate of burning of charcoal powder was greater because of its increased surface area. Those who went on to explain in terms of collision theory were not awarded credit as they did not make reference to particles or referred to more collisions rather than to a greater rate of collision.
 - (ii) There were some correct predictions that the products of the combustion had less chemical potential energy than the reactants, supported by recognition that energy had been lost from the system as heat. Other candidates attempted to apply the principle of conservation of energy incorrectly, considering the reactants and products as a closed system.

Question 5

- (a) Most candidates knew that domestic lamps were connected in parallel so that they operated independently. A few also stated that they each operated at full mains voltage and had full brightness.
- (b) (i) The most common explanation for the charge on the balloon was given correctly as the transfer of electrons from the cloth to the balloon. There was some suggestion of the mobility of protons and the existence of positive electrons.

- (ii) Although many candidates correctly made the statement 'that like charges repel', some candidates gave an alternative description of the phenomenon.
- (c) Most candidates knew the function of a circuit breaker, but could not always express their ideas using scientifically correct terms. The best answers were concise statements that the current was interrupted if it became too high. While some circuit breakers use the thermal effect on an internal component, some candidates suggested incorrectly that the device sensed the temperature of the drill.
- (d) Many candidates stated that the current in transmission cables was lower when the voltage was high gaining credit. However some inappropriately applied Ohm's Law and arrived at the wrong explanation. Only the most able made the link between low current and low heat energy loss.

Question 6

- (a) A few candidates gave a good definition of an ecosystem.
- (b) The correct food chain was usually written in the standard format gaining full credit.
- (c) (i) A significant number of candidates knew that there was a large energy loss between trophic levels.
 - (ii) A small minority explained the relative numbers of lions and zebras in terms of the energy available at the top of a food chain. The common answer compared diet or food availability, which was not creditworthy.
- (d) (i) *Decomposer* was often defined correctly.
 - (ii) Bacteria and fungi were the most common correct examples of decomposers seen.
 - (iii) A significant number of candidates did not realise that decomposers would feed on *all* the organisms in the food web.
 - (iv) Most candidates were aware of the role of decomposers in providing nutrients for grasses and trees, they did not always use the idea of recycling from one organism to another.

Question 7

- (a) (i) Most candidates gave the correct names and numbers of particles in the chlorine nucleus.
- (b) (i) The majority knew that chlorine was added to water to kill bacteria, although some terms such as 'cleaning' and 'purifying'.
 - (ii) The word equation was usually correct. A few candidates described the process in a sentence which was not creditworthy.
- (c) (i) and (ii) Most correctly showed that the relative formula mass was found by adding the relative atomic masses, and went on to calculate the number of moles of sodium chloride.
 - (iii) Of those who knew to multiply the number of moles by the molar volume, only the most able realised that the number of moles of chlorine was half that of sodium chloride.
 - (iv) Many candidates knew that chloride ions were negatively charged and were attracted to the positive anode. Only a few used the term *negatively charged chloride ions*, and were more likely to discuss the behaviour of 'negative chlorine'. The most able candidates described the loss of electrons at the anode to form chlorine atoms.

Question 8

- (a) A significant number of candidates did not address the question by referring to the energy transfers involved. For this the full term *heat energy* rather than just *heat* should have been used. Some responses included a description of a steam turbine and generator.

- (b) (i) Very few candidates suggested a dosimeter or a photographic film radiation badge. A common incorrect suggestion was a Geiger counter.
- (ii) The effects of ionising radiation were well known.
- (c) Only the most able correctly matched the parts of the electromagnetic spectrum to their uses.
- (d) (i) and (ii) Candidates who drew the generator coils in the correct positions were in the minority. Many had the positions reversed.
- (e) There were a number of careful sketches of the sinusoidal voltage output of the generator, with constant amplitude and period, and two cycles shown. The trace should not have been displaced off the time axis.

Question 9

- (a) The enzyme that digested fats was usually correctly named as lipase.
- (b) (i) The temperature at which both enzymes had the same activity was usually correctly given as 37 °C.
- (ii) To explain why the enzymes worked slowly at 10 °C, candidates had to refer to collision theory. The most able candidates referred to the kinetic energy and rate of collision of particles, rather than *the enzyme*.
- (iii) The term *denatured* was used correctly by many in explaining why the enzymes did not work above 60 °C.
- (c) (i) The best explanations of why the 'ECO' programme was better for the environment stated that it used less energy, rather than used less electricity or wasted more energy, linking this to the reduced use of fossil fuels.
- (ii) Most candidates suggested that enzyme 1 should be used for the 'ECO' programme because it was more active than enzyme 2 at the design temperature of 30 °C.
- (d) Candidates who knew the biuret test for proteins usually stated the positive outcome gaining full credit.

Question 10

- (a) (i) Almost all candidates knew that light travelled faster than sound.
- (ii) The propagation of sound was sometimes described in terms of specifically *longitudinal* waves or compression and rarefaction. Where the description involved particle vibrations the idea of transmission from one particle to the next was sometimes omitted.
- (iii) Most candidates correctly stated that the transmission of sound requires a medium.
- (b) (i) Some candidates knew the human audible frequency range, while many suggested a much narrower band of frequencies.
- (ii) The distance between the ultrasound device and the cat was usually calculated correctly with the working shown. A few candidates placed the decimal point incorrectly.
- (iii) Many knew the formula $v = f\lambda$, but some had difficulty rearranging.
- (c) There were many good circuit diagrams showing how the current could be increased by reducing the resistance or increasing the supply voltage. A minority of candidates incorrectly suggested that current would be increased by increasing the resistance.

Question 11

- (a) The type of tissue in the heart was usually correctly described as muscle.
- (b) (i) Only the most able candidates identified the coronary artery.
- (ii) There were some good answers explaining that blockage of the blood vessel would cause a lack of oxygen leading to cells not respiring and death of heart tissue. Some suggested that the artery was supplying oxygenated blood to the whole body, or deoxygenated blood to the lungs.
- (c) (i) Most candidates compared the numbers of deaths from heart disease in the two countries. Some used data from the table to support their observation by calculating the difference in one of the values rather than simply reproducing them. Many compared the of numbers of the deaths of men with those of the women within each country, even though it was not required by the question.
- (ii) Most candidates knew that desirable lifestyle changes would include stopping smoking, taking more exercise or eating less saturated fat. Some gave less precise details like 'adopting a healthy diet' which was not creditworthy without further explanation.
- (iii) The best responses suggested genetic susceptibility as a reason for the difference in rates of heart disease in the two countries.

Question 12

- (a) (i) The differences between metals and non-metals were generally well known, with most candidates identifying at least one physical property. Melting point and boiling point were not acceptable suggestions. Since the question asked for differences, it was necessary to compare the properties of metals and non-metals, rather than just describing metals.
- (ii) Radium was usually described as a metal, with its position on the left or in Group II of the Periodic Table being given as the reason.
- (b) (i), (ii) and (iii) The oxides were usually identified correctly and a correct explanation given in terms of pH. In (iii) some candidates incorrectly stated that metals were alkaline, rather than their oxides.
- (c) Most candidates made the general statement that rusting required air or oxygen and water present together. Good answers stated that the absence of water and oxygen in test-tubes **1** and **2**, respectively, explained why the nail did not rust. The best responses recognised that test-tubes **2** and **3** demonstrated that it was the oxygen in the air that was required for rusting. Explanations in terms of materials that were present only rarely gained full credit.

CO-ORDINATED SCIENCES

Paper 0654/32
Extended Theory

Key Message

The most successful candidates were able to apply the fundamental principles to explain phenomena in all branches of the subject. Candidates should be reminded to use key words provided in the question, e.g. *energy* for energy transfer, and *particle* in collision theory.

Many candidates tailored their answers to the requirements of the questions, discriminating between terms such as *state*, *describe* and *explain*. Candidates should be able to quote definitions as stated in each area of the syllabus.

General Comments

Successful candidates demonstrated their knowledge by presenting their answers with care, ensuring their meaning was unambiguous and showing the steps in their calculations. They quoted the formula they were using and where necessary showed how they rearranged it. They used units consistent with the data supplied.

Some responses could have been improved by making reference, as directed, to the data in tables, graphs and diagrams to support explanations. Candidates were often able to apply their knowledge to unfamiliar contexts.

Comments on Specific Questions

Question 1

- (a) Most candidates correctly identified at least two elements appropriate to the uses specified. A common error was thinking aluminium was used for galvanising steel.
- (b) Most candidates identified the alkali metal as **D** and because it conducted electricity and reacted quickly with water. Most did not appreciate that alkali metals do not have the characteristically high melting points of most metals.
- (c) (i) Most candidates wrote a correct word equation for the reaction. Candidates should be reminded that symbol equations should not be given when word equations are asked for.
- (ii) The majority of candidates knew that zinc was more reactive than copper and therefore displaced it. However some thought that the orange layer on the nail was zinc sulfate as zinc was a transition metal with coloured compounds.
- (d) (i) Many candidates correctly named this gas as oxygen but almost as many thought it was hydrogen. A few thought it was sulfur dioxide.
- (ii) The more able candidates correctly identified that copper ions were attracted to the cathode because it was oppositely charged and that copper ions gained two electrons becoming copper atoms and coating the electrode. Many gained partial credit, although some confused this process with electroplating using a copper anode.

Question 2

- (a) Only a very few candidates did not plot the points correctly on the graph or did not use straight lines.
- (b) Most candidates knew that the total distance travelled was equal to the area under the graph and carried out the calculation correctly in part (ii).
- (c) The majority of candidates knew that work done was equal to the force multiplied by the distance, and knew that the units were joules (J). However many did not realise it should be the distance moved in the direction of the force, used the distance along the slope rather than the vertical height in their calculations. Some candidates were unable to convert the mass of the skier into force (weight) correctly.

Question 3

- (a) Most candidates had some understanding of homeostasis but did not seem to understand the concept of negative feedback. Many did appreciate that the negative feedback was an action to bring the internal environment back to a set point but thought it meant the body was not controlling the internal environment.
- (b) Most candidates knew that the hormone was insulin and the gland the pancreas. Common errors were to give the hormone as glucagons and the gland as the liver. Some candidates referred to the Islets of Langerhans which, although where insulin is produced, are part of the gland rather than the gland itself.
- (c) This question was not well answered. The expected response was that the arteriole at **X** would dilate and there would be increased blood flow at **Y** which would lead to a greater heat loss from the blood through the skin. Although vasodilation was referred to by many candidates, it was a common misapprehension that this would move the blood vessels nearer to the surface of the skin. Many tried to explain the cooling in terms of sweating and evaporation. Some thought the increased blood flow would lead to increased respiration which would release heat but did not realise that this would be into the body rather than out of it. It was also common to see references to the speed of the blood flow increasing which was not acceptable.
- (d)(i) Many candidates thought the reduced blood flow in Raynaud's syndrome was due to weak heart, low blood pressure, clotting or diversion of blood to more important organs.
 - (ii) Few candidates realised that warmth would reduce vasoconstriction or encourage vasodilation. Some recognised that frostbite was a possibility.
 - (iii) The most able candidates knew that restricted blood flow would reduce the supply of oxygen to the cells and that this would hinder aerobic respiration causing tissue to die. Many simply described the effects of cold e.g. discoloration, loss of movement or numbness.

Question 4

- (a)(i) Many candidates distinguished clearly between elements and compounds. Candidates should be reminded to be precise when using terms such as atom and molecule.
 - (ii) Many candidates simply stated fossil fuels, without being specific, and were unable to awarded credit.
 - (iii) Although many candidates put fractional distillation, many thought it was cracking.
 - (iv) The majority knew that propane was used as a fuel. Some thought it was used as aviation fuel and although car fuel was acceptable petrol was not.
- (b)(i) Most candidates knew that saturated meant that the compound had no double bonds. The alternative is that it contains only single bonds. A few confused this with the meaning of saturated in terms of solubility.

- (ii) Only the more able candidates were able to draw a correct structural formula for propene. Many did not draw the double bond in a correct location, and a significant number drew either two or four carbon atoms.
- (iii) Formation of propene is not evidence that bonds between carbon atoms have been broken whereas that of methane and ethene is. Only the more able candidates related this to production of shorter carbon chains.

Question 5

- (a) Candidates were expected to answer in terms of induced magnetism and the attraction of opposite poles. Most candidates simply stated that iron was magnetic, but as this was given in the question, no credit was awarded.
- (b) (i) Many candidates answered in terms of relays being used as circuit breakers when the current was excessive, rather than as switches as required by the question.
(ii) Some candidates gave good responses explaining in terms of electromagnetic attraction of an armature which would operate a switch.
- (c) (i) Most realised that this required the sum of the currents through the two parallel circuits, although 0.15 A or 0.3 A were common incorrect responses.
(ii) Most realised this was the same as the voltage across L_3 .
(iii) Most gave the correct formula and calculated the resistance correctly.
(iv) Many candidates did this correctly, but incorrect responses of 5, 10 or 40 ohms were quite common.
(v) Most knew the correct formula for combining resistances in parallel. However the incorrect formula: $R = 1/R_1 + 1/R_2$ was often seen and some tried to combine the resistance of all 3 lamps into the formula for a parallel circuit. A significant number of candidates who had used the correct formula did not invert the calculation to obtain the final answer.

Question 6

- (a) (i) The majority of the candidates read the data in the table correctly. Some calculated a percentage of the sum of all the numbers in the table.
(ii) Almost all of those who gained credit in part (i) calculated this successfully.
- (b) Many candidates thought that the energy would be converted to chemical energy rather than thermal (heat) energy.
- (c) Most candidates gave movement as the answer to this part which gained credit.
- (d) (i) A significant number of candidates incorrectly stated that production of new tissue would increase to provide better insulation. Of those who realised that a higher percentage would be used in respiration were unable to explain that more energy was converted into thermal energy.
(ii) Many candidates knew that more energy would be lost in faeces but did not relate this to dietary fibre.

Question 7

- (a) (i) This part was poorly answered. Many candidates drew a curve below the original line or drew a line above the original which crossed the original line at the top and bottom. Only the most able candidates drew a line which stayed above the original line for the whole of the graph, although a line drawn 50 counts per second above the original line was rarely seen.
(ii) Most candidates correctly calculated the half-life. A few did not make their working clear, especially when using the graph.

- (iii) Most candidates knew that benefits of a short half-life in terms of limited radiation, and some that it was long enough for tests to be carried out. Only the more able candidates were aware of both these benefits.
- (b) The majority of candidates were aware that gamma radiation was the least ionising and would do least harm to body cells but some thought that gamma radiation had no ionising effect.
- (c) (i) Few candidates had problems with this although some included ultrasound and seismic waves.
(ii) Few failed to score here although some went to the other end of the spectrum.
(iii) Most candidates gained credit for knowing which part of the electromagnetic spectrum had waves with the shortest wavelength. .
- (d) Most candidates knew that electron transfer occurred because of friction but many did not go on to say what the resultant charge would be. A few candidates referred to movement of protons as well as electrons.

Question 8

- (a) Many candidates gave a standard definition of a chromosome. Some described the functions of a chromosome rather than what it was.
- (b) (i) Almost all candidates knew that diploid was the correct term for a cell of this type and most related this to pairs of chromosomes. Many were also aware that only sex cells were haploid.
(ii) Most candidates responded in terms of the cell being haploid, having unpaired chromosomes or half as many. Only the more able candidates added that as a female sex cell, an egg cell would have only an X chromosome.
- (c) Not many candidates were able to identify correctly the stage at which meiosis occurred although many knew that the egg and sperm cells only contained 6 chromosomes.
- (d)(i)(ii) Most candidates knew that sexual reproduction could lead to genetic variation although some made vague statements about evolution. Most candidates knew that asexual reproduction had the advantage of rapidity without the need to waste time or energy finding a mate.

Question 9

- (a) (i) Almost all candidates were able to draw the electronic structure of a sulfur atom.
- (b) (i) Only the most able candidates realised that there were four shared electrons in a double bond; with the most common incorrect response being 'two'.
(ii) Most candidates were aware that sulfur dioxide in the atmosphere led to formation of acid rain but there was careless reference to sulfur in the air and sulfur being acidic. Many candidates stated that 'sulfur dioxide got into the lake and made it acidic', which was not creditworthy.
- (c) (i) Many candidates did not read the question correctly and answered only in terms of the rate of reaction and did not state whether the time to fill the measuring cylinder would be shorter or longer. Candidates should be reminded to check that their answer addresses the question that is asked.
(ii) Most candidates were able to answer this part well although not all made it clear that it was kinetic energy (or speed) that increased with temperature. Some simply referred to more collisions but an answer in terms of collision frequency was required.
- (d)(i) Only a few candidates were able to carry out this calculation correctly, and a significant number were unable to do the conversion between cm^3 and dm^3 .
(ii) Many candidates recognised that there was a 1:1 ratio of moles of magnesium to hydrogen and knew that the mass was the number of moles multiplied by molar mass. However, many used the molar mass of hydrogen rather than magnesium.

Question 10

- (a) Nutrition is listed and defined in the syllabus as one of characteristics of living organisms. Many candidates related nutrition to foods and food types.
- (b)(i) Many candidates knew that bacteria were used to produce yoghurt and named *Lactobacillus*. A significant number wrote yeast.
- (ii) Most candidates knew that the bacteria needed to undergo anaerobic respiration although some thought the exclusion of air was to avoid contamination.
- (iii) The majority of candidates knew that pasteurisation would kill bacteria present in the milk but only the most able were able to give another reason.
- (iv) Many candidates related high fat intake as increasing risks of obesity, high cholesterol and coronary heart disease. In some cases candidates appeared to think that fat itself actually blocked blood vessels.
- (v) Most candidates related falling pH to increased acidity but were unable to identify this as being due to lactic acid.

Question 11

- (a)(i)(ii) Most candidates were able to carry out this task. Some did not draw or label the image.
- (iii) Few candidates labelled point **F** correctly as the principal focus. Many gave focal length as their answer.
- (b)(i) Many candidates stated that the image was a real image, but were unable to awarded credit, as the term 'real image' had been specifically excluded in the question.
- (ii) Many candidates knew that a real image could be projected on to a screen.

Question 12

- (a)(i) Most candidates identified nitric acid as being required to make ammonium nitrate from ammonia but it should be noted that when a name is asked for the formula alone should not be given. Some candidates suggested other mineral acids.
- (ii) Most candidates either deduced or knew that the ammonium ion was NH_4^+ but few explained this in terms of balancing positive and negative charges to give a neutral compound. The phrase 'cross and drop' was frequently seen, but without an explanation was not creditworthy.
- (b)(i) The majority of candidates gave a balanced equation but very few wrote the correct formula for methane.
- (ii) Few candidates knew all three reactions conditions. Many knew that high pressure and a catalyst was required but often gave the wrong catalyst. Candidates should use terms such as moderately high temperature or quote a temperature within a reasonable range.

CO-ORDINATED SCIENCES

Paper 0654/33
Extended Theory

Key Message

The most successful candidates were able to apply the fundamental principles to explain phenomena in all branches of the subject. Candidates should be reminded to use key words provided in the question, e.g. *energy* for energy transfer, and *particle* in collision theory.

Many candidates tailored their answers to the requirements of the questions, discriminating between terms such as *state*, *describe* and *explain*. Candidates should be able to quote definitions as stated in each area of the syllabus.

General Comments

Successful candidates demonstrated their knowledge by presenting their answers with care, ensuring their meaning was unambiguous and showing the steps in their calculations. They quoted the formula they were using and where necessary showed how they rearranged it. They used units consistent with the data supplied.

Some responses could have been improved by making reference, as directed, to the data in tables, graphs and diagrams to support explanations. Candidates were often able to apply their knowledge to unfamiliar contexts.

Common misconceptions included confusion between global warming and depletion of the ozone layer. For this syllabus, carbon dioxide and methane are the greenhouse gases having the greatest contribution to global warming.

Comments on Specific Questions

Question 1

- (a) (i) Successful responses suggested advantages of wind power such as being a renewable resource rather than reusable, a free energy source rather than just citing cost and lack of pollution. Good suggestions for disadvantages were high capital cost rather than just cost and the need for space rather than repeating the information about the amount of power achievable. Vague statements about being good for the environment needed explanation.
- (ii) Some candidates correctly calculated the efficiency while not quoting the formula. A significant number used an inverted formula.
- (b) (i) This question referred to energy transfer so the thermal to kinetic energy change should have been included in the description of the process occurring in a power station. Reference to heat energy or thermal energy rather than just heat was required in the response. Few candidates could describe the process as heat energy being used to produce steam which turned a turbine and generator.
- (ii) There was a wide range of suggestions for the nuclear process occurring in the Sun.
- (c) Candidates who knew the relationship between current and power usually calculated a correct value for the current.
- (d) Few responses recognised that power cables would contract in cold weather leading to damage. A common misconception was that they were hung loosely as they contracted at high temperature. Some candidates also referred to tension affecting resistance causing heating of the cable.

- (e) (i) Candidates who knew the relationship between cross-sectional area and resistance chose the correct wire.
- (ii) Those who knew that resistance was dependent on cross-sectional area, length and the material from which it was made chose the correct wire.
- (iii) When the Ohm's Law formula was correctly arranged the right value for current was usually obtained.

Question 2

- (a) (i) Most candidates were able to name the cilia.
- (ii) Some candidates showed that they understood the role of the mucus secreted by goblet cells in trapping pathogens and being pushed away from the lungs by the cilia.
- (b) (i) Tar was the best example of a damaging component of tobacco smoke. Some candidates may not have understood the word *component*.
- (ii) The most able candidates showed how the smoke component given in (b) (i) disrupted the process described in (a) (ii). A common misconception was that tobacco smoke reduced mucus production.

Question 3

- (a) (i) Some candidates knew the definition of an alloy.
- (ii) A significant number knew that the physical property was malleability. There was evidence that the term *physical property* was not well understood.
- (iii) Candidates needed to use the information about the composition of Dutch metal at the beginning of the question in order to name the compounds formed with chlorine.
- (b) Some candidates answered this question by drawing good diagrams showing electron transfers between atoms, however a significant number of these omitted the formula from their conclusion.
- (c) A correct equation was the result of deducing the formula of phosphorus oxide from the data and showing the subscript number of atoms per molecule.

Question 4

- (a) Most candidates knew the key constituent elements of fertilisers, and some named the ion present.
- (b) Run-off or the wind was often suggested as the mechanism by which mineral ions reached the river. Movement of soil was quoted as a less likely method.
- (c) (i) to (iv) Good answers stated that fertiliser increased the growth of algae. Others suggested that fertiliser acted as a toxin or reduced water transparency to sunlight.

The most able stated that fertiliser reduced photosynthesis by submerged plants due to shading by those at the surface leading to their death. Others suggested that fertiliser acted as a toxin, reduced water transparency to sunlight or encouraged more than initially strong growth.

Many stated that fertiliser increased the growth of bacteria as they fed on dead plants. Others suggested that fertiliser acted as a toxin or increased their growth.

Most stated that fish died due to lack of oxygen. A few suggested that fertiliser acted as a toxin or caused a reduction in available food.

- (d) Some candidates suggested using less fertiliser to reduce the effect on the river. Only the most able mentioned the timing of its application. Many suggested less practical measures such as building a barrier or not farming near the river.

Question 5

- (a) (i) Most candidates described the repulsion of the magnets. Only a few gave an explanation in terms of the general rule that like poles repel.
- (ii) Many candidates appreciated that the iron would become magnetised, sometimes then describing attraction. Some thought that magnetism could not be induced in unmagnetised iron.
- (b) (i) Most candidates described the attraction of the charged balls. Electric and magnetic fields were sometimes confused.
- (ii) Some candidates explained the electron transfer occurring when the ball was rubbed by a cloth.
- (iii) The concept of electric field was not generally understood. Only the most able knew that the charge experienced a force moving it towards the ball with the opposite charge.
- (c) Those who knew the formula for density, often correctly substituted the data, although a significant number did not state the correct units.

Question 6

- (a) (i) The correct number of electrons in a carbon atom was usually given. Only a few gave the equivalence of the numbers of protons and electrons as the reason. Some applied a rule which would not generally work, such as subtracting the atomic number from the mass number.
- (ii) A minority of candidates identified the ethane molecule and fewer explained their choice in terms of the numbers of carbon and hydrogen atoms.
- (iii) Many candidates knew that covalent bonding was found in the molecules, and a few explained it in terms of the bonding between non-metals. Others just described the covalent bond.
- (b) (i) Many candidates correctly calculated the mass of water by multiplying the relative molecular mass by the number of moles. Some were distracted by the molecular mass of methane.
- (ii) The best responses to this part of the paper showed the calculation of the mass of methane hydrate obtained by adding the molar mass of methane to the mass of water obtained in part (i).
- (iii) Some candidates began their explanation of how the breakdown of methane hydrate might affect global warming by stating that methane was a greenhouse gas. Very few went on to predict the further melting and release of methane which would increase the rate of global warming. There were several irrelevant references to depletion of the ozone layer.

Question 7

- (a) Many candidates described how air pumped into a tyre caused it to inflate by stating that the number of moving particles in the tyre increased causing the pressure to increase. Some explained this in terms of the increased rate of collision with the tyre wall. Others thought that there was a significant increase in volume of the tyre, or made vague statements about particles 'wanting' to get out.
- (b) The principles involved in the working of an electric motor were not well known. The most able candidates included the forces on the sides of the coil acting in opposite directions, and reversing of the current to keep the coil rotating in the same direction. Rather than explaining in terms of the interaction of the magnetic field produced by the current with the permanent magnetic field, many candidates postulated a force of attraction between poles and the coil.

Question 8

- (a) A minority of candidates gave an explanation of continuous variation, rather than discontinuous variation as asked by the question.
- (b) (i) Most counted the number of coloured grains correctly, although some counted the grains in the whole cob.

- (ii) The whole number ratio was usually correct if 'cancelled down'.
- (c) (i) Almost all candidates stated that the sweetcorn grain with genotype **Gg** was purple.
- (ii) Most candidates correctly used the ratio to deduce the genotypes of the parents.
- (d) There were a many excellent genetic diagrams. The most common error was in completing the gamete line.

Question 9

- (a) (i) While some knew that nitrogen was the major constituent of air, very few gave the percentage as 78. There was a wide range of other suggestions for both the constituent and the percentage.
- (ii) Where sulfur dioxide was given as a polluting gas from car exhausts, an effect of acid rain had to be mentioned to gain full credit. Only a few candidates suggested nitrogen dioxide, along with the effect of damage to respiratory systems. The greenhouse effect was often incorrectly cited.
- (b) (i) Most candidates knew the test for hydrogen but some thought that just seeing bubbles would suffice. Candidates should understand the scientific meaning of the term *test*.
- (ii) Very few candidates described the reaction in the form of a word equation.
- (c) (i) Although the question asked for an explanation in terms of energy, only the most able stated that thermal energy was released and the increase in kinetic energy of the particles. Some candidates correctly described the reaction as exothermic.
- (ii) The shape of the graph was sometimes correctly explained by realisation that the acid had been used up, although some candidates had difficulty in explaining that the magnesium was in excess. It was not always made clear that the reaction had stopped so that no more heat was being released. Some responses just described the temperature change over the course of the reaction.

Question 10

- (a) Most candidates matched the electromagnetic waves to their uses.
- (b) Frequency and wavelength were defined correctly by a minority of candidates. Diagrams were often inaccurate.
- (c) (i) Many candidates placed the radiations in the correct order of ionising ability.
- (ii) Only a few candidates gave a good explanation for the deflection of radiations in a magnetic field. Credit was awarded by candidates showing a link between deflection and charge. The most common misconception was that charged particles were attracted to the poles of a magnet.

Question 11

- (a) Most candidates knew that osmosis involved the transfer of molecules, and many provided a full definition.
- (b) (i) A few responses referred to the reduction in size of the vacuole or the withdrawal of the cell membrane from the cell wall.
- (ii) Some suggested that water moved out of the cell from high to low water concentration. Others wrote that sugar entered the cell.
- (iii) Many diagrams of the cells in water were carefully drawn.
- (c) (i)(ii) Only the most able described structural features such a shape or permeability of the cell wall and went on to relate them to the function. A few confused the function of root hairs cells with that of roots.

Question 12

(a) (i) The number of gases was usually counted correctly.

(ii) and (iii) Where the compound was correctly identified, a good definition of a compound was stated.

(b) Some candidates knew that cobalt was a transition metal.

(c) (i) Many candidates did not seem familiar with the industrial extraction of aluminium.

(ii) Oxygen or carbon dioxide were most often correctly named as the gas appearing at the anode, however a wide range of other gases was seen.

(iii) In describing what happened at the cathode when Al^{3+} ions were converted to atoms, most candidates just repeated information in the question and were unable to be awarded credit.

CO-ORDINATED SCIENCES

Paper 0654/04
Coursework

(a) Nature of tasks set by centres.

Of the Centres that submitted coursework for the June examination most had provided coursework in previous years and acted on advice given.

Several Centres provided a very comprehensive portfolio of practical exercises. In most Centres all the tasks set were appropriate to the requirements of the syllabus and the competence of the candidates. Centres are reminded to select tasks that meet the requirements of the syllabus.

(b) Teacher's application of assessment criteria.

In most Centres the assessment criteria were understood and applied well for all of their activities. There has been a steady improvement in the Centres' application of assessment criteria. Centres are reminded that it can be difficult to assess candidates for following instructions and planning in the same assignment.

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

Tick lists remain popular with particularly skill C1.

Many Centres write brief summaries on each candidate's script. The use of annotations to indicate where and / or to justify how credit has been awarded, continues to be helpful.

(d) Good practice.

Many Centres have developed a booklet of tasks and dedicated assessment criteria.

CO-ORDINATED SCIENCES

Paper 0654/51

Practical Test

Key Message

It is essential that candidates read through each question before carrying out practical work. Candidates should take care when constructing tables and in particular when choosing scales for graphs.

General Comments

Generally the exercises were carried out well and candidates were able to complete this paper in the time allocated.

Candidates should record actual observations in the Chemistry question and not what they expect to see. A solid formed when one liquid is added to another should be referred to as a precipitate (ppt). 'Cloudy' is not an alternative adjective for 'white or milky' because clouds can vary in colour.

Comments on Specific Questions

Question 1

Most candidates were able to carry out this experiment and obtain viable results without having to write maximum next to their readings. The number of drops used for each concentration was very variable although the values gave a reasonable graph in most cases. There were a small number of curves despite the instruction to draw the best-fit straight line. Some candidates included fruit juice as part of the x-axis of the graph, and therefore did not fully understand the meaning of part (c).

In part (c) only a few candidates were awarded full credit, either because the result for the juice did not fit on the graph or no mark was made on the graph as instructed.

In part (d) a significant number of candidates realised the need for the control test but the wording used to express this idea varied enormously.

The most common answer in part (e) concerned the volume of a drop but unfortunately the majority gave the improvement as the use of a measuring cylinder which was not a creditworthy response.

In part (f) most candidates recognised the need to repeat the experiment but far fewer supplemented this with the identification of anomalous results and the calculation of a mean.

In part (g) the consequences of a diet lacking in vitamin C were quite well known.

Question 2

Generally this experiment worked well and those who followed the heating instructions in part (a) obtained useful results. Many assumed that something should have happened to the solid so made up a description with some candidates even saying that it had melted.

Candidates should be reminded that the white precipitate produced by bubbling carbon dioxide through limewater may be described as milky, as in the Notes for use in Qualitative Analysis, but not as cloudy.

Parts (b) and (c) were usually well answered although there were some poor descriptions of precipitates.

The results for part **(d)(ii)** were affected if candidates had not used sufficient heating in part **(a)** (to produce the carbonate) and also on the quality of their observations in the previous parts. Generally answers to part **(d)(iii)** were poor with few giving sodium carbonate as an answer. A significant number reported carbon dioxide as a product.

Question 3

The Physics exercise was generally well answered.

The most common errors were: not recording the mass to the nearest 0.1 g; inconsistent accuracy in the recording of the volumes; not recording length, breadth and height to the nearest 0.1 cm; and recording density values to an inappropriately low or high number of significant figures.

In **Method 2**, candidates were asked to mould the plasticine into the shape of a cube but many shapes were far from cubic. This was not penalised.

The final values of density were almost within the limits set in the mark scheme.

Although there were four likely answers for part **(c)**, this was not well done and many candidates simply stated that the two masses were not equal. This suggested that these candidates did not appreciate that the methods and calculations allowed for this.

CO-ORDINATED SCIENCES

Paper 0654/52

Practical Test

Key Message

When recording data from measuring instruments it is important to use an appropriate number of decimal places consistently.

General Comments

Generally the exercises were carried out well and candidates were able to complete this paper in the time allocated.

Candidates should record actual observations in the Chemistry question and not what they expect to see. No reaction observed when using qualitative tests simply means that a particular ion is not present and this should be recorded.

Comments on Specific Questions

Question 1

Most candidates gained credit for part **(a)**.

In part **(b)** the times for the agar block to go colourless varied enormously however all candidates obtained results which allowed them to proceed with this question. Some of the tables were poorly drawn although the necessary figures were present. Candidates need practice at this task which should include the use of a ruler.

In part **(c)** most candidates understood that the alkali in the agar had been neutralised (by the acid) but only the most able stated that the process involved diffusion.

All possible answers to part **(d)** were seen but the most common response involved the volume of acid used in the experiment.

Answers to part **(e)** were generally weak and many candidates thought this was just a surface area effect or just a volume effect. Those who correctly referred to the 'surface area to volume ratio' often did not understand this concept. Consequently labels for the axes in **(f)** were often surface area or volume.

Most candidates appreciated the need to repeat the experiment using different sizes of blocks in part **(f) (i)**.

Question 2

A large range of colours was reported in part **(a) (i)** but despite this the experiment worked well and gave results which allowed correct conclusions to be made at the end.

Parts **(a) (ii)** and **(a) (iii)** gave negative results but all too often candidates felt that that they should be positive and so made up results. Many candidates who recorded 'grey ppt' for the silver nitrate test concluded that a chloride was not present.

Candidates should be reminded that negative results are important and help to eliminate ions in analysis.

Some candidates do not use the word precipitate (ppt) for a solid formed by the addition of two liquids despite this being used throughout the Notes for Qualitative Analysis on the last page of the question paper.

In part **(b)** some candidates confused residue and filtrate but were allowed this 'error carried forward' to the conclusion.

Naming of the salts in part **(c)** was quite well done but many candidates omitted the essential oxidation state for the iron salt.

The colour change was usually recorded in part **(d)** but only the most able recorded the 'steam' for full credit. This emphasises the need for gradual heating and careful observation.

Question 3

Generally this experiment was carried out well.

For part **(a)** candidates are reminded that credit cannot be awarded for poor recording; such as inconsistent use of significant figures and decimal places. The values used in the question can be used as a guide to the precision required. For example, when a value is a whole number and data is being recorded to one decimal place, a value of 2 should be recorded as 2.0.

Most candidates knew the unit of current.

Values of V and I were sometimes unexpected but in the majority of cases this was probably due to the recording of current values in the voltage column and vice versa.

Power calculations in part **(b)** were done well but many candidates did not state that the lamp became dimmer.

In part **(c)** the V/I values were often calculated to an appropriate number of significant figures but sometimes these were wrong due to transcription errors from one table to the other.

Many candidates were able to discuss the incorrect statement in part **(c)(ii)**. Although they were not necessarily penalised, a large number who thought the relationship was an inverse proportionality rather than another inverse relationship.

CO-ORDINATED SCIENCES

Paper 0654/61
Alternative to Practical

Key Messages

Candidates are expected to have carried out experiments and be familiar with experimental techniques similar to those shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from thermometers, burettes, voltmeters, ammeters etc.

General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques.

Candidates should be reminded that where handwriting is not clear, the Examiners are unable to award credit.

Comments on Specific Questions

Question 1

An investigation into the vitamin C content of a fruit juice.

- (a) and (b) Some results were given showing how much vitamin C of various concentrations was needed to decolourise DCPIP. Candidates were instructed to plot a graph with the vitamin C concentration on the horizontal axis, but a large number of candidates plotted the graph with reversed axes. A significant number of candidates tried to plot the fruit juice as a fifth point (at a concentration of 1.25%). The correct way is to clearly draw lines on the graph from the number of drops to the line and then drop it down to the vitamin C value.
- (c) The use of a 'control' experiment was not well known, candidates instead thinking this was a way of diluting the vitamin C even though there was no vitamin C present.
- (d) A number of candidates realised that the adding of drops is not very accurate although few explained how a syringe for example could be used for increased accuracy. Many incorrectly thought that repeating the experiment would increase accuracy.
- (e) The repeating of an experiment in itself does not improve the reliability (or repeatability) of the results. The results need to be studied and averaged or checked for outliers which could be ignored.
- (f) Scurvy was expected as the response, however a number of candidates gave specific symptoms for example bleeding from the gums. Some responses were too general, for example feeling unwell, to be awarded credit and some candidates gave rickets, which is caused by a deficit of vitamin D.

Question 2

A study of sodium hydrogencarbonate and sodium carbonate.

- (a) Candidates generally need to improve their drawing of diagrams; the diagrams drawn here were of a very poor quality. The information given was clear that the reaction vessel was a test-tube with a delivery tube to a test-tube containing limewater. Most candidates were aware that the carbon dioxide evolved produced a white precipitate with limewater, however only the most able were aware that the precipitate dissolves again as more carbon dioxide is bubbled into the limewater.

Finding the boiling point of water droplets is not practical, neither is distillation and Universal indicator would show the sample was neutral, but not that it was water. The use of anhydrous copper(II) sulfate or cobalt chloride was not very well known.

- (b) As candidates were told that sodium hydrogencarbonate is a weak alkali in solution many knew that the Universal Indicator would turn blue, but a number gave purple as the final colour. The addition of an acid to the solution to produce carbon dioxide gas was not well known.
- (c) A number of candidates seem to assume that the use of limewater mean would mean that it would produce a precipitate, but sodium carbonate is thermally stable and the limewater will remain colourless. When told that the solution is more alkaline than the previous one most candidates knew the Universal Indicator would reach a darker colour. Candidates struggled to name the blue precipitate formed when sodium carbonate solution is added to a solution of copper(II) sulphate; very few candidates suggested a copper compound.

Question 3

The density of a block of plasticine.

- (a) The candidates were instructed to use a ruler to measure the lengths of the arrows in order to calculate the volume of a plasticine block. Many candidates measured the three dimensions accurately, and subsequently calculated the volume. Some candidates were rather careless in recording their measurements.
- (b) Many candidates correctly used the diagram and information given to give the correct value for x . Others did not use the information and gave 69 cm or 4 cm. Most candidates correctly used their answers to calculate the density of the block.
- (c) When asked to suggest two reasons for any inaccuracy, Examiners are expecting possible errors in the actual method used. In this question, responses such as the difficulty in moulding the plasticine into a regular block, the difficulty in finding the balance point of the rule or the difficulty in finding the centre of the block, would have gained credit. The general answer 'human error' is too vague to be creditworthy.

Question 4

A question looking at onion cells using a light microscope.

- (a) Candidates were asked to make a drawing of cell **A** from the photograph, not a drawing of a cell they may have previously studied, therefore drawings with vacuoles, chloroplasts etc. were not credited. A cell membrane was expected and the nucleus should have been shown in a similar position as on the photograph.
- (b) Many candidates correctly calculated the average length of the cell, but significant number were unable to state that the field of view of the microscope was 6 mm. Although most candidates correctly calculated the magnification, a number inverted the values.
- (c) Many gained credit for this part, although some correctly stated that a vacuole was missing having drawn it in (a).
- (d) Most candidates knew that iodine stained starch blue-black.

Question 5

An investigation involving the cooling of a hot liquid.

- (a) Almost all candidates gained full credit for the reading of the thermometers. The graph was generally well attempted, a few swapped the axes around and some did not fully label the axes with the name and unit. The biggest error however was not following the points and not drawing a plateau at 69 °C. Although candidates are expected to ignore one possible outlier, there were three points here and as such the curve should follow the points. Most candidates realised that the plateau (whether drawn or not) corresponded to the melting point of the liquid.

- (b) This question proved difficult to all except the most able candidates. Some candidates did not appreciate the substance was cooling and therefore changing from a liquid to a solid, in fact many answers suggested that they thought it was a liquid throughout with the temperature rising.

Question 6

The relationship between voltage, current and resistance was investigated.

- (a) The majority of candidates knew the apparatus required to measure the potential difference and current but fewer could draw them correctly in a circuit. Incorrect symbols and arrangements were seen; voltmeters in series and ammeters in parallel being common errors. Although many candidates gave the correct formula for calculating resistance, a number gave the unarranged formula $V = IR$.
- (b) Many candidates had an almost correct line but it did not always pass through or reach the origin. The unit of resistance was reasonably well known, but R, watts, and joules were also seen.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

Key Messages

Candidates are expected to have carried out experiments and be familiar with experimental techniques similar to those shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from thermometers, burettes, voltmeters, ammeters etc.

General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques.

Candidates should be reminded that where handwriting is not clear, the Examiners are unable to award credit.

Comments on Specific Questions

Question 1

An investigation into the movement of acid into different sized agar blocks.

- (a) Most candidates knew that the colour of the agar was due to the pH of the agar being above 8 or alkaline.
- (b) Almost all candidates constructed a workable table, with a number of headings acceptable. The instruction to record the time in seconds was included twice, once in bold, but a number of candidates wrote their answers in minutes and seconds which was not creditworthy.
- (c) Some candidates confused the process by which the acid moves into the agar, diffusion, with the reason the indicator turns colourless, neutralisation.
- (d) Most candidates were able to link the faster time with the smaller dimensions of the cube, but not all were able to link this to the thin walls in the alveoli enabling efficient gas exchange.
- (e) The extension to the experiment expected was to use a greater range of block size. Full credit was given to candidates specifying one other size block. The labels to the axes were not well done. Candidates were expected to label time on one axis and a dimension (volume, surface area, size etc) on the other. A line or points were not needed.

Question 2

An unknown solid, a mixture of two salts which have the same anion, was investigated.

- (a) Candidates need to appreciate that negative results in chemical tests are just as important as positive tests. Therefore if there are no bubbles produced when an acid is added to the unknown solid we know that a carbonate ion is not present. Many candidates were able to name silver nitrate as one of the reagents required to identify chloride ions; fewer realised that nitric acid is also required. Most knew the term for the reaction that gives out heat.

- (b) Many candidates were aware that the cations present were copper and iron, but did not indicate which iron ion. Any indication of '2' was acceptable. Most candidates realised that filtration will separate a precipitate but a few did not show a funnel and filter paper, thus being unable to gain credit. The majority of candidates realised that the precipitate darkens or turns brown, but fewer gave oxidation as the process that darkens the precipitate. Combustion, diffusion, rusting and 'the Haber process' were among the answers seen.

Question 3

An experiment with a resistance wire.

- (a) Candidates are reminded that when completing tables their values should be quoted to the same number of decimal places as already shown. Therefore 1.3 has an insufficient number of significant figures in this case and 1.30 is expected. When calculating the power in part (ii) candidates were asked to record the values to an appropriate number of significant figures. Two or three were acceptable providing the same was used for all entries and any rounding required was done correctly. The observation that showed the power produced by the lamp decreases is that the lamp becomes dimmer or less bright. No credit was given to comments about the meter readings.
- (b) Candidates had to calculate V/I . The results should have been recorded to a consistent number of significant figures. The suggestion by the teacher was incorrect. If the teacher's suggestion had been correct, the sketch graph should have been a straight line through the origin. As the values calculated were not constant, candidates should have disagreed with the statement.

Question 4

An investigation into water uptake of a plant.

- (a) Many candidates thought that the process described was photosynthesis rather than transpiration. The evaporation of water creating a constant flow of water through the stem was not well known,
- (b) While most candidates knew that the uptake of water would increase in windy conditions, few gave enough experimental details. Examiners needed to know how the conditions would be altered (for example the use of a fan or hair dryer), what would be recorded (the distance moved by the bubble in a set time), what would be kept constant and the use of repeats. The number of marks available for this part question should be a guide to candidates that more than one solid point needs to be made.
- (c) Candidates had to measure the start and end point of an experiment. Candidates were not told from where to measure the bubble. Provided the candidate was consistent in which part of the bubble was used, credit was awarded.
- (d) Most candidates gave humidity or temperature as an environmental factor that affects the rate of water uptake.

Question 5

- (a) A large number of candidates did not read the question stem, where it was clearly stated that only solutions **A**, **B** and **C** were available, and no other reagents could be used. More able candidates realised if the solutions really were as labelled then, if hydrochloric acid was added to sodium carbonate solution, bubbles should be evolved. This does not prove the identity of either but means that the third solution must be barium chloride. Knowing that **C** was barium chloride this could be added in turn to the other solutions to identify them, barium chloride and hydrochloric acid showing no reaction.
- (b) Most candidates knew that **A** and **B** were the solutions required and that evaporation was required although a significant minority thought the process was filtration. The diagrams were again variable. A watch glass heated on a beaker of hot water was expected, but any valid method was accepted.
- (c) Most candidates knew the correct test for zinc ions, but not all remembered that the white precipitate dissolves in excess.

Question 6

The efficiency of a heating element was calculated.

- (a) Many candidates had no difficulty following the instructions and gaining full credit. Some candidates failed to note that the experiment took an hour therefore the number of seconds was 3600 not 60 or any other made up figure.
- (b) Most candidates correctly read the thermometer. A number gave 80.3 instead of 83. To complete the calculation, candidates had to refer to Fig. 6.1 which indicated 500 g of water present.
- (c) Many candidates gave the correct answer. Candidates who had made previous errors in part (a) or (b) could still gain full credit in this section if they used their incorrect values correctly.

CO-ORDINATED SCIENCES

Paper 0654/63
Alternative to Practical

Key Messages

Candidates are expected to have carried out experiments and be familiar with experimental techniques similar to those shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from thermometers, burettes, voltmeters, ammeters etc.

General Comments

Candidates from many Centres demonstrated good understanding of practical knowledge and techniques.

Candidates should be reminded that where handwriting is not clear, the Examiners are unable to award credit.

Comments on Specific Questions

Question 1

A photograph of a flower in section was shown and candidates were asked to make a pencil drawing of it and answer questions on their drawing.

- (a) A reasonable likeness detailing the petals, male and female parts was expected. Some candidates omitted this question. Candidates were asked to label a carpel and stamen. It was not sufficient to label parts male and female alone.
- (b) A pre-drawn line on the photograph had to be measured in mm. Some candidates did not use rulers and others did not answer this part. Some gave their answer in centimetres. Candidates must read the question and follow instructions.
- (c) Having measured the corresponding length on their drawing candidates had to calculate the magnification. Many found this challenging. Some subtracted one length from the other and a number divided the photograph length by their length rather than the other way around.
- (d) The positioning of a **Z** on the stigma was very hit or miss.
- (e) Candidates had to show that they knew from which part of the flower pollen is collected and how to view the pollen after collection; some candidates suggested the use of a telescope.

Question 2

This question involved the identification of some solutions of unknown chemicals.

- (a) By studying the table of observations it should be possible to identify which pair of unknowns were sodium carbonate and hydrochloric acid. The only combination which produces bubbles is **A** and **F**. Sulfuric acid can be used to distinguish between the unknowns; the sodium carbonate producing effervescence and the hydrochloric acid showing no observable reaction. It should be noted that observations were asked for, not the names of products.

- (b) The next pair of unknowns to identify were copper(II) chloride and sodium hydroxide. Candidates were asked for the observations when aqueous ammonia was used to distinguish between the pair. Again, observations were required and not the product names. A blue precipitate changing to a dark blue solution when excess was added was expected for copper(II) chloride. This answer was rarely seen.
- (c) Hydrochloric acid cannot be used to distinguish between zinc sulfate and barium chloride as there would be no visible change. Candidates were asked to name a different acid. Despite this a number gave hydrochloric as their acid of choice. Sulfuric acid was expected as it will give a white precipitate with barium chloride, the test for sulfates.

Question 3

An investigation to find out if the rate of cooling of a beaker of hot water depends upon the temperature of the water.

- (a) When given a table to complete candidates are expected to use the same number of decimal places as already given. Therefore a thermometer reading of 71°C should be recorded as $71.0(^{\circ}\text{C})$.
- (b) When drawing graphs, candidates should be encouraged to use as much of the paper as possible. When told in the question that an axis need not start at 0 candidates should start elsewhere, in this case, at somewhere between 50 and 60. Other points to note are that the axes should be labelled with a name and unit and, if asked for a best fit curve, the line should not be drawn with a ruler. A smooth curve passing through as many points as possible, avoiding any obvious outliers is expected.
- (c) Candidates were asked to calculate the rate of cooling during two different 90 second periods. This required two temperature falls to be found from the graph and then divided by 90. Many candidates managed this successfully, but others read their graphs incorrectly or divided by 390. Many incorrectly rounded 0.078888 to 0.078 rather than 0.079.
- (d) Altering the temperature of the water was the most common response to this question, despite the question asking for factors other than the initial temperature of the water.

Question 4

An investigation into the effect of exercise on heart rate.

- (a) Most candidates knew the effect of exercise on pulse rate.
- (b) Candidates were given a table showing the number of beats in 15 seconds and told to complete the column to show how many beats per minute. Many candidates multiplied by 4 with no problem, others produced answers that bore no relation to the figures given. Reading column headings in tables carefully is as important as reading the question carefully.
- (c) Candidates had to use their figure from above to calculate the aerobic fitness and hence the fitness rating of the candidate. Most managed this successfully whatever value was calculated in (b).
- (d) Results from identical twins were shown. The figures, although very close, gave the twins different fitness ratings. Candidates were expected to comment that although the table gave them different ratings in reality the figures were so close together that there was no real difference or there was an arbitrary cut off between 60 and 61.

Question 5

An investigation into the solubility of potassium nitrate.

- (a) The size of the grid provided should enable the candidate to use the entire area. Some candidates reversed the axes. The points were carefully chosen so that a smooth curve could be drawn through all the points. The curve could then be extended to cross the vertical axis at about 15g. Providing the candidate made a reasonable attempt at the extension, credit was awarded. An extension to the origin was not accepted as it was too far away from the pattern of the plotted points.

Candidates were told that a potassium nitrate solution was still a liquid at 0 °C. Many suggested that the effect was to lower the freezing point of water. Candidates were then asked to calculate the mass of solute that would be precipitated if a saturated solution was cooled from 65 °C to 25 °C. The candidate was instructed to show the working on the graph. Lines were expected to be seen at these temperatures linking to the mass of solute. Most calculated a value of about 90g. Candidates that did not draw lines on the graph were not awarded full credit.

- (b) Few candidates suggested valid reasons for the temperature to be measured as it cooled rather than when it was heated. Suggestions seen and credited included the fact that heating occurred at one position only or that as cooling was a slower process it was easier to concentrate and see when crystals started to form.

Question 6

The roles of current, voltage and resistance in a circuit were investigated.

- (a) A circuit was drawn with three errors, Candidates had to redraw the circuit with the errors removed. Some seemed to redraw it with no changes or by simply moving the variable resistor. Others left the space blank. Two dials were shown and candidates had to read the current and voltage shown. The expected answers were often seen, but some candidates introduced an accuracy that was unavailable from the scales shown e.g. 0.325 A, or values that were a nonsense e.g. 1.5.5 V. Candidates were asked to calculate the resistance using their figures and provide a unit; Ω or 'ohms' were acceptable, but not R, V, A or joules.
- (b) Finally candidates were asked to state what would happen when the variable resistor was turned to its highest setting and then explain the observations made when the resistor was set at its lowest resistance. Most correctly answered the former, but few gave full answers to the later, missing out that the lamp gets brighter due to more current before the filament melts or the lamp 'blows', as the current supplied gets too high.