CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/11
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Questions 1**, **2**, **7**, **11**, **12**, **13** and **14**. **Questions 19**, **25**, **27** and **37** proved the most challenging for candidates.

Comments on specific questions

Question 18

Options **A** and **B** were popular incorrect choices. Candidates should be familiar with the electron arrangement in the molecules listed in the syllabus.

Question 19

There was evidence of guessing as all of the options were popular choices. Candidates are expected to know the products of electrolysis of molten lead(II) bromide.

Question 20

Option **A** was as popular as the correct answer, option **D**, which would be the answer for an exothermic reaction.

Question 22

Option **C** was a common incorrect choice. Only option **B** shows a metal being oxidised.

Question 23

Option **B** was more popular than the correct answer, option **C**. Candidates should be familiar with the pH of water and the chemical test with anhydrous copper(II) sulfate.

Question 25

This was found to be the most demanding question on the paper. All three incorrect options were popular choices suggesting that few candidates had a clear understanding of poly(ethene).

Question 26

Options **B** and **C** were common incorrect choices. Candidates are expected to know that naphtha is used as a chemical feedstock.

Question 27

Option **B** was more popular than the correct answer, option **D**, and options **A** and **C** were as popular as the correct answer. Candidates who have experience with carrying out chemical tests are likely to perform better on questions that require recall of test results.

Question 28

Option **A** was more popular than the correct answer, option **B**. Candidates are expected to be able to convert cm to mm correctly.

Question 29

Option **B** was as popular as the correct answer, option **A**. Some candidates were not confident calculating the moment.

Question 31

Options **A** and **B** were as popular as the correct answer, option **D**. Candidates are expected to be familiar with the transfer of thermal energy by radiation, conduction and convection.

Question 34

Some candidates thought options **A** and **D** were the focal length. Candidates are expected to be able to define and use the focal length of a thin converging lens.

Question 35

Option **A** was more popular than the correct answer, option **B**. 40° is the angle between the mirror and the incident ray rather than the angle of incidence.

Question 37

All the incorrect options were more likely to be chosen than the correct answer. Candidates are expected to know that the combined resistance of two resistors in parallel is less than that of either resistor by itself.

Question 39

Options **B** and **C** were common incorrect choices. Tongs of 10 cm length protect the user from alpha radiation, option **A**. Candidates are expected to know how radioactive materials are moved, used and stored in a safe way including distance and shielding.

Question 40

Options **B** and **C** were popular incorrect choices.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/12
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Questions 1**, **8**, **9**, **13** and **19**. **Questions 14**, **28**, **31** and **38** proved the most challenging for candidates.

Comments on specific questions

Question 2

Option **B** was a popular incorrect choice. Candidates correctly identified the function of the cell wall but many selected cell membrane as its name.

Question 3

Option **A** was as popular a choice as the correct answer, option **C**. The increase in mass is due to water moving into the cells by osmosis and not sugar.

Question 7

Options **A** and **C** were common incorrect choices. Some candidates were not confident in identifying the xylem from a diagram of a root and did not know which substance it transports.

Question 10

Options **A** and **D** were popular incorrect choices indicating that some candidates were not familiar with the order in which impulses pass through neurones in a reflex action.

Question 14

This was found to be one of most challenging questions on the paper. Option **C** was more commonly chosen than the correct answer, option **D**. The number of neutrons was correctly identified but some candidates had not recognised that two electrons are lost to make the positive ion.

Question 17

Option **B** was more popular than the correct answer, option **A**. Candidates realised that thermal energy is taken in from the surroundings in an endothermic reaction but had not appreciated that the temperature of the reaction mixture decreases.

Question 25

Option **C** was equally as popular as the correct answer, option **D**. Option **C** is the structure of ethane and not methane.

Question 27

There was evidence of guessing as all options were chosen with equal frequency. Candidates who carry out regular practical work are more likely to perform well on questions that assess practical methods.

Question 29

Options **B** and **D** were popular incorrect choices showing confusion with both force and pressure at a flat and pointed surface.

Question 31

Option **B** was more commonly chosen than the correct answer, option **A**. Candidates recognised that the mass would decrease during evaporation but thought the temperature would increase.

Question 33

Option **C** was a popular incorrect choice. The wave causes the ball to move up and down rather than only to the right.

Question 36

Options **B** and **C** were both more commonly chosen than the correct answer, option **D**, indicating a lack of confidence in how to determine the resistance of a fixed resistor.

Question 38

This was found to be one of most challenging questions on the paper. Option **D** was more popular than the correct answer, option **A**. Candidates are expected to know that the combined resistance of two resistors in parallel is less than that of either resistor by itself.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/13
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Questions 1**, **8**, **9**, **13** and **19**. **Questions 14**, **28**, **31** and **38** proved the most challenging for candidates.

Comments on specific questions

Question 2

Option **B** was a popular incorrect choice. Candidates correctly identified the function of the cell wall but many selected cell membrane as its name.

Question 3

Option **A** was as popular a choice as the correct answer, option **C**. The increase in mass is due to water moving into the cells by osmosis and not sugar.

Question 7

Options **A** and **C** were common incorrect choices. Some candidates were not confident in identifying the xylem from a diagram of a root and did not know which substance it transports.

Question 10

Options **A** and **D** were popular incorrect choices indicating that some candidates were not familiar with the order in which impulses pass through neurones in a reflex action.

Question 14

This was found to be one of most challenging questions on the paper. Option **C** was more commonly chosen than the correct answer, option **D**. The number of neutrons was correctly identified but some candidates had not recognised that two electrons are lost to make the positive ion.

Question 17

Option **B** was more popular than the correct answer, option **A**. Candidates realised that thermal energy is taken in from the surroundings in an endothermic reaction but had not appreciated that the temperature of the reaction mixture decreases.

Question 25

Option **C** was equally as popular as the correct answer, option **D**. Option **C** is the structure of ethane and not methane.

Question 27

There was evidence of guessing as all options were chosen with equal frequency. Candidates who carry out regular practical work are more likely to perform well on questions that assess practical methods.

Question 29

Options **B** and **D** were popular incorrect choices showing confusion with both force and pressure at a flat and pointed surface.

Question 31

Option **B** was more commonly chosen than the correct answer, option **A**. Candidates recognised that the mass would decrease during evaporation but thought the temperature would increase.

Question 33

Option **C** was a popular incorrect choice. The wave causes the ball to move up and down rather than only to the right.

Question 36

Options **B** and **C** were both more commonly chosen than the correct answer, option **D**, indicating a lack of confidence in how to determine the resistance of a fixed resistor.

Question 38

This was found to be one of most challenging questions on the paper. Option **D** was more popular than the correct answer, option **A**. Candidates are expected to know that the combined resistance of two resistors in parallel is less than that of either resistor by itself.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/21
Multiple Choice (Extended)

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

General comments

Candidates performed very well on **Questions 1**, **2**, **3**, **5**, **8**, **13**, **14**, **17**, **21**, **22**, **25**, **26**, **27**, **30** and **32**. **Questions 4**, **19**, **28**, **31**, and **37** proved the most challenging for candidates.

Comments on specific questions

Question 4

Option **B** was a common incorrect answer. Magnesium ions are essential for making chlorophyll, not cellulose.

Question 12

Options **A** was a popular choice with candidates that processed the 10% calculation incorrectly or were not confident identifying the herbivore and tertiary consumer.

Question 15

Option **C** was a popular incorrect choice. These candidates may have incorrectly determined the relative molecular mass of carbon dioxide to be the lowest of the four gases shown, rather than ammonia.

Question 19

Candidates found this a challenging question and there was evidence of guessing. Options **B** and **D** were slightly more popular than the correct answer, option **C**, and option **A** was chosen with equal frequency to the correct answer. All statements in the syllabus that refer to define should be learnt by candidates.

Question 20

Option **B** was a popular incorrect choice. Candidates knew that 24 dm^3 of oxygen molecules contain one mole of oxygen molecules but incorrectly thought that 16 g of oxygen molecules also contains one mole.

Question 22

Options **A** and **D** were popular incorrect choices. Candidates were not confident interpreting the reaction pathway diagram to determine the activation energy of the reaction.

Question 28

Options **A** and **D** were common incorrect choices. Some candidates were not confident interpreting the extension-load graph. Those selecting **D** thought the 5.0 cm referred to the extension and did not realise that the extension was 1.0 cm.

Question 29

Option **B** was a popular incorrect answer. Candidates correctly recognised the unit as the joule but thought this was equivalent to newton / metre rather than newton metre.

Question 31

Both options **A** and **B** were common incorrect choices. These candidates were not familiar with Brownian motion.

Question 34

Option **A** was a popular incorrect answer. These candidates had reversed the order of the speeds of light in the three mediums and gave the order from highest to lowest.

Question 37

Option **B** was chosen with equal frequency as the correct answer, option **A**. Candidates knew that current I_1 was larger than I_3 but thought the resistance of R_T was larger than R_1 rather than smaller than R_2, indicating a lack of confidence when dealing with combined resistance in a parallel circuit.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/22
Multiple Choice (Extended)

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

General comments

Candidates performed very well on **Questions 1**, **2**, **3**, **4**, **5**, **8**, **10**, **13**, **16**, **17**, **30**, **31**, **33** and **39**. **Questions 6**, **12**, **15**, **19**, **23**, **27**, and **37** proved the most challenging for candidates.

Comments on specific questions

Question 6

Option **A** was as popular as the correct answer, option **D**. These candidates knew that nitrate ions are used to make amino acids but incorrectly thought the phloem is used to transport nitrate ions around a plant.

Question 12

Option **C** was a common incorrect answer. The structural adaptation shown for wind pollination was not feathery anthers but feathery stigmas.

Question 15

This was found to be a demanding question. Options **B** and **C** were more popular than the correct answer, option **D**, and option **A** was as commonly chosen as the correct answer. Candidates were not confident manipulating the data to determine the percentage of unreacted ammonia using the volumes of gases given and the equation for the reaction.

Question 19

Option **B** was as popular as the correct answer, option **A**. Candidates thought that elements on the left of the Periodic Table were non-metallic and therefore formed acidic oxides.

Question 23

Option **C** was as commonly chosen as the correct answer, option **B**, and options **A** and **D** were also popular incorrect choices indicating a lack of familiarity with how oxides of nitrogen are formed in a car engine.

Question 24

Option **C** was a popular incorrect choice. Candidates who carry out regular practical work are more likely to perform well on questions based on practical chemistry.

Question 27

Option **B** was commonly chosen. Candidates thought that nylon contained a carbon chain between the C=O and NH. Candidates are expected to know the structure of nylon.

Question 29

Option **D** was a popular incorrect choice. These candidates determined the percentage of energy wasted rather than subtracting the 760 J from 1000 J and converting this into a percentage.

Question 34

Option **D** was a common incorrect choice. Candidates had confused the properties of real images with virtual images. A real image can be shown on a screen, but a virtual image cannot.

Question 37

Option **C** and **D** were both popular incorrect choices. Candidates were not confident calculating charge using current and time.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/23
Multiple Choice (Extended)

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

General comments

Candidates performed very well on **Questions 2**, **3**, **4**, **6**, **8**, **9**, **11**, **24**, **25**, **28**, **30**, **35** and **40**. **Questions 17**, **27**, **33** and **37** proved the most challenging for candidates.

Comments on specific questions

Question 12

Option **B** was as popular as the correct answer, option **D**. A decrease in respiration will not cause an increase in carbon dioxide.

Question 13

Options **B** and **D** were both common choices showing confusion with where changes in carbon dioxide concentrations will occur as the rate and depth of breathing increases and also the organ that detects the increase.

Question 15

Options **A** and **C** were both common choices. Isotopes of the same element have the same properties because they have the same number of electrons in their outer shell.

Question 16

Option **A** was a common incorrect choice. Sodium chloride is an ionic compound that exists in a lattice as shown in the correct diagram, option **C**.

Question 17

This was found to be a demanding question. Options **A**, **B** and **D** were all more popular than the correct answer, option **C**. Candidates are expected to be able to construct symbol equations, including ionic equations. Many candidates are not confident dealing with spectator ions or balancing charges.

Question 18

Options **A** and **C** were common incorrect choices. Candidates were not confident concluding the reaction pathway diagram was exothermic and then identifying which reactions were exothermic in nature.

Question 19

Option **B** was a popular incorrect choice. Candidates are expected to understand that increasing the temperature of the reaction increases both the frequency of particle collisions and the number of colliding particles that have the minimum energy needed to react.

Question 20

Option **D** was as popular as the correct answer, option **C**. Candidates that carry out regular practical work are more likely to perform well on questions that involve practical chemistry.

Question 23

Option **C** was more commonly chosen than the correct answer, option **D**, and option **B** was as popular as option **D**. Candidates did not recognise that white copper(II) sulfate is anhydrous.

Question 26

Option **A** was more popular than the correct answer, option **B**, showing a lack of confidence in how to determine R_f values from a chromatogram.

Question 27

Option **A** was chosen as frequently as the correct answer, option **C**. Methane is a hydrocarbon and when combusted it does not produce hydrogen.

Question 33

Option **B** was more popular than the correct answer, option **D**. Candidates thought the ray of light would refract out of the glass into the air rather than undergo total internal reflection. These candidates had not considered the critical angle.

Question 36

Option **D** was as commonly selected as the correct answer, option **C**. Candidates were not confident determining the resistance in the circuit and then calculating current.

Question 37

There was evidence of guessing as all options were chosen with equal frequency. Candidates were not confident calculating the time for the lamp to transfer 100 J of energy using current and p.d.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/31
Theory (Core)

Key messages

When drawing or labelling diagrams, candidates should make sure what they present is unambiguous. Use of a pencil is recommended to allow incorrect attempts to be erased and replaced. Care should be taken to ensure any label lines finish on the object being labelled.

Candidates should remember to quote formula in calculations in a recognised form using words or symbols. Use of units to represent quantities in formula should be avoided.

General comments

Candidates were clear and thorough in their approach to the questions requiring a small amount of continuous prose. They made good use of the information in the question to suggest an answer.

Candidates were not so clear in their understanding of scientific terms including their definition and use. A solid underpinning in the knowledge and use of such terms will help candidates across the paper as a whole, for example use of the terms atom and molecule was often confused and prevented clear communication of correct science.

Particular strengths were the calculations in the physics section and the interpretation of the food web in the biology section.

Candidates followed the instructions in the questions, generally giving the appropriate number of responses in the correct format.

Some candidates gave confused answers due to overuse of they, their, them and it. This is particularly important when discussing multiple organisms/factors.

Comments on specific questions

Question 1

(a) Most candidates incorrectly labelled the middle line of cells running through the vascular bundle. Others labelled the large xylem vessels at the bottom of the diagram. It was rare for candidates to correctly label the top section of the vascular bundle.

(b) Candidates could generally identify the process as photosynthesis and knew that light was required. They found identification of carbon dioxide as the other raw material more difficult with a lot of candidates writing oxygen or glucose. A small number of candidates thought the process was respiration which led them down the wrong route for the remainder of the question.

(c) Some candidates gave exemplary responses but a range of incorrect answers were also seen. Some candidates did not know this pathway and so improvised using plant related language from other parts of the syllabus, for example stem, leaf, palisade, hair (repeating the first box) and chlorophyll.

(d) (i) Candidates who did not score commonly wrote osmosis or evaporation. Candidates need to carefully consider the information provided. In this case evaporation could not gain credit because it happens within the leaf, which they were told in the stem of the question. Those candidates who wrote diffusion were credited for correct science.

(ii) Most candidates gave the correct answer of stomata, but all the options were seen.

Question 2

(a) (i) Most candidates found this identification straightforward. The liver was slightly more difficult for candidates to locate with some confusion with the pancreas.

(ii) A significant number of candidates attributed absorption to **A**, the mouth, presumably confusing it with ingestion. The majority of candidates correctly selected a site of digestion, with an equal number for each of the options available. The most common mistake was to identify the colon as a site of digestion.

(b) The marks most regularly awarded were for mechanical and chemical digestion. Candidates were less likely to state that the molecules changed from being insoluble to soluble.

(c) (i) This mathematical question was well answered. Some candidates chose to complete the calculation using the total of the nutrients and were able to gain partial credit for the correct method. Care should be taken not to round to too small a number of significant figures, using the data provided as a guide.

(ii) The question asked for a type of nutrient and a number of candidates gave specific examples, such as calcium or iron which was not creditworthy. Others gave a type of carbohydrate or stated lipids, which were already included in the categories in the table.

Question 3

(a) (i) Most candidates could identify the nucleus as being in both plant and animal cells. Incorrect responses commonly included the cell wall (instead of membrane) or chloroplasts. Candidates often missed off the mitochondria from their correct lists.

(ii) The function of the cell wall was understood by the majority of candidates. The function of the cytoplasm was much less well understood with vague comments about being a jelly substance or incorrect ideas about giving colour to the cell or being involved in transport and support of the cell.

(b) (i) Some candidates were able to give the equation but it was very common to see reactants and products reversed or the equation for photosynthesis given.

(ii) There is an extensive list of the uses of energy from respiration in the syllabus. In this case, candidates generally did not utilise this information and gave vague answers like breathing (potentially showing a misconception of the difference between breathing and respiration), pumping blood or reproduction all of which are indirect uses of energy reliant on direct process like muscle contraction or cell division.

(c) Candidates answered this question logically showing some understanding of the process involved. Candidates should be careful to answer the question asked, in this case relating to the mass of the potato, rather than discussing a change in size. The process of osmosis was often replaced with the vague term absorption. A small number of candidates gave irrelevant answers relating to the water cleaning the potato.

(d) Many candidates did not know that leaves are organs so were unable to gain full credit.

Question 4

(a) Candidates were generally familiar with the role of the Sun in a food web. Giving the name of one or both plants was a common incorrect answer.

(b) Most candidates could correctly identify the direction of consumption in the food web. The two incorrect organisms most commonly seen were hedgehog and fox showing the incorrect direction of consumption.

(c) Again, candidates were able to interpret the food web in most cases. All the organisms in the food web were seen as responses here, rather than just the two plants.

(d) Most candidates had a clear and logical approach to this question which allowed them to gain credit. Some candidates stumbled with overuse of they, their and them which made it very unclear which organism was being referred to. Candidates should be encouraged to be specific in their use of language. They found describing the competition for food (in the form of caterpillars) a harder idea to convey. Those who did not understand the relevance of the direction of the arrows also struggled here as they thought the lapwings ate the hedgehogs.

(e) The term decomposer was well known by many. Candidates tried to give an answer from the food web, which was not required, or gave the general term of primary consumer.

(f) Chemicals was commonly given in the first gap gaining credit. The second gap was often filled with motor or ciliated.

Question 5

(a) (i) Almost all candidates gave the correct answer.

(ii) Most candidates identified E, with a range of incorrect answers.

(iii) Candidates struggled to identify D with a lot giving F but other answers were also seen.

(iv) Again, candidates found this difficult, identifying D or E as the ion.

(v) E and F were the most common incorrect answers, as candidates saw they were related but didn't appreciate that isotopes have different numbers of neutrons.

(b) The negative numbers made this more demanding for candidates. Quite a few gave –253 or –259 and others did not include the negative sign in their answers.

(c) Candidates often stated that either the temperature or volume had increased rather than talking about the effect on pressure. Other candidates described the effect on the particles rather than the effect on pressure. Candidates need to answer the specific question asked, in this case the effect on pressure.

(d) A significant number of candidates had the idea of a pop noise being made but couldn't indicate the test that led to this noise, often confusing it with the test for oxygen.

(e) Candidates were generally not specific enough in their response to this question, either not including the relevant temperature or the idea that only pure water boils at this temperature. Candidates often had the idea of boiling the water and then looking for a residue, or using a pH indicator.

Question 6

(a) Lots of candidates just added up the mass of each atom giving 49 without reference to the formula. Candidates should be encouraged to practice this skill and be clear what is represented by the formula, including the need to multiply by the subscript values.

(b) (i) Vague labels to the apparatus were not given credit and candidates should be encouraged to label carefully and precisely. Candidates also commonly labelled the sides of the cell which are not the electrodes.

(ii) Many candidates labelled the black bung. Others, whether intentionally or unintentionally, labelled the bubbles of gas. Candidates should be encouraged to be unambiguous with their labelling.

(iii) Hydrogen was more commonly known than oxygen, but candidates often placed it at the anode. A number of candidates thought sulfur was produced at the anode with hydrogen at the cathode, only gaining one mark. In some cases, candidates introduced incorrect gases such as methane and carbon dioxide.

(iv) Common incorrect answers include coal, platinum and carbon dioxide. A large portion did give the correct answer.

(c) (i) The colour change of litmus was well known. Very few candidates knew the colour change for methyl orange, with many guessing orange.

(ii) Most candidates stated a figure in the correct range. A wide range of numbers outside this were also given, many not even on the pH scale.

(iii) This was not well known with a range of unrelated answers seen.

Question 7

(a) (i) Many candidates gave vague answers around the idea of having less of something and did not understand that reduction was used in a technical sense. Candidates should be familiar with these technical terms. Others repeated the sentence from the stem of the question, describing the process in a blast furnace. Some who attempted an explanation in terms of electrons got the change the wrong way around.

(ii) Common incorrect answers included bauxite or iron ore with few correct answers seen.

(b) This question was well answered. Some candidates only got one mark because they suggested hydrogen or carbon dioxide as the other condition.

(c) (i) Candidates didn't link the formation of a coloured compound to iron's status as a transition metal. They merely described the reaction or restated iron's reaction with hydrochloric acid as evidence.

(ii) Candidates were usually able to balance the equation but often gave iron chloride a solid state symbol. Occasionally, hydrogen received similar treatment but candidates more often knew this was a gas. Candidates should be encouraged to carefully read the question to determine the state of the products.

(d) Most candidates could correctly answer this question. Malleable, shiny and high melting point were the most common responses.

Question 8

(a) (i) Candidates were often able to state coal as a correct answer. Responses which didn't gain credit commonly related to fractions of petroleum or carbon dioxide.

(ii) Candidates found this more demanding with a range of other gases including nitrogen, hydrogen, oxygen and carbon dioxide seen. Possibly candidates were not familiar with natural gas and so gave gases from air.

(b)(i) Few candidates recognised the process of fractional distillation.

(ii) Lots of vague answers were given which described changes of state or substances not changing. Candidates should be encouraged to learn the distinguishing features of chemical changes from the syllabus so that they can apply them in contexts such as this.

(iii) Many candidates thought bitumen was a fuel and did not score here.

(c) (i) Candidates could generally link the presence of carbon and hydrogen to the classification of octane as a hydrocarbon, but they did not indicate the idea of only these atoms in order to gain full credit. Others were not careful in their use of terms describing octane as containing carbon molecules or described the bonding present.

(ii) This question was well answered. Candidates were clearly familiar with how to deduce the formula of a compound. However, they should be encouraged to follow convention and list the carbon atoms before hydrogen. Some gave the general formula for an alkane which was not the requirement of the question.

(iii) A mixture of ionic and covalent bonding were given as answers, with only the latter gaining credit.

(iv) Although candidates recognised the presence of single bonds, they often did not specify 'only' and so did not gain credit. Candidates should be encouraged to answer questions about saturated hydrocarbons in terms of the bonding present rather than trying to explain the saturation of carbon atoms with hydrogen as this can easily become confused.

(v) Many candidates wrote just carbon and hydrogen as products in this reaction, not appreciating there is a reaction with oxygen. Others broke down octane into other smaller hydrocarbons like methane and propane.

Question 9

(a) (i) Candidates completed this calculation well. Some gave the wrong equation for speed.

(ii) Where candidates are required to show a particular outcome they must include the relevant equation for the relationship, in this case, work done = force × distance. Some candidates just showed the mathematical relationship between the numbers with no other indication of what this represented.

(iii) A significant number of candidates did not know the relationship between power, work done and time and so manipulated the figures incorrectly or used the value for force.

(b) Many candidates knew the appropriate range for a human and were able to make a comparison. Others were too vague in their comparison, often not being clear in their references to horses or humans. Others referred to better hearing which was not the correct idea.

(c) (i) Most candidates gave the correct answer. The atomic mass, 192, and the number of neutrons,115, were common incorrect answers.

(ii) Most candidates were able to perform the correct calculation. Those that did not often gave 49 or 192.

(iii) There was no consistent approach to this question with candidates performing a wide variety of incorrect calculations. Candidates need a clear understanding of a half-life in order to complete these manipulations and it was evident that many were trying to multiply by 0.25 to somehow determine the answer.

Question 10

(a) (i) Candidates often referred to the force as gravity, which gained credit, however, those referring to the force as gravitational potential and gravitational field strength did not gain credit as there was a clear misunderstanding of these terms.

(ii) The vast majority of candidates knew the name for the galaxy. The most common incorrect answer was the Solar System.

(b) (i) This was one of the more demanding questions for candidates. Many did not know the relationship and so tried various manipulations of the figures. Quite a few started down the route of calculating power but then divided by time instead of multiplying. Some gained the mark for the unit, which was awarded independently of the calculation. Some candidates did show their working which allowed them to gain partial credit.

(ii) Candidates were not able to give clear descriptions of direct current (d.c.) and alternating current (a.c). Often, they referred to the d.c. as coming from a battery or going straight, neither of which were creditworthy. Similarly, a.c. current was described as changing, without reference to changing direction (in the context of current) or polarity (in the context of voltage).

(c) (i) Candidates generally knew the relationship and completed the calculation well, gaining full credit in most cases.

(ii) Some candidates divided the area by the pressure, showing some confusion and resulting in incorrect answers. Those that knew the relationship successfully completed the calculation.

Question 11

(a) (i) Candidates were often inaccurate in their drawing of the cells, either drawing the wrong number, putting them in opposing directions or instead using the symbol for a capacitor or resistor. Although candidates knew the symbols for an ammeter and voltmeter, they rarely placed the voltmeter in parallel and if it was in parallel it was not across the lamp.

(ii) Candidates, when required to state a formula, should use the name or symbol of the relevant quantity, not the units. This question was not well answered by most candidates with many showing current divided by voltage.

(b) (i) Candidates put visible light in a range of boxes, although the correct answer was the most commonly seen. Some candidates filled in all the boxes, showing they knew the full range.

(ii) Gamma was well known.

(c) (i) Some candidates knew the line was the normal. Others described it as the reflection, mirror line or line of refraction, none of which gained credit.

(ii) Most candidates either wrote reflection or refraction. Some tried words in between which were not awarded credit.

(iii) The position of the angle of incidence was not well known with the letter *i* being scattered across the diagram. Again, candidates need to be clear when labelling.

(iv) Candidates struggled to draw a line parallel with the incident ray but there were some excellent, carefully drawn refractions seen. It was a common mistake to draw it along the normal, but a wide range of angles were seen. Candidates should be given practical experience where possible to allow them to see this effect.

Question 12

(a) (i) Candidates found this question demanding. They often gave the boiling point, 100 °C, but other common incorrect answers were 30 °C and 1 °C.

(ii) When considering the particle model and the differences between solids, liquids and gases, candidates should be encouraged to consider three aspects: motion, arrangement and spacing. Depending on the question asked different aspects will be relevant. This question asked about the difference in motion and arrangement between solids and liquids. Many candidates gave extensive commentary on the spacing of particles which was not relevant to the question (partly because the particles are close together in both solids and liquids). When considering motion, candidates should be identifying that particles in liquids move randomly, the idea that they slide over each other or move around each other was also given credit. In contrast, particles in solids vibrate in place. Candidates should not state that particles in solids don't have motion as vibration is a form of motion. Regarding arrangement, the key difference between solids and liquids relevant here is that liquids are irregular and solids are regular. Few candidates gave this idea in their responses. Others wrote about bulk properties which are not relevant to these particle level discussions, such as solids having a fixed shape or liquids being able to flow. Candidates must carefully consider which aspects are being addressed before formulating their response.

(iii) Most candidates gained credit through a cancer related argument, often skin cancer which was appropriate for the context.

(b) (i) Some candidates were not specific enough, stating just constant speed, rather than identifying that the climber was not moving. A wide range of acceptable descriptions were seen and accepted.

(ii) Many candidates did not find the steepest part of the graph and calculated the gradient using the total distance and total time to calculate average speed. Those that stated the equation were able to gain partial credit for this approach, showing the importance of showing working.

(iii) Most candidates correctly identified the friction force.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/32
Theory (Core)

Key messages

Reading the question carefully and making sure that the instructions are carefully followed will give candidates a better opportunity to achieve higher marks. They should also ensure that they are reading all the information given in a question stem to make sure that their answers do not just repeat the information given but go beyond this in some way. It is particularly important when being asked to give another example, not to restate the example already given.

Candidates should remember to quote formula in calculations in a recognised form using words or symbols. Use of units to represent quantities in formula should be avoided.

General comments

Candidates were clear and thorough in their approach to the questions requiring a small amount of continuous prose. They made good use of the information in the question to suggest an answer.

Candidates were not so clear in their understanding of scientific terms including their definition and use. A solid underpinning in the knowledge and use of such terms will help candidates across the paper as a whole, for example use of the terms atom and molecule was often confused and prevented clear communication of correct science.

Particular strengths were the calculations in the physics section and the identification of different processes in chemistry.

Some candidates gave confused answers due to overuse of they, their, them and it. This is particularly important when discussing multiple organisms/factors.

Comments on specific questions

Question 1

(a) Almost all candidates could identify the cell wall. The few that did not score often wrote cell membrane (despite it being already labelled on the diagram) or cellulose.

(b) Many candidates knew the role of the cell membrane and expressed it clearly. However, many seemed to think it offered protection or support to the cell. It was also a common misconception that the function was to prevent or control other cells entering the cell.

(c) Many candidates did not know this definition. A lot of very confused answers were seen and also some vague ones which were not specific enough to gain credit. Candidates gave ideas about something that's contagious or that a pathogen is a disease which was insufficient.

(d) Most could identify that blood from a cut was direct transmission but there was confusion as to whether dirty surfaces and contaminated air were indirect or direct.

(e) Most candidates connected all the boxes correctly. Where candidates did make a mistake, they often thought white blood cells trap pathogens and mucus produces antibodies.

(f) A good proportion of candidates gave the correct answer but those who did not often wrote vague answers relating to medicines or confused it with antibodies or antigens. A number incorrectly thought alcohol was a suitable treatment.

Question 2

(a) Candidates struggled to use the terms given in this question correctly. Many thought it was continuous variation with only two genotypes. Gaining familiarity with the use and meaning of these terms through their application in different contexts is important if candidates are to be successful in answering such questions.

(b) (i) More candidates could identify the ovary but some confused it with the stigma. The sepal proved more of a challenge with all other plant parts given as responses.

(ii) Candidates found the identification of these parts demanding. A common misconception was that pollination took place when a pollen grain is transferred from the stigma (**A**) to the ovary (**E**).

(c) (i) The writing of the homozygous genotype was generally well done. However, many candidates repeated homozygous dominant for the description of **Yy**.

(ii) There were a significant number of very clear, well-presented answers given. Others were evidently not familiar with the use of a Punnet square. This was shown by the use of phenotypes or genotypes instead of alleles in the gametes.

(iii) Most candidates tried to use their Punnet square to answer this question. Common mistakes were to state that the **Yy** genotype would give green peas or to add up the number of **Y** and **y** alleles and give this as the ratio rather than the phenotypes.

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(a) Most candidates could identify sensitivity. Some candidates circled multiple responses. These candidates should be encouraged to carefully read the instructions in the question.

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(ii) Most candidates correctly gave the pancreas, with the occasional adrenal gland and liver seen.

(iii) Candidates often selected from the diagram again here, rather than referring to their own knowledge. Others suggested muscle cells.

(iv) Candidates gave a range of responses for each gap. Many seemed to think hormones were growth substances and that they were carried in the spinal cord.

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(a) Most candidates used the information to identify that rhinos are herbivores. Some thought it was a secondary consumer rather than primary, presumably because it is on the second trophic level. It was clear some candidates had not read the information provided as they guessed carnivore.

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(c) (i) The most common answer was the idea of hunting which candidates were clearly familiar with. Others correctly referred to climate change and pollution. It was rare to see the idea of introduced species or disease. Some candidates who were clearly familiar with the specific context referred to an imbalance in the sexes preventing reproduction and gained credit.

(ii) The ideas that humans use the land for farming and building were commonly seen. Some good responses explained that the trees are cut down to provide wood for building.

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(iv) A common incorrect answer was 29 (the sum of the different types of atom present) with no attempt to look at how many of each type of atom were in the formula. Familiarity with what a chemical formula represents is fundamental to chemistry and it was clear a number of candidates either did not look at the formula or did not understand it.

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(ii) Candidates were unfamiliar with the chemical tests for water. Some suggested using an indicator, others named other chemical tests such as limewater, biuret reagent and bromine water.

(iii) A good number of candidates were able to draw the electronic structure correctly, with many more able to place two electrons correctly in one of the bonds. The placement of the electrons outside of the bond proved more challenging with many placing one or more around the hydrogen atoms. Some candidates expected the hydrogen atoms to have the same requirement of 8 electrons in the outer shell that they are familiar with in other elements.

Question 7

(a) (i) Many candidates thought 29 represented the number of electrons or the mass number of the atom, although a large proportion did know it was the proton number. Candidates are encouraged to be specific in their use of language and state in full that the 'number of protons' is represented by this number not just 'protons'.

(ii) The majority of candidates gave the correct answer. Some incorrectly used 29 or 64.

(b) Most candidates gained partial credit on this question but many of these either did not complete the number of responses required or included an incorrect tick. There was no clear pattern in the incorrect responses and all the alternatives proved to be tempting to the candidates.

(c) (i) Most candidates found the balancing of the equation straightforward.

(ii) A significant number of candidates gave the correct answer. Others suggested grams or gravity.

(d) (i) Candidates often expressed part of the meaning: that an alloy is a mixture or that it is a metal. A number misused the term element, describing an alloy as an element made of metals. Despite these mistakes a good number were able to link the ideas and give a complete answer to gain the mark.

(ii) The majority of candidates gave the correct response.

(iii) This question was well answered by most candidates, with those that gained credit generally referring to resistance to rusting or steel being strong. Candidates should be encouraged not to comment on cost in this type of question.

Question 8

(a) (i) Three was the most common answer, but answers in the range of 2–9 were commonly seen as suggestions. Some candidates stated two because it contained calcium and carbonate.

(ii) This proved more challenging to candidates than **8(a)(i)**. 50 was a common incorrect answer, a result of adding up the masses of the atoms but many other figures were given.

(b) (i) Although many candidates suggested apparatus to measure time, measuring cylinder and thermometer were also regularly seen. A number of candidates suggested a chronometer or mobile phone to time, this is not standard apparatus used in practical science.

(ii) It was common for candidates to suggest evaporation or dissolving as the cause of the loss in mass. Others gave vague answers about the reactants being used up. It was also common for candidates to suggest that the hydrochloric acid was turning to gas (implying evaporation) or being boiled which was not credited.

(iii) Many candidates gave the correct answer, others suggested alternative methods of separation which were not applicable in this case.

(iv) Candidates were not consistent in saying what the change would be. In many cases they identified a variable that they could change, for example temperature, but did not then go on to explain that they would increase the temperature. Candidates particularly struggled to explain how they would change the calcium carbonate to increase the rate of reaction. Many suggested more pieces rather than using powder or increasing surface area.

(c) When discussing particles in solids, liquids and gases candidates should be encouraged to consider three aspects: motion, separation and arrangement. In this question relating specifically to a model only the latter two were relevant as the model did not show the motion of the particles and so provided no evidence in this regard. Therefore, candidates should have responded with the idea that particles are close together and regularly arranged in a solid and far apart and randomly arranged in the gas model. Many either did not include both aspects for the solid or gave lengthy discussions about the movement of the particles without referring to one of the two relevant aspects.

Question 9

(a) (i) Almost all candidates were able to identify a time from the appropriate part of the graph. Candidates should be selecting a time on the slope rather than at a point where the acceleration finishes, in this case 40 s, as this shows better understanding of the speed-time graph.

(ii) Candidates found this calculation demanding and took a number of different approaches with different levels of success. Some pursued the wrong approach and sought to calculate the distance using the speed equation, thus gaining no credit. Others tried to work out the area under graph but were unable to use the correct method for the various shapes involved, generally gaining partial credit due to the fact they showed their working. There were two approaches to calculating the area which were both acceptable, splitting the shape into two triangles and a rectangle or treating it as a trapezium. When seen, the latter probably had less success due to the difficulty in calculating the length of the top line in the trapezium. Candidates should ensure that they show working in these questions to allow partial credit to be awarded.

(b) Many candidates described increased collisions rather than describing the change in motion. Others just gave the idea of particles having more energy which was too vague as a response describing kinetic energy or speed of particles was required.

(c) Many candidates were able to apply the formula to calculate the moment. Others tried to manipulate the figures inappropriately gaining no credit.

(d) (i) A wide range of answers were seen, such as energy, electrostatic forces, movement and magnetism. Few candidates knew that friction was responsible for the transfer.

(ii) Few knew that the transfer of charge was due to electrons. Many alternative suggestions were seen, a significant number of which related to electricity.

(iii) Even when candidates had identified electrons in **9(d)(ii)** they often gave positive as the answer.

Question 10

(a) (i) This question was well answered. Some candidates mistakenly gave the upper range and others were clearly guessing.

(ii) Candidates who selected the correct equation for speed successfully completed the calculation. However, some tried to use the speed = distance / time equation without success.

(iii) Wavelength was given correctly more often than amplitude. Switching the two answers around entirely was also common.

(iv) Few candidates gave the correct answer, with many suggesting heat or visible light.

(v) Candidates attempted a wide range of ray diagrams. The best responses showed straight lines, refracting the correct way at the surface of the water, with arrows showing the direction of the light. Some included the incoming ray correctly refracted. However, most responses showed little understanding of refraction or light. Mistakes included showing the light reflecting off the surface of the water, curved lines, dashed lines, lines not finishing at the polar bear or the eye or stopping either side of the water. Some candidates contradicted correctly drawn lines with further lines which either did not refract or came from other parts of the polar bear.

(b) (i) Most correct responses referred to the cancer-causing properties of ionising radiation, including via mutation.

(ii) The most common answer saw candidates reverse the correct order.

Question 11

(a) This question proved demanding for candidates. Many included the moon in their list and it was common for the order to be incorrect as well as lists with lots of gaps.

(b) A significant proportion of candidates gave the correct products, however, many thought a nucleus or neutron was produced.

(c) (i) Most candidates correctly calculated the volume. Some candidates just added the three lengths together. The additional mathematical requirements should be covered in the study of mathematics at this level, but candidates will need practice utilising them in a science context and it may be necessary to reinforce what they have learnt elsewhere.

(ii) Candidates who did not link this question to the relationship between mass, weight and gravitational field strength generally did not gain any credit. Those who did sometimes did not specify this relationship which they must do in questions requiring them to show the given result. Candidates often realised that the units needed conversion with evidence of a variety of conversions gaining credit.

(iii) A number of candidates did not use the figure for volume they had calculated but tried to use the figure for the weight of the block instead. Generally, those who knew the correct relationship to use completed the mathematical skill without problems.

(d) Some candidates gave very clear explanations comparing the density of granite and water. In many cases candidates did not make a comparison of granite with water, just saying it is very dense or has more mass than water. Other responses which did not get credit referred to just that granite is heavier. Arguments relating to weight needed to complete the comparison by mentioning both forces involved and those relating to mass needed to discuss the mass of the water displaced rather than the mass of the water more generally.

Question 12

(a) (i) Candidates found the switch easier to identify then the lamp. The cell proved difficult with most thinking it represented a battery.

(ii) Candidates were generally able to draw the three components in series. Care must be taken not to leave gaps in the circuit, particularly around the cell.

(iii) The equation for resistance was one of the better-known relationships and those who correctly applied it were able to complete the calculation. Candidates should take care to record their answers to the appropriate number of significant figures (shown by the number used in the question) meaning an answer of 3.0 was most appropriate here.

(b) (i) Not all candidates recognised the normal line with many describing it as the mirror line or line of reflection.

(ii) Candidates should be unambiguous in the labelling, avoiding putting letters over lines.

(iii) Candidates did not find this straightforward with many considering the angle to be 80°, 50° or 20°.

(c) Most candidates either attempted refraction through the prism or dispersion but many did not seem aware that both took place. Some candidates only showed dispersion at the exit point from the prism and others were not aware that the light ray would bend towards the normal. It was common for candidates to not show the ray of light passing through the prism and to leave a gap here, before showing the ray emerging out of the prism (usually refracted). The ray of light should be continuous in these diagrams.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/33
Theory (Core)

Key messages

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(ii) This proved more challenging to candidates than **8(a)(i)**. 50 was a common incorrect answer, a result of adding up the masses of the atoms but many other figures were given.

(b) (i) Although many candidates suggested apparatus to measure time, measuring cylinder and thermometer were also regularly seen. A number of candidates suggested a chronometer or mobile phone to time, this is not standard apparatus used in practical science.

(ii) It was common for candidates to suggest evaporation or dissolving as the cause of the loss in mass. Others gave vague answers about the reactants being used up. It was also common for candidates to suggest that the hydrochloric acid was turning to gas (implying evaporation) or being boiled which was not credited.

(iii) Many candidates gave the correct answer, others suggested alternative methods of separation which were not applicable in this case.

(iv) Candidates were not consistent in saying what the change would be. In many cases they identified a variable that they could change, for example temperature, but did not then go on to explain that they would increase the temperature. Candidates particularly struggled to explain how they would change the calcium carbonate to increase the rate of reaction. Many suggested more pieces rather than using powder or increasing surface area.

(c) When discussing particles in solids, liquids and gases candidates should be encouraged to consider three aspects: motion, separation and arrangement. In this question relating specifically to a model only the latter two were relevant as the model did not show the motion of the particles and so provided no evidence in this regard. Therefore, candidates should have responded with the idea that particles are close together and regularly arranged in a solid and far apart and randomly arranged in the gas model. Many either did not include both aspects for the solid or gave lengthy discussions about the movement of the particles without referring to one of the two relevant aspects.

Question 9

(a) (i) Almost all candidates were able to identify a time from the appropriate part of the graph. Candidates should be selecting a time on the slope rather than at a point where the acceleration finishes, in this case 40 s, as this shows better understanding of the speed-time graph.

(ii) Candidates found this calculation demanding and took a number of different approaches with different levels of success. Some pursued the wrong approach and sought to calculate the distance using the speed equation, thus gaining no credit. Others tried to work out the area under graph but were unable to use the correct method for the various shapes involved, generally gaining partial credit due to the fact they showed their working. There were two approaches to calculating the area which were both acceptable, splitting the shape into two triangles and a rectangle or treating it as a trapezium. When seen, the latter probably had less success due to the difficulty in calculating the length of the top line in the trapezium. Candidates should ensure that they show working in these questions to allow partial credit to be awarded.

(b) Many candidates described increased collisions rather than describing the change in motion. Others just gave the idea of particles having more energy which was too vague as a response describing kinetic energy or speed of particles was required.

(c) Many candidates were able to apply the formula to calculate the moment. Others tried to manipulate the figures inappropriately gaining no credit.

(d) (i) A wide range of answers were seen, such as energy, electrostatic forces, movement and magnetism. Few candidates knew that friction was responsible for the transfer.

(ii) Few knew that the transfer of charge was due to electrons. Many alternative suggestions were seen, a significant number of which related to electricity.

(iii) Even when candidates had identified electrons in **9(d)(ii)** they often gave positive as the answer.

Question 10

(a) (i) This question was well answered. Some candidates mistakenly gave the upper range and others were clearly guessing.

(ii) Candidates who selected the correct equation for speed successfully completed the calculation. However, some tried to use the speed = distance / time equation without success.

(iii) Wavelength was given correctly more often than amplitude. Switching the two answers around entirely was also common.

(iv) Few candidates gave the correct answer, with many suggesting heat or visible light.

(v) Candidates attempted a wide range of ray diagrams. The best responses showed straight lines, refracting the correct way at the surface of the water, with arrows showing the direction of the light. Some included the incoming ray correctly refracted. However, most responses showed little understanding of refraction or light. Mistakes included showing the light reflecting off the surface of the water, curved lines, dashed lines, lines not finishing at the polar bear or the eye or stopping either side of the water. Some candidates contradicted correctly drawn lines with further lines which either did not refract or came from other parts of the polar bear.

(b) (i) Most correct responses referred to the cancer-causing properties of ionising radiation, including via mutation.

(ii) The most common answer saw candidates reverse the correct order.

Question 11

(a) This question proved demanding for candidates. Many included the moon in their list and it was common for the order to be incorrect as well as lists with lots of gaps.

(b) A significant proportion of candidates gave the correct products, however, many thought a nucleus or neutron was produced.

(c) (i) Most candidates correctly calculated the volume. Some candidates just added the three lengths together. The additional mathematical requirements should be covered in the study of mathematics at this level, but candidates will need practice utilising them in a science context and it may be necessary to reinforce what they have learnt elsewhere.

(ii) Candidates who did not link this question to the relationship between mass, weight and gravitational field strength generally did not gain any credit. Those who did sometimes did not specify this relationship which they must do in questions requiring them to show the given result. Candidates often realised that the units needed conversion with evidence of a variety of conversions gaining credit.

(iii) A number of candidates did not use the figure for volume they had calculated but tried to use the figure for the weight of the block instead. Generally, those who knew the correct relationship to use completed the mathematical skill without problems.

(d) Some candidates gave very clear explanations comparing the density of granite and water. In many cases candidates did not make a comparison of granite with water, just saying it is very dense or has more mass than water. Other responses which did not get credit referred to just that granite is heavier. Arguments relating to weight needed to complete the comparison by mentioning both forces involved and those relating to mass needed to discuss the mass of the water displaced rather than the mass of the water more generally.

Question 12

(a) (i) Candidates found the switch easier to identify then the lamp. The cell proved difficult with most thinking it represented a battery.

(ii) Candidates were generally able to draw the three components in series. Care must be taken not to leave gaps in the circuit, particularly around the cell.

(iii) The equation for resistance was one of the better-known relationships and those who correctly applied it were able to complete the calculation. Candidates should take care to record their answers to the appropriate number of significant figures (shown by the number used in the question) meaning an answer of 3.0 was most appropriate here.

(b) (i) Not all candidates recognised the normal line with many describing it as the mirror line or line of reflection.

(ii) Candidates should be unambiguous in the labelling, avoiding putting letters over lines.

(iii) Candidates did not find this straightforward with many considering the angle to be 80°, 50° or 20°.

(c) Most candidates either attempted refraction through the prism or dispersion but many did not seem aware that both took place. Some candidates only showed dispersion at the exit point from the prism and others were not aware that the light ray would bend towards the normal. It was common for candidates to not show the ray of light passing through the prism and to leave a gap here, before showing the ray emerging out of the prism (usually refracted). The ray of light should be continuous in these diagrams.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/41
Theory (Extended)

Key messages

Candidates should be reminded to read the stimulus material and each question carefully. To be awarded full marks, candidates should ensure that they complete all the instructions contained within the question and pay attention to the command word, or words, given. This was particularly important for **Questions 1(c)**, **2(a)**, **2(b)**, **2(c)(ii)**, **4(b)**, **4(c)**, **5(b)**, **8(c)**, **11(a)(i)** and **11(a)(ii)**.

Candidates should try to match the answers they give with the number of marks available for each part of a question. For example, a two-mark question will require two separate points to be made.

When completing calculations, candidates should remember to state the formula used; 'Formula triangles' are not given credit. Care should be taken when extracting data and units from a question. Candidates should show the working, express the value to an appropriate number of significant figures and include units. When writing numbers, candidates should ensure that they are clear. This was particularly relevant for **Questions 3(a)**, **6(f)**, **7(d)**, **8(c)**, **9(b)**,**10(a)(ii)**, **10(a)(iii)**, **12(b)** and **12(c)(i)**.

Candidates should be reminded to always use correct scientific terminology when describing phenomena. It is important that candidates express their ideas using scientific language, have a good understanding of what the specific scientific terms in the syllabus mean and be able to apply these when giving responses. This is particularly relevant for **Questions 2(a)**, **2(b)**, **2(c)(ii)**, **3(c)(ii)**, **4(b)**, **7(f)**, **8(b)**, **9(d)**, **10(b)** and **11(b)**.

General comments

A high standard of scientific knowledge and understanding was displayed by many of the candidates. Many candidates should be congratulated for their articulate and accurate responses.

Overall, candidates displayed a broad knowledge of the syllabus. However, it was evident that some areas of the syllabus were better known than others. This was especially evident in the case of the new curriculum content.

Comments on specific questions

Question 1

(a) The balanced symbol equation for photosynthesis was well known. Amongst candidates that did not attain both marks, the left-hand side of the equation was more frequently correct than the right-hand side.

(b) Most candidates correctly recognised process **X** as respiration. The most common incorrect responses were transpiration and diffusion. Most correctly stated sunlight, but some used insufficient terms such as sun and solar. Almost all stated that the rate increased. The majority identified the correct time from the graph.

(c) Most candidates linked the reduction in carbon dioxide uptake to a reduction in the rate of photosynthesis. Only the strongest candidates were able to explain this reduction in terms of lower kinetic energy and lower frequency of successful collisions between enzymes and substrate**.**

Question 2

(a) Most candidates understood that one blood vessel was an artery, and one was a vein and stated this. However, more detailed descriptions of the physiological differences between the two were not commonly seen. The most common misconception was that one carries oxygenated blood. Another commonly seen error was to give an idea and then to write the reverse argument in the second space, so effectively only giving one idea. Answers were not always comparative.

(b) The question asked for a description of blood flow from the pulmonary vein to the aorta. Many candidates did not focus on this part of the cycle. As marks were only credited for this section, many quite lengthy answers did not meet the required content. The right side of the heart was frequently misidentified. Some candidates made correct references to the role of valves in the pathway. Fewer mentioned the role of chambers contracting.

(c) (i) The term electrocardiogram or ECG was correctly identified by some candidates. A few referred to listening to the sound of valves closing. The most common insufficient ideas seen were using a stethoscope and taking blood pressure.

(ii) Some candidates correctly identified blood vessel **A** as the coronary artery. There was a good understanding that a blockage would restrict blood flow, but not all candidates explained why this would cause problems to the heart as directed in the question but instead explained impacts of circulation on the wider body.

Question 3

(a) The majority of candidates understood how to use the data given to calculate the average size of the cells shown in the diagram. How to convert the measurement from mm to μm was less well understood. Not all candidates displayed working.

(b) Only some candidates recognised that phloem cells were made in the root. All other options were seen.

(c) (i) Mitosis was correctly stated by the majority of candidates.

(ii) Not all candidates tried to explain cell division in mitosis specifically. Descriptions of the processes in mitosis, when seen, often lacked clarity. The best answers referred to the replication or duplication of chromosomes. Weaker responses referred to an increase or doubling of DNA.

(d) (i) Candidates should be encouraged to engage with questions that require a diagram to be labelled. Label lines should end exactly on the structure being labelled.

(ii) Many candidates named pollen as the male gamete. Almost all correctly stated haploid. A large proportion of the candidates thought that male gametes were genetically identical. Many stated that the joining of gametes was the process of fertilisation.

(iii) Many candidates understood that sexual reproduction provides genetic variation. Some did not explain fully that the advantage of this is to be able to adapt to changes in the environment**.**

Question 4

(a) The correct terminology to describe the position in the food chain were widely known.

(b) Stronger candidates understood that the relative position of the monkey and the frog in their respective food chains needed to be compared. The idea that energy is lost between trophic levels was commonly seen. Not all candidates gave examples of ways this loss occurs. Common incorrect ideas included that it was more efficient to eat a monkey as it was larger than a frog, or that the monkey was higher up the food chain.

(c) The negative effects of deforestation were well known. However, the question asked that these effects were explained. Without correctly linking the effect and the explanation, it was not possible to attain the higher marks. The most commonly seen pairs were; reduction in photosynthesis linked to global warming and increase in carbon dioxide in the atmosphere, and habitat loss linked to extinction**.**

Question 5

(a) The majority of candidates correctly identified the state as gas.

(b) Not all candidates understood to focus on the movement of water molecules during melting. The idea that particles would move faster was well understood, but fewer candidates were able to describe the movement of particles in a liquid, with many describing the movement of particles in a gas.

(c) (i) Many candidates correctly identified the part of the graph where melting was occurring.

(ii) The idea that melting of a pure substance occurs at one temperature only was well understood. Being able to explain this in terms of the horizontal part of the graph was less well expressed.

(d) Candidates displayed a very good understanding of domestic water treatment.

(e) (i) Most candidates correctly identified the shared bonds between hydrogen and oxygen. The rest of the structure was less successfully completed.

(ii) Not all candidates identified that it is the lack of free moving electrons or ions that makes water a poor conductor. A fairly common misconception is that it does not contain a metal.

Question 6

(a) The majority of candidates were able to correctly identify the atomic number. Calculating the number of protons and neutrons was more challenging for some.

(b) The majority of candidates selected the correct electron configuration of element **E**.

(c) Many candidates did not recognise that the question was asking about the same chemical properties, not similar ones. Therefore, responses about having the same number of electrons in the outer shell were frequently seen and were insufficient. To have the same chemical properties the isotopes most have the same electron configuration.

(d) Most candidates did not identify that an acidic oxide would be formed. There was a wide variety of incorrect answers given. This concept was not well understood.

(e) There was a good understanding of how carbon dioxide causes global warming, with almost all candidates scoring some marks and the majority scoring full marks.

(f) The correct answer of 6000 dm^3 was frequently seen. The majority of candidates correctly calculated the M_r of CO_2 as 44.

Question 7

(a) The correct response of exothermic was commonly seen.

(b) The strongest candidates were more successful in recognising that the carbon dioxide was reduced.

(c) Many candidates correctly identified the products as Fe and CO_2. The most commonly seen incorrect answer was Fe_2. Fewer candidates were successful at balancing the equation.

(d) The correct M_r for $CaCO_3$ was frequently seen. Not all candidates realised that the M_r for CaO also needed to be calculated and used to obtain the final answer. Commonly seen incorrect answers were 7 and 700.

(e) The majority of candidates identified that zinc was more reactive than iron. Fewer explained that this meant zinc would give up its electrons more readily.

(f) This question proved demanding. Most candidates recognised that there were delocalised electrons, but far fewer understood that positive zinc ions were also shown. These were often described as particles, atoms or metal. Few candidates correctly mentioned electrostatic attraction.

Question 8

(a) Many correct responses were seen. Most candidates correctly identified how either chain length or boiling point changed at the top of the fractionating column.

(b) (i) The term cracking was not widely known as the correct process. More candidates understood that the process involved high temperatures. The term catalytic cracking was seen quite often.

(ii) The correct formula for butane was only sometimes seen. The most awarded marking point was recognising that the formulas quoted for butane and an alkene balanced with the large alkene given.

(c) Many responses correctly calculated the moles of ethene and steam and clearly displayed the working. The majority of candidates then went on to identify the correct limiting reactant. Some candidates calculated the molecular mass and just compared these, deducing that steam was the limiting reactant as it had less mass.

Question 9

(a) (i) Almost all candidates correctly stated hydrogen or helium and many were able to identify both.

(ii) There was a good level of understanding that increasing the distance from the Sun would decrease the strength of the Sun's gravitational field. The effect on the orbital speed of a planet was less well understood, with a fair percentage thinking the speed would not change.

(b) Many responses incorrectly tried to calculate the speed of the Earth using $s = d / t$.
Another common area where mistakes were made was the conversion of 1 year to seconds. Using 360 days in the calculation was the most common error. Working was almost always seen, as required by the question.

(c) Most candidates correctly stated that the final stage was a black hole or neutron star. Not all candidates attempted this question, suggesting this may be a less well-known area of the syllabus.

(d) A number of responses did not include the term nucleus. There were some good answers, but many were very vague and did not demonstrate a clear understanding of the processes.

Question 10

(a) (i) Most candidates recognised that the graph showed the rocket accelerating, which was an insufficient response on its own. However, only the strongest candidates recognised that the acceleration was changing or increasing.

(ii) Many candidates correctly understood the need to calculate Δv and Δt and use these values to calculate the deceleration. The majority of errors were seen in the quotation of the units, m / s was a common incorrect answer.

(iii) Not all candidates recognised that it was necessary to calculate the area under the graph to calculate the distance. Common incorrect answers were 4500 and 4000 m.

(iv) Many candidates misunderstood and took the time value from the graph where the line peaked, rather than where the motion ceased. The most commonly seen response was 20 s, which was incorrect.

(b) The majority of candidates correctly identified forces that resisted movement, but many struggled to name the force pushing the car forwards. It was common for candidates to name types of energy as a force. It was quite often recognised that there must be a pair of forces acting in opposite directions, but it was less commonly stated that these forces must also be equal in size. A common misconception was that the forward force must be larger as the car was moving forwards.

Question 11

(a) (i) Some candidates were able to explain similarities and differences between boiling and evaporation. Marks were often missed as candidates just made a statement about one of the processes and did not describe the difference. The most common correct ideas where that they both involve a liquid changing to a gas, and that boiling produces bubbles and evaporation does not.

(ii) Most candidates identified a factor that would change the rate of evaporation, but many did not clarify how this factor would need to change to increase the rate of evaporation. Basic responses of temperature and surface area were commonly seen, but the qualification that these would need to increase was often omitted.

(b) Many responses did not describe convection as the bulk movement of a fluid, instead focusing on single molecules of water. A commonly seen misconception was that heat transfers in liquid by conduction. The best answers linked changes of density to movement within the beaker.

Question 12

(a) (i) There was an error in Question **12(a)**. The question should have stated: 'Fig. 12.1 shows a 10 Ω resistor and a resistor **R** of unknown resistance connected in parallel with a 1.8 V cell.' This has been corrected in the published version of the paper. Due to this issue, full marks have been awarded to all candidates for Question **12(a)(i)** to make sure that no candidates were disadvantaged.

(ii) Due to the issue with **Question 12(a)**, full marks have been awarded to all candidates for **Question 12(a)(ii)** to make sure that no candidates were disadvantaged.

(b) The most common error was that total resistance = 1/20 + 1/40. The inverse transformation step was frequently missing, so a final answer of 3/40 or 0.075 was commonly seen. 60 was also commonly seen.

(c) (i) Many candidates correctly calculated the electrical current. The most common error was the inversion of the formula to $I = V / P$.

(ii) Many candidates found this question demanding. It was most common to see the first ray drawn correctly. Candidates should be reminded to use a ruler and pencil to draw rays. This makes corrections easier and also ensures that rays and arrows are depicted as straight lines.

(iii) Some candidates correctly suggested magnification. Projection was a frequently seen incorrect response.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/42
Theory (Extended)

Key messages

Candidates should be able to recognise the different responses required by different command words. 'Describe' and 'Explain' require different responses. For example, in **Question 2(c)(ii)**, a description and an explanation were required, with many candidates often only giving a description of the results.

Candidates should be reminded to use the correct terminology as stated in the syllabus. This can be used to answer questions directly as well as being an aid to answering longer prose questions. Using the correct scientific terminology and language was particularly important for **Question 3(c)**, **5(d)(ii)**, **9(a)(i)** and **11(a)**.

One skill that would be beneficial for candidates to practise is the rearrangement of formulae. This skill was particularly important for **Questions 9(b)(iii)** and **10(c)**.

General comments

There was a high standard of scientific knowledge and understanding evident, with many candidates providing detailed and accurate responses. On occasion, some responses were lacking detail. Candidates can use the mark allocation of the question as a guide to how many specific points to include in their responses.

While many candidates had a broad knowledge of the syllabus, it was evident that some areas of the syllabus were better known than others. For general guidance, the syllabus can be used as a guide to what content needs to be covered and can provide an excellent revision tool for candidates.

Comments on specific questions

Question 1

(a) This question was generally answered well. Some candidates confused the ribosomes with the mitochondria, incorrectly identifying the site of protein synthesis as **B**.

(b) A number of incorrect processes were given including transpiration, active transport and diffusion.

(c) Most candidates were able to give the correct method of absorption and use in a plant for water. This was less successful for nitrate ion. The method of absorption was often incorrectly given as diffusion and the use in a plant incorrectly given as energy.

(d) Many candidates recognised that the vacuole would appear smaller. Fewer were able to draw the detachment of the cell membrane from the cell wall.

(e) There was some confusion with some candidates stating that higher wind speeds decrease the transpiration rate. Only the strongest candidates were able to explain this phenomenon in terms of differences in concentration gradient.

Question 2

(a) Most candidates were able to correctly identify the trachea and the diaphragm. Occasionally some candidates confused the trachea with the larynx.

(b) Many candidates were able to describe two features of gas exchange surfaces.

(c) (i) The majority of candidates could calculate the difference in carbon dioxide percentage between inspired and expired air.

(ii) Candidates that recognised that the process responsible for the changes in composition was aerobic respiration, generally scored highly. Some candidates misinterpreted the question and only described the data in the table.

(d) Candidates should be reminded to read questions carefully. Some candidates tried to explain why breathing rate increased during exercise, which is not what the question required. Few candidates were able to accurately describe the breakdown of lactic acid in the liver by aerobic respiration.

Question 3

(a) (i) The biggest issue was that many candidates were not able to identify which of the cells were animal cells, often simply subtracting the smallest value from the largest. Those that recognised which cells from the list were animal cells usually completed the calculation correctly.

(ii) Most candidates were able to give the correct cell as a red blood cell.

(b) Candidates found this topic more demanding. The proteins were often given as phagocytes or lymphocytes rather than antibodies; lymphocytes were often given in place of phagocytes and passive given in place of active.

(c) Candidates generally were able to state that vaccination contains a weakened version of the flu virus. Fewer were able to explain how this triggers an immune response and long-term immunity. There was some confusion between antigens and antibodies. Candidates should take care to ensure they are using the correct scientific terminology.

(d) This question proved demanding for all but the strongest candidates. A significant number of candidates tried unsuccessfully to explain this in terms of natural selection and the development of resistance. The best responses referred to changing shapes of antigens and the need for new antibodies to match them.

Question 4

(a) Candidates often stated the presence of a jelly coat. The presence of energy stores was less commonly seen.

(b) (i) Few candidates gave the correct response. Common incorrect responses included phytoplankton, producer and secondary consumer.

(ii) Candidates were generally able to complete the food web.

(c) Candidates found it difficult to express their responses and often repeated the stem in the question. Other reasonable suggestions for how human activity decreases the population of orcas such as hunting or removal of the orca's prey were also accepted.

Question 5

(a) The electronic configuration was generally completed well.

(b) Many candidates gave the mass number of 12. The most common incorrect number given was 6.

(c) Few candidates were able to state the number of atoms in 1 mole. Candidates that did attempt this often gave an inaccurate value.

(d) (i) Some candidates seemed reluctant to enter the response of covalent bond twice, often giving ionic bond in place of one of the covalent bonds.

(ii) The use of the correct terminology was important as references to strength were rejected. Explanations in terms of structure were more successful with some candidates describing the tetrahedral structure of diamond.

(e) The sharing of one pair of electrons between the carbon and hydrogens was generally shown correctly. Occasionally, candidates mistakenly added additional electrons to the hydrogen atoms.

Question 6

(a) (i) There were a wide variety of incorrect responses. Occasionally, candidates miscounted the number of hydrogen atoms.

(ii) This question was answered well with many candidates recognising that hydrocarbons only consist of carbon atoms and hydrogen atoms.

(b) This question was very demanding. Only the strongest candidates were able to draw the polymer. Credit was given to candidates that drew continuation bonds, even if the repeating unit was incorrect.

(c) Many candidates only gave information about addition polymerisation or condensation polymerisation rather than giving information about both. The most common difference identified was that addition polymerisation produces the polymer only whereas condensation polymerisation produces the polymer along with a smaller molecule, usually water.

(d) This question was answered well. Very occasionally candidates gave the test for oxygen instead.

(e) This question was generally answered well.

Question 7

(a) Occasionally, candidates tried unsuccessfully to include charges. However, most candidates could determine the correct formula.

(b) Many of the candidates gave the observations that would occur at the cathode, rather than the anode.

(c) (i) This was generally well done. Some candidates gave the electrons a positive charge and some got the equation the wrong way around.

(ii) Candidates that recognised this was an example of oxidation identified the loss of electrons.

(d) (i) The majority of candidates could use the information to give the correct order of reactivity of the metals.

(ii) Sometimes candidates tried to write a singular product incorporating magnesium, sulfur, oxygen and zinc.

(e) Several candidates recognised that the metal atoms were of different sizes. Fewer were able to explain that this prevented the layers of atoms sliding over each other.

Question 8

(a) The state symbols for carbon dioxide and calcium carbonate were generally recognised. The most common incorrect response was to use the state symbol (l) rather than (aq) for hydrochloric acid.

(b) (i) Most candidates could interpret the graph to give a correct time.

(ii) Some candidates did not interpret the question correctly and suggested that a larger piece of calcium carbonate would result in a faster reaction time. Some candidates also suggested that reaction would result in a smaller or higher total volume of carbon dioxide.

(c) This question was generally well answered. Some candidates tried unsuccessfully to explain this in terms of increased kinetic energy rather than increased density of particles.

(d) The biggest difficulty candidates encountered was calculating the number of moles of calcium chloride. Candidates could usually calculate the relative molecular mass of calcium chloride but often gave incorrect values of 22.2 g or 44.4 g for the mass.

Question 9

(a) (i) Some candidates seemed confused about the meaning of energy store and several incorrect responses were seen. These included voltage, cell and battery.

(ii) It was evident there was some misinterpretation of the term energy transfer. Common incorrect responses included current, voltage, chemical and thermal energy.

(iii) This question was answered more successfully, with many candidates giving light or thermal as the energy transfer.

(b) (i) Candidates could generally calculate the change in gravitational potential energy. Occasionally, candidates used the incorrect value for gravity.

(ii) Some candidates tried to calculate the kinetic energy rather than recognising that the kinetic energy just before reaching the water would be the same as the gravitational potential energy.

(iii) An important skill for candidates to practise is the rearrangement of formulae. Only the strongest candidates were able to do this successfully. Partial credit was given for being able to recall the correct formula.

Question 10

(a) (i) Most candidates could give perpendicular as the correct response.

(ii) A common omission was to not include water waves. Sound being incorrectly identified was also commonly seen.

(b) (i) This proved challenging for all but the strongest candidates. Many candidates recognised that **Y** would appear beyond the mirror at approximately the same height and distance. Fewer were able to draw correct angles of reflections for rays from **X**.

(ii) Occasionally, candidates circled inverted in place of upright. The property of virtual was generally identified.

(c) A common error was an incorrect rearrangement of the formula giving the value of 1.98×10^{23} or 2.2×10^{8}.

(d) The best responses answered this question in terms of different frequencies refracting to differing degrees. Candidates generally recognised that different colours of light had different frequencies.

Question 11

(a) Candidates should use the terminology as given in the syllabus. Candidates often tried to describe nuclear fission with no reference to nuclei.

(b) (i) The number of protons was generally identified by many of the candidates.

(ii) The number of neutrons was generally identified by many of the candidates.

(c) (i) The correct change of an increase in voltage was generally identified.

(ii) Candidates answered this question well with many referring to the increase in voltage, decrease in current and subsequent reduction in energy loss through heat.

(d) A common issue was with errors in the formula. Candidates that stated the correct formula generally gave the correct value of the secondary voltage of 108 V.

Question 12

(a) It was clear that candidates were not as familiar with this topic as the other topics in the syllabus. Candidates often stated white dwarf star which result from a planetary nebula and not a supernova.

(b) (i) There was some misinterpretation of the question with some candidates trying to explain this in terms of energy release through radiation. The best responses referred to nuclear fusion and described this in detail.

(ii) Candidates found this demanding and often stated that particles themselves changed in density. There were also many references to air rather than gas.

(iii) This question was answered well with many candidates giving the correct answer.

(c) This question was answered less well. It was clear that some information from the syllabus was less well known by the candidates. Occasionally the candidates omitted the word billion suggesting that the universe was 13 years old.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/43
Theory (Extended)

Key messages

Candidates should check their answers against the questions to make sure that they have answered exactly what is being asked and all instructions have been followed.

Candidates are advised to practise the rearrangement of formulae. When completing calculations, candidates should remember to state the formula used, show their working, express the value to an appropriate number of significant figures and include units.

Candidates should be encouraged to practise balancing equations.

General comments

Generally, candidates showed a good level of understanding of the syllabus content and were able to apply their knowledge to unfamiliar contexts. Some candidates were able to articulate their ideas and give clear and concise responses.

The questions requiring more free response style answers, particularly those in biology, were often lacking the detail required. It is advisable for candidates to practice these styles of questions.

Whilst many candidates had a broad knowledge of the syllabus, it was evident that some areas of the syllabus were better known than others.

Comments on specific questions

Question 1

(a) Many candidates added a correct label but some placed a cross on the left-hand side of the circulatory system.

(b) Candidates found this question demanding. Many stated that the blood circulates faster as their only correct response. A small number also gave blood being pumped at a high pressure. Many discussed the backflow of blood, the role of arteries and veins and an increased oxygen flow.

(c) (i) Most candidates chose the correct statement. Increase the rate of blood flow was the most common incorrect response.

(ii) Stronger candidates gave a correct feature. Many repeated part of the question i.e. a good blood supply, thin walls and allows oxygen in.

(d) (i) The majority of candidates calculated the number correctly. Common errors included inverting the division and multiplying the numbers.

(ii) The role of platelets was quite well known but terminology was often misused. Few commented on whether the number of platelets was above or below the healthy range but instead described the role of platelets. Many discussed the time to heal and scabs forming instead of clotting.

Question 2

(a) (i) Candidates found the explanations demanding but most gained some credit. The need for more oxygen was well known but few explained why it was needed. Many stated the build-up of an oxygen debt but did not explain why. A significant number attempted to answer all three bulleted points rather than just heart rate and breathing or simply repeated the bulleted points.

(ii) Candidates found this demanding. Sweating was well known and frequently the only correct description. A few discussed the hairs lying flat.

(b) (i) This proved to be demanding. Non-creditworthy responses included medicines, antibiotics, cures diseases, prevents diseases and stops diseases. Few stated that drugs are taken into the body.

(ii) Balanced and heathy diets, low-salt diets and low-fat diets were quite well known. Non-scoring responses were often too vague, such as simply stating less fat and less salt.

Question 3

(a) Label **C** was more well known than **G**. A common incorrect response for **C** was **A** and **E** or **F** for **G**.

(b) The function of the flagellum was the most well known and for many this was their only correct response. Whilst many appreciated that the function of mitochondria involves energy, many incorrectly discussed making or creating energy or termed them the powerhouse of the cell. Acrosome was the least well known. Common non-creditworthy responses included head, sperm, cytoplasm, membrane and cell wall.

(c) (i) DNA, genes and genetic information were quite well known. The most common non-creditworthy response was something passed down from parents.

(ii) Haploid was well known. Common incorrect responses included diploid, egg, nucleus and cell.

(d) (i) The majority of candidates knew at least one of the terms and many two. Frequent incorrect responses were antibodies for antibiotics and vaccinations for mutation.

(ii) Most candidates knew at least one method and some two. The most common non- creditworthy answer was to use protection with no further explanation.

Question 4

(a) Many candidates labelled both source and sink correctly. Many reversed the labels.

(b) Candidates found this very demanding. Many knew that starch was broken down but very few knew what was formed from the breakdown or thought amino acids were formed. Many thought that amylase contained starch or that starch was broken down to make energy which is needed for photosynthesis. A small number discussed respiration.

(c) (i) Most described at least one difference. Non-creditworthy responses discussed speed of changes, an enzyme staying constant, alpha showing a greater increase in activity, alpha being more consistent, alpha staying constant for longer and some simply repeated the information in the question.

(ii) Denaturing of the enzyme was quite well known but few explained what the term meant. Common non-creditworthy responses included no activity because it is neutralised and that the pH is too high for the enzyme to be active.

(iii) Candidates found this very demanding and most repeated the information in the question as their answer.

Question 5

(a) Most candidates knew the dye was impure but found the explanation difficult with many stating that it contained many things with no reference to the spots. A significant number thought it to be pure because it only contained black.

(b) Stronger candidates chose the correct distances. **B** and **C**, **A** and **D** and **A** and **C** were all popular.

(c) Stronger candidates calculated the value correctly although many inverted the division or multiplied the distances.

(d) Few candidates appreciated that the particles only move slightly further apart. Incorrect responses included spreading out, moving apart from each other and separating. Many gave the separation in the liquid rather than the change from a solid to a liquid. More knew that the motion increased from vibrating to moving over each other. Again, many described the motion of the liquid but not the changes to the motion from solid to liquid.

(e) The vast majority of candidates gained full credit. The most common error was to reverse the ionic solid and the solid metal.

Question 6

(a) The formula was quite well deduced. Incorrect responses included Mg_2O, MgO_2 and $Mg_{13}O_{14}$.

(b) Stronger candidates knew the classification. Common incorrect responses included basic because magnesium is reactive, basic because magnesium is unreactive, amphoteric because there is a metal and a non-metal and acidic because magnesium is a metal.

(c) The electronic configuration was well deduced by many. 2 and 12 were seen often.

(d) Many candidates answered this correctly. Incorrect similarities included same number of neutrons, same mass number and same element. Incorrect differences included different number of protons and different atomic number.

(e) Stronger candidates calculated the amount correctly. Many calculated an incorrect M_r for magnesium sulfate or inverted the division.

(f) The boiling point of pure water and the criteria of purity was well known. A small number thought pure water boiled at a higher temperature.

Question 7

(a) (i) Most candidates identified the hydrocarbon. **B** and **C** were popular incorrect responses.

(ii) Most candidates identified propene. **B** and **D** were popular incorrect responses.

(iii) Candidates found this demanding. **D** was the most popular incorrect response and then **B**.

(iv) The polymer was quite well known. All responses were seen with no pattern.

(b) Candidates found this very demanding. The products of compete combustion were not well known and hydrocarbons, hydrogen and oxygen were frequently formed. Oxygen as a reactant was often given as O. Those that had the correct formulae found it very difficult to balance the equation.

(c) Stronger candidates calculated the values correctly and showed their working. Many did not calculate anything and attempted an explanation of a limiting reagent. Of those that did the correct calculations many did not explain limiting reagent in terms of the numbers of moles calculated.

(d) The vast majority of candidates knew the dot-and-cross diagram for hydrogen. Some had eight electrons on each hydrogen or an extra non-bonding electron.

Question 8

(a) The fact that energy is released was quite well known but few gave the energy as thermal energy. Many thought that energy was produced or created.

(b) (i) Stronger candidates subtracted the values correctly. Many read the energy for the top of the hump and so 74 kJ / mol was a very common incorrect response.

(ii) Many candidates appreciated that the enthalpy change is the difference in energy between the reactants and products but very few appreciated that the change had a minus sign since energy is released. The energy of the products, 4 kJ / mol, and also 34 kJ / mol, were common incorrect responses.

(c) The role of a catalyst was quite well known. Some discussed it speeding up the reaction or thought the activation energy was increased.

(d) Most candidates gained at least partial credit. Many discussed molecules gaining energy rather than kinetic energy or more collisions rather than more of the collisions being successful.

(e) State symbols were quite well known. Common incorrect responses had sodium chloride as a solid and water as aqueous or gaseous. Some put numbers into the state symbol brackets.

Question 9

(a) (i) Stronger candidates circled the two correct responses. Many candidates circled 3, 4 or all of the quantities.

(ii) Many candidates gave speed but far fewer included the given direction. How fast something travels was a common non-creditworthy response.

(b) The majority of candidates calculated the acceleration correctly. A significant number read the values from the graph incorrectly.

(c) (i) Many candidates calculated the ratio correctly.

(ii) Candidates found this demanding. Some gave the expression for kinetic energy but could not rearrange it and evaluate the answer. Some attempted to use $F = ma$.

Question 10

(a) The Big Bang Theory was not well known. Many discussed explosions to make matter, stars or planets or the explosion of large planets to make particles.

(b) Candidates found this demanding. All possibilities were seen in all boxes; black hole was the most frequent correct response.

(c) (i) Sun was well known. Incorrect responses included inner planets and stars.

(ii) Many candidates gave a correct relationship. Some reversed the relationship or discussed time rather than speed.

(d) Candidates found this very demanding. Many responses were alpha and beta sometimes with no explanations. Many confused penetrating and ionising and so reversed the arguments and thought that gamma was not stopped by the lead.

Question 11

(a) Carelessly drawn arrows caused marks not to be awarded, for instance, where the wavelength was marked partway down the wave but not to the same point each time. The amplitude was frequently drawn from trough to crest.

(b) The equation was quite well known and evaluated. The most common incorrect responses had the rearranging of the equation incorrect, hence, the quantities given in the question were divided instead of multiplied.

(c) (i) Stronger candidates completed the ray diagram carefully and accurately. Common errors included not drawing the rays to the centre of the lens, mistaking which rays went through the principle focus and which went straight through and drawing multiple rays at random. Some drew an incorrect image with no supporting rays.

(ii) Candidates found this demanding. Upright was the best-known characteristic. Common incorrect responses included diminished, inverted, real, blurry and reflected to the other side.

(d) Whilst many candidates appreciated the changes in temperature, few could explain the changes. Most said that the Earth received heat from the Sun during the day and not during the night with no comparison between the energies received and emitted.

Question 12

(a) (i) Many candidates could not define e.m.f. and very few gained any credit. Incorrect responses included electromotive force, current flowing through the circuit, force in volts, voltage flowing through the circuit and the power of the cell.

(ii) Partial credit was often gained for the unit with few giving the correct numerical answer. Incorrect responses included 3.8, 1.5, 11.2 and 2.5.

(iii) Most candidates calculated the value correctly. The most common incorrect response was 3.8 Ω.

(b) Candidates did not read the question carefully and the majority explained the conduction of heat through the wire and few mentioned electrons. Those that did discuss electrical conductivity usually did not include the direction of travel.

(c) (i) Candidates found this demanding; all options were seen with doubled being the most common.

(ii) This was marked consequentially on the answer given to **12 (c)(i)** and so the stronger candidates gained credit. Many could not link the resistance to the change given in **12 (c)(i)**.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/51
Practical Test

Key messages

Underlining key points in questions may help candidates to answer all of what is being asked e.g. giving answers to the appropriate number of significant figures. Rounding of numerical values was not well understood.

The working on graphs to show estimates requires two lines to be drawn. A mark on the axis or a mark on the curve is insufficient.

General comments

Candidates were generally well prepared for this examination and were familiar with several experimental techniques. Experiments were often carried out carefully and with some precision.

Candidates need to remember that axes should be in the orientation given in the question and labelled with both the quantity and unit. The scales chosen should be linear and appropriate so that calculators are not needed to use them and the plotted points cover at least half of the grid. A line of best fit needs to be a single line which takes account of all the points which are not anomalous.

Answers to the planning question were sometimes detailed and logical. Candidates found interpreting and evaluating experiments difficult. Some had not experienced titrations and reading values from a burette.

Comments on specific questions

Question 1

(a) (i) The majority of candidates recorded both times with the time for the smaller cube being smaller than the time for the larger cube. The most common error was recording the values to the nearest 0.1 or 0.01 s.

(ii) Almost all candidates calculated the surface areas correctly. Some did not use the dimensions of the cube given in the procedure.

(iii) The majority of candidates calculated the volumes correctly. Some did not use the dimensions of the cube given in the procedure.

(iv) Most candidates gave either cutting the cube or determining the end point. Starting the stop-watch was sometimes seen but this was not creditworthy.

(b) (i) The standard of graph drawing was variable. A significant number of candidates did not include the quantity and/or the unit on each axis. The scales were often non-linear or the plotted points did not cover at least half of the grid. It is expected that the linear scales will be appropriate e.g. increasing in regular increments. Many scales were difficult to use. It is not appropriate to have 3 or 6 spread over 5 squares or need to use a calculator to work out what each small square is worth. A small number had one or both axes reversed i.e. had the 0 at the right-hand side or at the top of the axis and not at the origin. The plotting of the points was quite good except where the scales were awkward.

(ii) The curve of best fit proved demanding. Many curves were feathery, straight dot-to-dot between points or comprised multiple lines, none of which are creditworthy. Where candidates have a clearly anomalous point which they do not wish to be considered in the curve of best fit they should label the point as anomalous, otherwise the line drawn should take into account all of the points.

(iii) Many candidates estimated the value correctly. Far fewer showed their working on the graph and so only gained partial credit. To show working there needed to be a vertical line from the 2.5 on the horizontal axis up to the curve, and then a horizontal line from the curve to the vertical axis. One line, a mark on the axis or a mark on the curve are not sufficient.

(iv) Candidates found this demanding and many gave the relationship between the variables or discussed an answer in terms of cubes rather than large animals.

Question 2

(a) (i) Most candidates measured both heights and had the value for yeast higher than the apple or in accordance with the Supervisor's results. Some gave the values in cm or in mm but to one decimal place.

(ii) Many candidates correctly compared the amount of catalase in the two samples. Some did not give a reason for their choice or discussed rate of reaction rather than height of foam.

(b) (i) Candidates found this demanding, not appreciating that the catalase is in the cells. Many discussed the hydrogen peroxide being able to get into the cells rather than the catalase being released.

(ii) Candidates found this very demanding with most focussing on faster reactions or complete reactions rather than obtaining an even distribution of the reagents.

Question 3

(a) Almost all candidates completed both experiments. Some were unfamiliar with burettes and had the initial volumes higher than the final volumes or had the initial volume as 50 cm^3, both suggesting that the values were read from the bottom of the burette upwards rather than from the top of the burette downwards. Few candidates achieved values which were within 20% of the Supervisor's results.

(b) (i) Candidates found this demanding, with many describing a faster reaction and a few mixing to distribute reagents. Swirling is important so that what is added each time reacts fully.

(ii) The use of a volumetric pipette or burette was not well known. Incorrect responses included beaker, syringe, pipette unqualified, ruler and measuring cylinder.

(iii) Most candidates subtracted their values correctly.

(iv) Candidates found this demanding. Some divided the two titre values to obtain the ratio, others incorrectly subtracted them. Some appreciated that **J** was more concentrated but often did not have a calculation and so did not explain how they knew this. Many gave **K** as more concentrated because it required a lower volume of acid.

(c) The majority gave the correct colour. Blue and green were the common incorrect responses.

(d) Candidates found this demanding. Not using the indicator was a common response with few appreciating that the volumes found in the procedure needed to be used in order to obtain a neutral solution. Some used a different indicator without specifying which one.

Question 4

Candidates were generally well prepared for this planning question. Many addressed the bullet points and gave a logical description of the investigation. The full range of marks was seen and some candidates gave detailed answers gaining full or almost full credit.

A list of apparatus is unable to gain credit unless the apparatus is used in the method. Many used the number of batteries rather than using a voltmeter to check the voltage in the circuit. Whilst some used a

balance, they discussed weight throughout the plan rather than mass. Scale or scales is insufficient for balance. Many used a timer to control the time for each number of volts in the circuit. Many did not specify the apparatus they would use to make their measurements.

Stronger candidates measured the mass of the key at the start and at the end. Some candidates used a balance to measure the increase in mass without specifying how this would be done and some only measured the mass at the end of the experiment.

Many repeated the experiment for each voltage without explaining why it should be repeated. Where a graph is to be drawn, there needs to be at least five different voltages used.

Control variables were generally well known. Some discussed variables without either describing them as control variables or stating that the variable was the same each time. A significant number thought the voltage should be controlled or thought that the control meant specifying how it was changed e.g. 1.5 V, 3 V, 4.5 V etc.

Candidates found processing results and reaching conclusions demanding. Stating a conclusion from previous knowledge or simply looking for a pattern in the results is not creditworthy. Many suggested drawing a graph without specifying the quantities on each axis. Few candidates explained how the shape of the best-fit line would lead to a conclusion. If a graph is not drawn, a statement about when the voltage applied is increased does the mass of the key increase, hence a positive relationship, or decrease, hence a negative relationship, or stay the same, should be made.

Question 5

(a) Most candidates recorded the mass and volumes correctly. The most common error was to give the two volumes to different numbers of decimal places.

(b) (i) Almost all candidates subtracted the values correctly.

(ii) Most candidates calculated the density correctly using their values. A significant number did not give the final value to three significant figures.

(iii) Many candidates included their working and explained what it shows. There are many acceptable methods for this calculation. Some candidates calculated 10% of one of the values, then added and subtracted this from the original value to get a range which the other value was compared to. Some candidates gave a statement with no calculation which was not creditworthy.

(c) Stronger candidates gained credit, often from a well-drawn diagram. Incorrect responses included reading underneath the meniscus, viewing at eye-level or at 90° but with no reference to the reading, or reading the scale on the measuring cylinder.

(d) (i) The majority of candidates appreciated the issue and gave a reasonable suggestion. The most common non-creditworthy responses were to use a different balance, check the balance is at 0 and add 0.6 g to the mass of the marbles.

(ii) Candidates found this quite demanding. Many candidates trapped the marble between the two blocks to hold them steady without explaining what would be measured.

(iii) Candidates found this very demanding. Many thought the density of the marble would increase or stay the same. Those that had decrease often thought that air has no mass or has no density. More candidates appreciated that the glass would not change density but often did not explain why.

Question 6

(a) (i) Most candidates measured the length correctly. A few did not give a value to the nearest 0.1 cm.

(ii) Most candidates recorded the time correctly.

(iii) Most candidates calculated the period correctly. A small number inverted the division. Calculated values are expected to have a minimum of two significant figures.

(iv) Most candidates calculated the value correctly. The most common error was $2T$.

(v) Most candidates calculated *g* correctly using their values. Some candidates substituted their values into the equation and then did not evaluate it.

(b) (i) Most candidates chose ruler **A**. Many gave a non-creditworthy explanation including more accurate and measures in decimals.

(ii) Candidates found this demanding and many moved the fan or switched the fan off. Moving the pendulum away from the fan, putting the fan in a box and using a heavier bob were also seen frequently.

(c) Candidates found this very demanding with many discussing averages and anomalous results. Those that appreciated it would be difficult to measure often did not explain why.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/52
Practical Test

Key messages

Underlining key points in questions may help candidates to answer all of what is being asked e.g. giving answers to the appropriate number of significant figures. Rounding of numerical values was not well understood.

The working on graphs to show estimates requires two lines to be drawn. A mark on the axis or a mark on the curve is insufficient.

Biological diagrams should have a single continuous outline and should not be shaded.

General comments

Candidates were generally well prepared for this examination and were familiar with several experimental techniques. Experiments were often carried out carefully and with some precision.

Candidates need to remember that axes should be in the orientation given in the question and labelled with both the quantity and unit. The scales chosen should be linear and appropriate so that calculators are not needed to use them and the plotted points cover at least half of the grid. A line of best fit needs to be a single line which takes account of all the points which are not anomalous.

Answers to the planning question were sometimes detailed and logical. Candidates found interpreting and evaluating experiments difficult.

Comments on specific questions

Question 1

(a) (i) All candidates drew the flower and most gained at least partial credit with many gaining full credit. The most common errors were feathery outlines, gaps in the outline, not using at least half of the box and not including the details of the reproductive organs. Drawings should not be shaded.

(ii) Many candidates labelled the stigma correctly, although some labelled the style or an anther. The label line should end on the part being labelled.

(b) (i) Many candidates drew the line and measured it correctly. A significant number did not draw the line and so could not gain credit.

(ii) The majority of candidates recorded a width in mm.

(iii) Calculation of the magnification was often correct although many did not give their answer to two significant figures. Some confused decimal places with significant figures. Incorrect rounding was also an issue.

(iv) The concept of measuring more petals and then calculating an average was well known although many candidates only gave part of the required answer.

(c) Candidates found this very demanding. Stronger candidates identified carbon dioxide as one of the products but far fewer could identify water. Sodium hydroxide, ammonia, glucose, copper and copper sulfate were common incorrect responses. Few candidates could state the correct elements with many repeating the compounds given in the first part of their answer.

Question 2

(a) Candidates found drawing the table demanding. There needed to be columns or rows for the three reagents and for the final colours observed for both solutions. Whilst many candidates included a row or column for the reagents, few included a header for the final colour observed, usually heading the column **A** and **B**.

(b) (i) The majority of candidates completed the experiment carefully and obtained correct results. Common incorrect responses included red as the colour of iodine solution and writing no change or no reaction rather than the colour for the negative tests.

(ii) The nutrients tested for were quite well known. The most common non-creditworthy responses for **A** were sugar and glucose. Candidates should recall that the Benedict's test is for reducing sugars. Protein was well known for **B**. Since negative results were included, it was expected that candidates should also include what the solutions did not contain which many candidates omitted.

Question 3

(a) The majority of candidates achieved a full set of results with values increasing with increasing volume of water. A small number had decreasing values.

(b) (i) The standard of graph drawing was generally good. A significant number did not include the unit and/or quantity on each axis and some reversed the orientation of the axes. The scales were sometimes non-linear or the plotted points did not cover at least half of the grid. It is expected that the linear scales will be appropriate e.g. increasing in regular increments. Some scales were difficult to use. It is not appropriate to have 3 or 6 spread over 5 squares or need to use a calculator to work out what each small square is worth. The most appropriate scale on the vertical axis increased by 2 for every cm, although 5 was acceptable, and the horizontal axis by 20 every cm. The plotting of the points was generally excellent except where the scales were awkward.

(ii) The line of best fit was often a straight line which took account of all the plotted points such that there was approximately the same number of points on each side of the line. Some did not use a ruler, gave very thick lines or joined the points dot-to-dot or drew a curve. Where a candidate plots a point which they believe to be anomalous and do not want to consider this in their line of best fit they should label that point as anomalous.

(iii) Many described the relationship well, using the variables in the question. The most common error was to describe the relationship as proportional when according to their graph it was not. For two variables to be proportional the graph needs to be a straight line going through the origin.

(iv) Most candidates read the value correctly. Far fewer showed their working on the graph and so only gained partial credit. To show working there needs to be a vertical line from the 45 on the horizontal axis up to the curve, and then a horizontal line from the curve to the vertical axis. One line, a mark on the axis or a mark on the curve is insufficient.

(c) More able candidates appreciated that 10 times more solid would dissolve in 10 times more water. Common incorrect responses included values that were 10 or 100 times too small.

(d) Candidates found this very demanding and only a small number named measuring equipment of greater precision than that used in the procedure. Non-creditworthy responses included repeat the measurements, parallax, use smaller volumes of water, measure the potassium sulfate more accurately, read the volume of water at eye-level, measure the volume of potassium sulfate, higher concentration, stirring and use a wider range of volumes of water.

Question 4

(a) (i) Almost all candidates recorded two temperatures with the solution at a higher temperature. The most common error was not recording to the nearest 0.5 °C.

(ii) The vast majority of candidates subtracted the values and calculated the energy change accurately.

(b) (i) Candidates found this demanding. Many described the colour as blue but did not record a precipitate or gave dark blue solution with no first result of a pale blue precipitate. Some did not add a sufficient excess of **L** to attain the precipitate redissolving.

(ii) Since this was marked consequentially from the results in **4(b)(i)**, many candidates gave a correct identity of aqueous **L**. Some gave ammonium rather than ammonia.

Question 5

(a) The majority of candidates recorded a full set of increasing diameters. Incorrect responses included measurements in cm, one or more values decreasing down the table and the readings in mm to the nearest 0.1 mm.

(b) Many candidates described the relationship correctly, using both of the variables in the question. Some misunderstood the term proportional; the ratio of the variables was not constant and so they were not proportional.

(c) (i) Protractor and set square were not well known and few candidates gained credit. Some described or drew the apparatus, but the question asked for it to be named. Incorrect responses included right angled ruler, measuring tape, spirit level, clamp and leveller.

(ii) Candidates found this demanding. Common non-creditworthy responses included stating poor scientific practice such as parallax, human error or reading the hight incorrectly. The most common response was the sand not being level despite the procedure including levelling the sand.

(d) (i) Most candidates calculated the average correctly. However, many did not follow the pattern of whole number values in the table and so recorded their value incorrectly as 23.3 or 23.33 or rounded incorrectly to 24 mm.

(ii) Stronger candidates circled the incorrect value and identified the anomalous value used. The most popular incorrect response was 28 because it was rounded to a whole number.

(e) (i) Most calculated the value correctly. Some used $3r$ instead of r^3.

(ii) The majority of candidates thought the variables were proportional because as volume increased so the diameter of the crater increased. However, this is not the correct use of the term proportional. For the variables to be proportional, the ratio of the variables should be constant and here it is not.

Question 6

Candidates were generally well prepared for this planning question. Many addressed the bullet points and gave a logical description of the investigation. The full range of marks was seen and some candidates gave detailed answers gaining full or almost full credit.

A list of apparatus is unable to gain credit unless the apparatus is used in the method. Thermometer was seen more often than apparatus to measure volume. Many described measuring temperature or volume but did not specify the apparatus they would use to make their measurements.

Stronger candidates appreciated that the question required rate and so measured either the time for a specific fall in temperature or the fall in temperature for a specific time for a minimum of two thicknesses of newspaper. Some only measured a temperature change or just the time for the water to cool without specifying temperatures.

Many repeated the experiment for each number of layers of newspaper without explaining why it should be repeated. Where a graph is to be drawn, there needs to be at least five different layers of newspaper used.

Control variables were generally well known. Some discussed variables without either describing them as control variables or stating that the variable was the same each time. A significant number thought the

number of layers should be controlled or thought that the control meant specifying how the number was changed e.g. 1 layer, 2 layers, 3 layers etc.

Candidates found processing results and reaching conclusions demanding. Stating a conclusion from previous knowledge or simply looking for a pattern in the results is not creditworthy. Many suggested drawing a graph without specifying the quantities on each axis. Few candidates explained how the shape of the best-fit line would lead to a conclusion. If a graph is not drawn, a statement about when the number of layers is increased does the rate of cooling of the hot water increase, hence a positive relationship, or decrease, hence a negative relationship, or stay the same, should be made.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/53
Practical Test

Key messages

Underlining key points in questions may help candidates to answer all of what is being asked e.g. giving answers to the appropriate number of significant figures. Rounding of numerical values was not well understood.

The working on graphs to show estimates requires two lines to be drawn. A mark on the axis or a mark on the curve is insufficient.

Biological diagrams should have a single continuous outline and should not be shaded.

The term proportional was not well understood by candidates.

General comments

Candidates generally demonstrated a reasonable understanding of basic practical knowledge and techniques, although many found explaining why steps in a procedure are undertaken difficult.

Candidates need to remember that axes should be in the orientation given in the question and labelled with both the quantity and unit. The scales chosen should be linear and appropriate so that calculators are not needed to use them and the plotted points cover at least half of the grid. A line of best fit needs to be a single line which takes account of all the points which are not anomalous.

Undertaking practical work helps candidates to interpret and evaluate experimental methods and results and also to describe methods such as those required by the planning question. Many candidates appeared to have little experience of flame tests or a disappearing cross experiment.

Comments on specific questions

Question 1

(a) Many candidates constructed a table with appropriate row and column headings. A small number drew separate tables for the three solutions or had 3 sets of 3 rows for the solutions.

(b) (i) The colours for the positive tests were well known, the negative colours less so. Some wrote no reaction or no change for the negative results.

(ii) The information was processed well and most candidates gave detailed responses. A small number gave diseases with no explanations.

(c) (i) Candidates found determining the concentration quite demanding and some did not attain values commensurate with the Supervisor's value.

(ii) Candidates often gave at least one correct reason and many gave two. Some gave vague non-creditworthy answers such as easy or dangerous.

Question 2

Candidates were generally well prepared for this planning question. Many addressed the bullet points and gave a logical description of the investigation. The full range of marks was seen and some candidates gave detailed answers gaining full or almost full credit.

A list of apparatus is unable to gain credit unless the apparatus is used in the method. Universal indicator was often used but there were few who discussed the use of a pH colour chart in order to determine the pH of the urine. Many incorrectly thought that litmus could be used to determine a pH value. Measuring cylinder was often seen and timer less commonly. Many discussed measuring volume but did not specify the apparatus they would use to make their measurements.

The method proved problematic for many candidates. Some collected urine, added various quantities of water to the urine and then tested its pH. Some used several people each drinking different quantities of water. Many omitted the wait of three hours before sampling the urine. Often the only measurement taken was the pH of urine after drinking water.

Few repeated the experiment for each volume of water, and those who did usually did not explain the reason for repeating. Where a graph is to be drawn, there needs to be at least five different volumes of water used.

Control variables were generally not well known. Some had the same person for each volume of water, but many had several people with no control.

Candidates found processing results and reaching conclusions demanding. Stating a conclusion from previous knowledge or simply looking for a pattern in the results is not creditworthy. Many suggested drawing a graph without specifying the quantities on each axis. Few candidates explained how the shape of the best-fit line would lead to a conclusion. If a graph is not drawn, a statement about when the volume of water is increased does the pH of urine increase, hence a positive relationship, or decrease, hence a negative relationship, or stay the same, should be made.

Question 3

(a) The majority of candidates had a complete set of results increasing down the table. A small number had one value out of sequence and some did not record their values to the nearest second.

(b) (i) The difficulty in seeing when the cross just appears was well known. The most common non-creditworthy response was not starting or stopping the stop-watch at the right time without explaining why.

(ii) Candidates found this very demanding. Many discussed rate rather than time and very few used data from the table to explain their answer.

(c) (i) The majority of candidates calculated the rate correctly. Some did not give their answer to two significant figures and rounding proved demanding for some.

(ii) Candidates found this quite demanding. Many discussed volume or time instead of the variables detailed in the question. Proportional was a common incorrect response. To be proportional the ratio of the two variables needs to be constant, which it was not.

(d) (i) The apparatus was quite well known. Incorrect responses included syringe, beaker, test-tube and pipette unqualified. When referring to a pipette for measuring volume, graduated or volumetric should be specified. A dropping pipette is not suitable for measuring volume.

(ii) This proved to be very demanding with many repeating the information in the question or discussing the rate of the reaction.

(iii) Stronger candidates knew the reason for repeating experiments. Common non-creditworthy responses included more accurate, more precise and to find the average.

(e) Some candidates applied the information given in the question and discussed more collisions. Others repeated the question or stated that more particles react without explaining why.

Question 4

(a) Almost all candidates recorded a full set of results. Common errors included colour with no precipitate, a precipitate with no colour, emulsion instead of precipitate and yellow-orange for the flame colour.

(b) Since this was marked according to the results obtained by the candidates in **4 (a)**, many gave the correct ions. Some candidates probably did not use the qualitative analysis notes printed in the paper and so made incorrect guesses.

(c) Again, the qualitative analysis notes would have helped candidates. Carbonates also give white precipitates with both barium nitrate and silver nitrate and the addition of nitric acid reacts with the carbonates removing them so they cannot give a white precipitate. Incorrect responses included to acidify, to mix and to neutralise.

Question 5

(a) (i) Many candidates identified the component as a resistor but far fewer appreciated it was a variable resistor. The other common response was switch.

(ii) Almost all candidates recorded a value for I.

(iii) The vast majority recorded 6 different values of I, increasing down the table.

(iv) Most candidates calculated the values correctly. Common errors were not recording to the same number of significant figures and rounding incorrectly.

(v) Candidates found the reason for opening the switch difficult to understand. Resetting the meters, stopping the current, stopping electrocution and not draining the battery were popular non-creditworthy responses.

(b) (i) Many candidates did not include the quantity and/or the unit on each axis and some reversed the axes. The scales were often non-linear or the plotted points did not cover at least half of the grid. It is expected that the linear scales will be appropriate e.g. increasing in regular increments. Many scales were difficult to use. It is not appropriate to have 3 or 6 spread over 5 squares or need to use a calculator to work out what each small square is worth. The plotting of the points was generally good except where the scales were awkward. A few had the horizontal axis reversed i.e. had the 0 at the right-hand side and not at the origin.

(ii) The line of best fit was often a straight line which took account of all of the plotted points such that there was approximately the same number of points on each side of the line. Some did not use a ruler, gave very thick lines or joined the points dot-to-dot or drew a curve. Where a candidate plots a point which they believe to be anomalous and do not want to consider it in their line of best fit they should label that point as anomalous.

(iii) Many candidates described the relationship well, using the variables in the question. The most common error was to describe the relationship as proportional when according to their graph it was not. For two variables to be proportional the graph needs to be a straight line going through the origin.

(iv) Candidates found this extremely demanding. Many incorrectly agreed that the variables were proportional. For two variables to be proportional the graph needs to be a straight line going through the origin or the ratio of the two variables needs to be constant.

Question 6

(a) (i) The majority recorded both lengths with l_0 less than l_1. The most common error was not recording both lengths to one decimal place.

(ii) Most calculated the value correctly.

(iii) Most calculated the value correctly.

(b) (i) Many candidates included their working and explained what it shows. There are many acceptable methods for this calculation. Some candidates calculated 10% of one of the values, then added and subtracted this from the original value to get a range which the other value was compared to. Some candidates gave a statement with no calculation which was not creditworthy.

(ii) This proved to be very demanding. Those that correctly chose a lower value often did not explain their choice sufficiently well.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/61
Alternative to Practical

Key messages

Underlining key points in questions may help candidates to answer all of what is being asked e.g. giving answers to the appropriate number of significant figures. Rounding of numerical values was not well understood.

General comments

Some candidates demonstrated a general understanding of basic practical knowledge and techniques, although many found explaining why steps in a procedure are undertaken difficult.

Candidates need to remember that axes should be in the orientation given in the question and labelled with both the quantity and unit. The scales chosen should be linear and appropriate so that calculators are not needed to use them and the plotted points cover at least half of the grid. A line of best fit needs to be a single line which takes account of all the points which are not anomalous.

Answers to the planning question were sometimes detailed and logical. Candidates found interpreting and evaluating experiments difficult. Many had not experienced titrations and reading values from a burette or used the apparatus for heating an evaporating basin.

Comments on specific questions

Question 1

(a) (i) The majority of candidates read the stop-watch correctly, converting the minutes into seconds. The most common incorrect response was 61 s, where the reading was not rounded correctly.

(ii) The majority of candidates calculated the average correctly. The most common incorrect responses gave the value to the nearest 0.1 s rather than to the nearest whole second required by the question

(iii) Almost all candidates calculated the surface areas correctly. There was no pattern to incorrect responses.

(iv) The majority of candidates calculated the volumes correctly. There was no pattern to incorrect responses.

(v) The vast majority of candidates calculated the rate correctly. The most common error was incorrectly rounding to 35.

(b) (i) The standard of graph drawing was variable. A significant number of candidates did not include the quantity and/or the unit on each axis. The scales were often non-linear or the plotted points did not cover at least half of the grid. It is expected that the linear scales will be appropriate e.g. increasing in regular increments. Many scales were difficult to use. It is not appropriate to have 3 or 6 spread over 5 squares or need to use a calculator to work out what each small square is worth. The vertical axis should have increased by 2 for every cm and the horizontal axis by 0.5 every 2 cm.

The plotting of the points was quite good except where the scales were awkward. A small number had the horizontal axis reversed i.e. had the 0 at the right-hand side and not at the origin.

(ii) The curve of best fit proved demanding. If the points were plotted correctly there were no anomalous points and so the curve should have gone through every point or within half a small square of every point. Many of the curves were feathery, straight dot-to-dot between points or comprised multiple lines, none of which are creditworthy. Where candidates plotted a point incorrectly and appear to have an anomalous point which they do not wish to be considered in the curve of best fit, they should label the point as anomalous.

(iii) Most candidates read the value correctly, far fewer showed their working on the graph and so only gained partial credit. To show working there needs to be a vertical line from the 2.5 on the horizontal axis up to the curve, and then a horizontal line from the curve to the vertical axis. One line, a mark on the axis or a mark on the curve is not sufficient.

(c) Candidates found this demanding. Many discussed human error, working out an average, reading errors or making a mistake, none of which were creditworthy.

(d) Many candidates discussed the large animal and the slow rate of diffusion. Many cited the relationship between the variables or discussed an answer in terms of cubes.

Question 2

(a) (i) Many candidates measured just the foam or just the suspension or from somewhere in between.

(ii) Many candidates correctly compared the amount of catalase in the two samples. Some did not give a reason for their choice or discussed rate of reaction rather than height of foam.

(b) (i) Candidates found this demanding, not appreciating that the catalase is in the cells. Many discussed the hydrogen peroxide being able to get into the cells rather than the catalase being released.

(ii) Candidates found this very demanding with most focussing on faster reactions or complete reactions rather than obtaining an even distribution of the reagents.

(c) Many candidates did not focus on the volume being measured and so were imprecise with their answers, measuring cylinder was insufficient, it needed to be a 5 cm^3 or 10 cm^3 measuring cylinder. Unqualified pipette, beaker, test-tube and gas syringes were common incorrect responses.

(d) Stronger candidates gained credit. Incorrect responses included parallax, small size and no measurements on the tube.

(e) Stronger candidates gained credit. Incorrect responses included reliability, calculating an average, more accurate and eliminating errors.

Question 3

(a) Many candidates were unfamiliar with burettes and so read the scale from the bottom upwards like a measuring cylinder rather than from the top to the bottom, hence 28.25 cm^3 was the most common response. 27.65 cm^3 was also quite common.

(b) (i) Candidates found this demanding, with many describing a faster reaction and a few mixing to distribute reagents. Swirling is important so that what is added each time reacts fully.

(ii) The use of a volumetric pipette or burette was not well known. Incorrect responses included beaker, syringe, pipette unqualified, ruler and measuring cylinder.

(iii) Repeating was not well known. Measuring drop by drop, taking the reading at eye level, recording the initial and final volumes, reading to the bottom of the meniscus and reading to 0.05 cm^3 were all non-creditworthy responses.

(c) The majority of candidates subtracted their values correctly. The most common error was adding the values together.

(d) Candidates found this demanding. Some divided the two titre values to obtain the ratio, others incorrectly subtracted them. Some appreciated that **J** was more concentrated but often did not have a calculation and so did not explain how they knew this. Many gave **K** as more concentrated because it required a lower volume of acid.

(e) Many candidates remembered that the colours of the indicator in acid, alkali and neutral solutions were given at the beginning of the question. Blue was the most common incorrect response.

(f) Candidates found this very demanding. Not using the indicator was a common response with few appreciating that the volumes found in the procedure needed to be used in order to obtain a neutral solution.

(g) (i) The diagram proved quite demanding. Few candidates included a gauze on top of the tripod. Some candidates labelled the apparatus correctly.

(ii) Candidates found this very demanding with few gaining credit. Most did not appreciate the comment that the balance was used correctly. The most common response was subtracting the mass of the container from the final mass.

(h) Most candidates did not use the qualitative analysis notes to identify the test for chloride ions and sulfate ions. Incorrect responses included adding litmus, adding universal indicator and testing for hydrogen.

Question 4

Candidates were generally well prepared for this planning question. Many addressed the bullet points and gave a logical description of the investigation. The full range of marks was seen and some candidates gave detailed answers gaining full or almost full credit.

A list of apparatus is unable to gain credit unless the apparatus is used in the method. Many used the number of batteries rather than using a voltmeter to check the voltage in the circuit. Whilst some used a balance, they discussed weight throughout the plan rather than mass. Scale or scales is insufficient for balance. Many used a timer to control the time for each number of volts in the circuit. Many did not specify the apparatus they would use to make their measurements.

Stronger candidates measured the mass of the key at the start and at the end. Some candidates used a balance to measure the increase in mass without specifying how this would be done and some only measured the mass at the end of the experiment.

Many repeated the experiment for each voltage without explaining why it should be repeated. Where a graph is to be drawn, there needs to be at least five different voltages used.

Control variables were generally well known. Some discussed variables without either describing them as control variables or stating that the variable was the same each time. A significant number thought the voltage should be controlled or thought that the control meant specifying how it was changed e.g. 1.5 V, 3 V, 4.5 V etc.

Candidates found processing results and reaching conclusions demanding. Stating a conclusion from previous knowledge or simply looking for a pattern in the results is not creditworthy. Many suggested drawing a graph without specifying the quantities on each axis. Few candidates explained how the shape of the best-fit line would lead to a conclusion. If a graph is not drawn, a statement about when the voltage applied is increased does the mass of the key increase, hence a positive relationship, or decrease, hence a negative relationship, or stay the same, should be made.

Question 5

(a) (i) Most candidates recorded the mass correctly. The most common incorrect response was 36.66 g.

(ii) Most candidates recorded the volume correctly. Many did not read to the bottom of the meniscus and so 22 cm^3 was a common incorrect response.

(iii) Almost all candidates subtracted their value correctly.

(iv) The vast majority of candidates calculated the density correctly using their values. A significant number did not give the final value to three significant figures.

(v) Many candidates included their working and explained what it shows. There are many acceptable methods for this calculation. Some candidates calculated 10% of one of the values, then added and subtracted this from the original value to get a range which the other value was compared to. Some candidates gave a statement with no calculation which was not creditworthy.

(b) Stronger candidates gained credit, often from a well-drawn diagram. Incorrect responses included reading underneath the meniscus, viewing at eye-level or at 90° but with no reference to the reading, or reading the scale on the measuring cylinder.

(c) (i) The majority of candidates appreciated the issue and gave a reasonable suggestion. The most common non-creditworthy responses were to use a different balance, check the balance is at 0 and add 0.6 g to the mass of the marbles.

(ii) Candidates found this demanding. Many candidates trapped the marble between the two blocks to hold them steady without explaining what would be measured or placed the marble on top of the blocks.

(iii) Candidates found this very demanding. Many thought the density of the marble would increase or stay the same, those that had decrease often thought that air has no mass or has no density. More candidates appreciated that the glass would not change density but often did not explain why.

Question 6

(a) (i) Many candidates measured from the bottom of the bob and so the most common incorrect response was 34.1 cm.

(ii) The majority of candidates recorded the time correctly. 24 and 24.0 s were common incorrect responses.

(iii) Most candidates calculated the period correctly. Calculated values are expected to have a minimum of two significant figures.

(iv) Most candidates calculated the value correctly. The most common error was $2T$.

(v) Most candidates calculated g correctly using their values. Some candidates substituted their values into the equation and then did not evaluate it.

(b) (i) Most candidates chose ruler **A**. Many gave a non-creditworthy explanation including more accurate and measures in decimals.

(ii) Candidates found this demanding and many moved the fan or switched the fan off. Moving the pendulum away from the fan, putting the fan in a box and using a heavier bob were also seen frequently.

(c) Candidates found this very demanding with many discussing averages and anomalous results. Those that appreciated it would be difficult to measure often did not explain why.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/62
Alternative to Practical

Key messages

Underlining key points in questions may help candidates to answer all of what is being asked e.g. giving answers to the appropriate number of significant figures. Rounding of numerical values was not well understood.

The working on graphs to show estimates requires two lines to be drawn. A mark on the axis or a mark on the curve is insufficient.

Biological diagrams should have a single continuous outline and should not be shaded.

General comments

Some candidates demonstrated a general understanding of basic practical knowledge and techniques, although many found explaining why steps in a procedure are undertaken difficult.

Candidates need to remember that axes should be in the orientation given in the question and labelled with both the quantity and unit. The scales chosen should be linear and appropriate so that calculators are not needed to use them and the plotted points cover at least half of the grid. A line of best fit needs to be a single line which takes account of all the points which are not anomalous.

Undertaking practical work helps candidates to interpret and evaluate experimental methods and results and also to describe methods such as those required by the planning question. Many candidates appeared to have little experience of flame tests or the formation of precipitates in reactions.

Comments on specific questions

Question 1

(a) (i) All candidates drew the flower and most gained at least partial credit with many gaining full credit. The most common errors were feathery outlines, gaps in the outline, not using at least half of the box and not including the details of the reproductive organs. Drawings should not be shaded. Often the stigma was drawn floating in mid-air or the stamens were missing.

(ii) Many candidates labelled the stigma correctly, although some labelled the style or an anther. The label line should end on the part being labelled.

(b) (i) The majority of candidates measured the width correctly. Some confused units and recorded their value in cm or gave a value 10 or 100 times too small or too large.

(ii) Many candidates drew the line and measured it correctly. The most common responses did not have the line drawn and so credit was not awarded.

(iii) Calculation of the magnification was often correct although many did not give their answer to two significant figures. Some confused decimal places with significant figures. Incorrect rounding was also an issue.

(iv) The concept of measuring more petals and then calculating an average was well known although many candidates only gave part of the required answer.

(c) Candidates found this very demanding. Stronger candidates identified carbon dioxide as one of the products but far fewer could identify water. Sodium hydroxide, ammonia, glucose, copper and copper sulfate were common incorrect responses. Few candidates could state the correct elements with many repeating the compounds given in the first part of their answer.

Question 2

(a) Candidates found drawing the table demanding. There needed to be columns or rows for the three reagents and for the final colours observed for both solutions. Whilst many candidates included a row or column for the reagents, very few included a header for the final colour observed. Completing the table also proved demanding although the final colours of the reagents were quite well known. Many wrote positive or negative in their table instead of giving the required colours. No change was often given for the colour of a negative test.

(b) The nutrients tested for were quite well known. The most common non-creditworthy responses for **A** were sugar and glucose. Candidates should recall that the Benedict's test is for reducing sugars. Protein was well known for **B**. Since negative results were included, it was expected that candidates should also include what the solutions did not contain which many candidates omitted.

Question 3

(a) (i) The majority of candidates recorded the temperature correctly. Common incorrect responses included 22.0, 20, 20.0, 22 and 22.0 °C.

(ii) The majority of candidates appreciated that this was a continuous process and so calculated the total number of spatulas correctly. A common incorrect response was 3, 3, 4, 3, 2.

(b) (i) The standard of graph drawing was generally quite good. Incorrect values in the table were marked as error carried forward. A significant number of candidates did not include the unit and/or quantity on each axis and some reversed the orientation of the axes. The scales were sometimes non-linear or the plotted points did not cover at least half of the grid. It is expected that the linear scales will be appropriate e.g. increasing in regular increments. Some scales were difficult to use. It is not appropriate to have 3 spread over 5 squares or need to use a calculator to work out what each small square is worth. The most appropriate scale on the vertical axis increased by 2 for every cm, although 5 was acceptable, and the horizontal axis by 20 every cm. The plotting of the points was generally excellent except where the scales were awkward.

(ii) The line of best fit caused issues for some candidates and the most common error was to join the first two points and the last point which then gave the remaining two points above the line. A line of best fit should take account of all the points and have an even number of points above and below the line where possible. Straight lines should be drawn with a ruler and should not be thick. Where a candidate plots a point which they believe to be anomalous and do not want to consider in their line of best fit, they should label that point as anomalous.

(iii) Many candidates described the relationship well, using the variables in the question. The most common error was to describe the relationship as proportional when according to their graph it was not. For two variables to be proportional the graph needs to be a straight line going through the origin.

(iv) Most candidates read the value correctly, far fewer showed their working on the graph and so only gained partial credit. To show working there needs to be a vertical line from the 45 on the horizontal axis up to the curve, and then a horizontal line from the curve to the vertical axis. One line, a mark on the axis or a mark on the curve is not sufficient.

(c) Stronger candidates appreciated that 10 times more solid would dissolve in 10 times more water. Common incorrect responses included 1.5, 0.15 and 0.0015 spatula loads / 1000 cm^3 of water.

(d) Many candidates appreciated that water would have frozen. Stating 'it freezes' is insufficient as this could also refer to the potassium sulfate. Other incorrect responses included the solubility is too low, too slow and it would not dissolve.

(e) Candidates found this very demanding and only a small number named measuring equipment of greater precision than that used in the procedure. Non-creditworthy responses included repeat the measurements, parallax, use smaller volumes of water, measure the potassium sulfate more accurately, read the volume of water at eye-level, measure the volume of potassium sulfate, higher concentration, stirring and use a wider range of volumes of water.

(f) Candidates found this very demanding. Few used a water-bath and of those that did, few mentioned the temperature. Many heated the water with a Bunsen burner not appreciating that the temperature would cool down during the experiment. Other incorrect responses included the use a thermometer to measure the temperature and add more spatulas of potassium sulfate.

Question 4

(a) (i) Whilst most candidates read the thermometer correctly, a large proportion recorded the value as 46 and some 40.6 °C.

(ii) Most candidates subtracted the values and calculated the energy change accurately.

(b) Many candidates either knew the reactions of aqueous ammonia or used the qualitative analysis notes printed at the end of the paper. Incorrect responses included sodium hydroxide, copper ions and copper.

(c) Candidates found this demanding with many repeating information in the question instead of giving a different reason. Non-creditworthy responses included discussing sodium, yellow changing the flame colour and discussing results with no reference to colour.

(d) Candidates were unfamiliar with either leaving the precipitate to settle so that the colour of the precipitate can be seen separate from a coloured solution or filtering the precipitate out of the solution. Many described adding nitric acid and barium nitrate instead of determining the colour of the precipitate.

Question 5

(a) (i) The majority of candidates recorded the correct height. A significant number measured either to the middle or the top of the ball.

(ii) The vast majority of candidates recorded the ruler readings correctly and subtracted them to get the diameter of the crater; 8.7 and 13.2 cm were common. Those that measured to the outer edges of the crater gained partial credit as error carried forward for the correct subtraction of their values to give the diameter.

(b) Many candidates described the relationship correctly, using both of the variables in the question. Some misunderstood the term proportional, the ratio of the variables was not constant and so they were not proportional.

(c) (i) Protractor and set square were not well known and few candidates gained credit. Some described or drew the apparatus, but the question asked for it to be named. Incorrect responses included right angled ruler, measuring tape, spirit level and leveller.

(ii) Candidates found this very demanding. Common non-creditworthy responses included parallax, wind affects the sand, ball bounces off the surface, human error, reading the ruler incorrectly, and the most common that the sand is not flat.

(iii) The fragility of glass was well known.

(d) (i) Most candidates calculated the average correctly. However, many did not follow the pattern of whole number values in the table and so recorded their value incorrectly as 23.3 or 23.33 mm.

(ii) Stronger candidates circled the incorrect value and identified the anomalous value used. The most popular incorrect response was 28 because it was rounded to a whole number.

(e) (i) Most calculated the value correctly. Some used $3r$ instead of r^3.

(ii) The majority of candidates thought the variables were proportional because as volume increased so the diameter of the crater increased. However, this is not the correct use of the term proportional. For the variables to be proportional the ratio of the variables should be constant and here it is not.

Question 6

Candidates were generally well prepared for this planning question. Many addressed the bullet points and gave a logical description of the investigation. The full range of marks was seen and some candidates gave detailed answers gaining full or almost full credit.

A list of apparatus is unable to gain credit unless the apparatus is used in the method. Thermometer was seen more often than apparatus to measure volume. Many described measuring temperature or volume but did not specify the apparatus they would use to make their measurements.

Stronger candidates appreciated that the question required rate and so measured either the time for a specific fall in temperature or the fall in temperature for a specific time for a minimum of two thicknesses of newspaper. Some only measured a temperature change or just the time for the water to cool without specifying temperatures.

Many repeated the experiment for each number of layers of newspaper without explaining why it should be repeated. Where a graph is to be drawn, there needs to be at least five different layers of newspaper used.

Control variables were generally well known. Some discussed variables without either describing them as control variables or stating that the variable was the same each time. A significant number thought the number of layers should be controlled or thought that the control meant specifying how the number was changed e.g. 1 layer, 2 layers, 3 layers etc.

Candidates found processing results and reaching conclusions demanding. Stating a conclusion from previous knowledge or simply looking for a pattern in the results is not creditworthy. Many suggested drawing a graph without specifying the quantities on each axis. Few candidates explained how the shape of the best-fit line would lead to a conclusion. If a graph is not drawn, a statement about when the number of layers is increased does the rate of cooling of the hot water increase, hence a positive relationship, or decrease, hence a negative relationship, or stay the same, should be made.

CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/63
Alternative to Practical

Key messages

Underlining key points in questions may help candidates to answer all of what is being asked e.g. giving answers to the appropriate number of significant figures. Rounding of numerical values was not well understood.

The working on graphs to show estimates requires two lines to be drawn. A mark on the axis or a mark on the curve is insufficient.

Biological diagrams should have a single continuous outline and should not be shaded.

The term proportional was not well understood by candidates.

General comments

Some candidates demonstrated a general understanding of basic practical knowledge and techniques, although many found explaining why steps in a procedure are undertaken difficult.

Candidates need to remember that axes should be in the orientation given in the question and labelled with both the quantity and unit. The scales chosen should be linear and appropriate so that calculators are not needed to use them and the plotted points cover at least half of the grid. A line of best fit needs to be a single line which takes account of all the points which are not anomalous.

Undertaking practical work helps candidates to interpret and evaluate experimental methods and results and also to describe methods such as those required by the planning question. Many candidates appeared to have little experience of flame tests or a disappearing cross experiment.

Comments on specific questions

Question 1

(a) (i) The vast majority of candidates gained some credit. Benedict's reagent and the colours for a positive test were well known. Heating was usually omitted and the starting colour was often blue-black. Some incorrectly thought biuret was used.

(ii) Biuret and the colours for a positive test were well known. Both Benedict's and iodine were common incorrect responses.

(b) The information was processed well and most candidates gave detailed responses. A small number gave diseases with no explanations and some omitted the explanation for starvation.

(c) Candidates found this demanding, often giving vague non-creditworthy answers such as easy or dangerous. Candidates needed to discuss the reasons for using the test strip not the chemical test.

Question 2

Candidates were generally well prepared for this planning question. Many addressed the bullet points and gave a logical description of the investigation. The full range of marks was seen and some candidates gave detailed answers gaining full or almost full credit.

A list of apparatus is unable to gain credit unless the apparatus is used in the method. Universal indicator was often used but there were few who discussed the use of a pH colour chart in order to determine the pH of the urine. Many incorrectly thought that litmus could be used to determine a pH value. Measuring cylinder was often seen and timer less commonly. Many discussed measuring volume but did not specify the apparatus they would use to make their measurements.

The method proved problematic for many candidates. Some collected urine, added various quantities of water to the urine and then tested its pH. Some used several people each drinking different quantities of water. Many omitted the wait of three hours before sampling the urine. Often the only measurement taken was the pH of urine after drinking water.

Few repeated the experiment for each volume of water, and those who did usually did not explain the reason for repeating. Where a graph is to be drawn, there needs to be at least five different volumes of water used.

Control variables were generally not well known. Some had the same person for each volume of water, but many had several people with no control.

Candidates found processing results and reaching conclusions demanding. Stating a conclusion from previous knowledge or simply looking for a pattern in the results is not creditworthy. Many suggested drawing a graph without specifying the quantities on each axis. Few candidates explained how the shape of the best-fit line would lead to a conclusion. If a graph is not drawn, a statement about when the volume of water is increased does the pH of urine increase, hence a positive relationship, or decrease, hence a negative relationship, or stay the same, should be made.

Question 3

(a) Many recorded both times correctly, although some copied the full reading into the table. Many recorded the time for 10 cm^3 as 84 s.

(b) (i) Candidates found this very demanding, suggesting they may have had no experience of this type of reaction. Incorrect responses included human error and stopping the stop-watch early or late with no reason given.

(ii) The reason for stirring was quite well understood. Non-creditworthy responses included faster reaction and to ensure a complete reaction.

(iii) Candidates found this very demanding. Very few used data from the table to explain their answer.

(c) (i) The majority of candidates calculated the value correctly. Some did not give their answer to two significant figures and rounding proved demanding for some.

(ii) The proportionality of this relationship was rarely seen and where it was, it was rarely explained. Many discussed time instead of rate or had direct or positive relationship. Partial credit was allowed for explaining that as concentration increased so the rate increased.

(d) (i) The apparatus was not well known. Incorrect responses included syringe, beaker, ruler, test-tube and pipette unqualified. When referring to a pipette for measuring volume, graduated or volumetric should be specified. A dropping pipette is not suitable for measuring volume.

(ii) This proved to be very demanding with many repeating the information in the question or discussing the rate of the reaction.

(iii) Stronger candidates knew the reason for repeating experiments. Common non-creditworthy responses included more accurate, more precise and to find the average.

(iv) Candidates found this demanding. Many repeated the stem of the question. Those that gave 0 often could not explain why.

(e) Many candidates applied the information given in the question and discussed more collisions. Some simply repeated the question.

(f) The colour of universal indicator in weak acid was often thought not to change or to go red, hence the fact that it would be the same colour as the iron(III) nitrate was missed my most candidates.

Question 4

(a) (i) Almost all candidates recorded the volume correctly.

(ii) Some candidates did not use the qualitative analysis notes to identify ions confirmed to be present. Hence, candidates found this demanding.

(b) Again, the qualitative analysis notes would have helped candidates. Carbonates also give white precipitates with both barium nitrate and silver nitrate and the addition of nitric acid reacts with the carbonates removing them so they cannot give a white precipitate. Incorrect responses included to acidify, to mix and to neutralise.

(c) The procedure for doing a flame test was not well known, possibly because many had no previous experience of doing one.

Question 5

(a) (i) Many candidates identified the component as a resistor but far fewer appreciated it was a variable resistor. The other common response was switch.

(ii) The voltmeter reading was usually correct. 1.4 and 1.7 V were also common responses. The ammeter reading proved more demanding with common answers being 0.83 and 0.82 A.

(iii) The vast majority calculated the value correctly using their values from **5 (a)(ii)**.

(iv) Candidates found the reason for opening the switch difficult to understand. Resetting the meters, stopping the current, stopping electrocution and not draining the battery were popular non-creditworthy responses.

(b) (i) Many candidates did not include the quantity and/or the unit on each axis and some reversed the axes. The scales were often non-linear or the plotted points did not cover at least half of the grid. It is expected that the linear scales will be appropriate e.g. increasing in regular increments. Many scales were difficult to use. It is not appropriate to have 3 or 6 spread over 5 squares or need to use a calculator to work out what each small square is worth. The plotting of the points was generally good except where the scales were awkward. A few had the horizontal axis reversed i.e. had the 0 at the right-hand side and not at the origin.

(ii) The line of best fit proved demanding. If the points were plotted correctly there were no anomalous points and so the line should have been straight. A line of best fit should take account of all of the points and have an even number of points above and below the line where possible. Straight lines should be drawn with a ruler and should not be thick. Where a candidate plots a point which they believe to be anomalous and do not want to consider it in their line of best fit, they should label that point as anomalous.

(iii) Many candidates described the relationship well, using the variables in the question. The most common error was to describe the relationship as proportional when according to their graph it was not. For two variables to be proportional the graph needs to be a straight line going through the origin.

(iv) Candidates found this extremely demanding. Of those that answered, the majority agreed that the variables were proportional which is incorrect. For two variables to be proportional the graph needs to be a straight line going through the origin or the ratio of the two variables needs to be constant.

Question 6

(a) (i) The majority recorded the length correctly. The most common incorrect response was 2 cm.

(ii) The meaning of one-half full scale was not well understood. 1, 0.5 and 1.5 cm were seen commonly.

(iii) Candidates found this demanding. Some measured to the top of the loop giving 10 cm, or to the bottom of the loop giving 11 cm, or to the top of the masses giving 12 cm. 10.6 cm was also seen often.

(iv) The majority of candidates calculated the extension correctly.

(v) The majority of candidates calculated the spring constant correctly. A calculated value is expected to be given to a minimum of two significant figures. Some rounded their value incorrectly.

(vi) Candidates found this demanding. Many used a ruler, measured multiple times or used many people to measure.

(b) (i) Many candidates included their working and explained what it shows. There are many acceptable methods for this calculation. Some candidates calculated 10% of one of the values, then added and subtracted this from the original value to get a range which the other value was compared to. Some candidates gave a statement with no calculation which was not creditworthy.

(ii) This proved to be very demanding. Those that correctly chose a lower value often did not explain their choice sufficiently well.