CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/11
Multiple Choice (Core)

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

General comments

Candidates found the biology section easier than chemistry and physics. They found **Questions 7**, **18**, **23**, **29** and **36** particularly easy.

Questions 14, **15**, **17**, **19**, **21**, **22**, **24**, **27**, **28**, **33**, **35**, **39** and **40** were found to be more challenging.

Comments on specific questions

Question 14

Option **C** was equally as popular as the correct answer, **A**. These candidates thought mixtures can only be separated by chemical means.

Question 15

Option **B** was chosen more often than the correct answer, **C**, and option **A** was as popular, indicating a lack of confidence in determining nucleon number from nucleotide information.

Question 17

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Option **B** was more commonly selected than the correct answer, **C**, and options **A** and **D** were equally chosen. Candidates did not appreciate that the question was asking for two elements that form a covalent bond together.

Question 19

Options **B** and **D** were sometimes chosen. These candidates either did not know that hydrogen is produced at the cathode in the electrolysis of concentrated aqueous sodium chloride or did not know the correct test for hydrogen gas.

Question 21

Option **B** was more frequently chosen than the correct answer, **C**. Candidates were not aware that a carbonate reacts with an acid to give salt, water and a gas, whereas a base gives a salt and water.

Question 22

Option **A** was selected more frequently than the correct answer, **B**, and option **C** was equally popular. Candidates did not recognise that rubidium is a metal and its oxide is basic.

Question 24

Options **B** and **C** were often chosen, showing a lack of knowledge of the air pollutants produced by the combustion of fossil fuels.

Question 27

Option **A** was as likely to be selected as the correct answer, **D**, and option **C** was more popular. These candidates did not know the colour of the flame produced by sodium in the flame test.

Question 28

Option **D** was more popular than the correct answer, **B**. Candidates needed to use the information in the diagram to determine the mass of the liquid and then use this to determine the density.

Question 33

Option **D** was more popular than the correct answer, **C**. These candidates assumed that the angle of reflection was measured between the reflected ray and the mirror.

Question 35

All of the options were selected more commonly than the correct answer, **D**, indicating a lack of understanding of how to produce a sound with a higher pitch.

Question 39

All of the options were selected more commonly than the correct answer, **B**, indicating a lack of understanding of using half-life to determine a mass after a set number of hours.

Question 40

Options **A** and **D** were sometimes chosen. These candidates could either not name a dwarf planet or thought that an asteroid orbits a planet.

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CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/12
Multiple Choice (Core)

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

General comments

Candidates found **Questions 2**, **4**, **8**, **18**, **22**, **23**, **26**, **27**, **28**, **34**, **38**, **39** and **40** to be the most challenging on this paper.

Comments on specific questions

Question 2

Option **C** was more popular than the correct answer, **B**. Option **C** is incorrect, as starch does contain hydrogen but does not contain nitrogen.

Question 4

Option **A** was more commonly chosen than the correct answer, **A**, and option **C** was equally popular. This indicates a lack of familiarity with identifying the parts of a leaf.

Question 8

All options were chosen with equal frequency, indicating guessing and a lack of confidence with how the depth and rate of breathing change after exercise.

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Question 18

All options were chosen with equal frequency, indicating guessing and a lack of confidence in understanding what happens to thermal energy in an endothermic reaction and how the temperature of the reaction mixture changes.

Question 22

Options **A** and **C** were more popular than the correct answer, **B**. Candidates did not realise that potassium (a metal) reacts with water to form a hydroxide, which will therefore increase the pH of the mixture.

Question 23

Option **B** was chosen more often than the correct answer, **D**. Candidates did not know that to obtain crystals, they needed to partially evaporate the solution and then leave it to cool.

Question 26

Option **D** was more commonly selected than the correct answer, **B**. Option **A** was equally popular as the correct answer. Candidates did not know that gas oil is used as a fuel in diesel engines.

Question 27

Option **C** was chosen more often than the correct answer, **A**. Candidates did not know that acidified aqueous silver nitrate forms a white precipitate with chloride ions.

Question 28

Option **B** was more popular than the correct answer, **C**, and option **A** was chosen with equal frequency. Candidates were not confident in determining the period of the pendulum.

Question 34

Options **A** and **D** were as popular as the correct answer, **C**. Many candidates did not know how to interpret the wave diagram to identify the amplitude and wavelength.

Question 38

All options were chosen with equal frequency, indicating guessing and a lack of understanding that the combined resistance of two resistors in parallel is less than that of either resistor by itself.

Question 39

Option **B** was more popular than the correct answer, **A**, and options **C** and **D** were chosen with the same frequency. Candidates were not confident in working out which types of radiation are stopped by 20 mm thick aluminium.

Question 40

Options **A** and **D** were both more commonly chosen than the correct answer, **B**. Candidates either did not recognise the force keeping an object in orbit around the Sun or the force responsible for forming a protostar.

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CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/13
Multiple Choice (Core)

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

General comments

Candidates found **Questions 2**, **4**, **8**, **18**, **22**, **23**, **26**, **27**, **28**, **34**, **38**, **39** and **40** to be the most challenging on this paper.

Comments on specific questions

Question 2

Option **C** was more popular than the correct answer, **B**. Option **C** is incorrect, as starch does contain hydrogen but does not contain nitrogen.

Question 4

Option **A** was more commonly chosen than the correct answer, **A**, and option **C** was equally popular. This indicates a lack of familiarity with identifying the parts of a leaf.

Question 8

All options were chosen with equal frequency, indicating guessing and a lack of confidence with how the depth and rate of breathing change after exercise.

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Question 18

All options were chosen with equal frequency, indicating guessing and a lack of confidence in understanding what happens to thermal energy in an endothermic reaction and how the temperature of the reaction mixture changes.

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Question 23

Option **B** was chosen more often than the correct answer, **D**. Candidates did not know that to obtain crystals, they needed to partially evaporate the solution and then leave it to cool.

Question 26

Option **D** was more commonly selected than the correct answer, **B**. Option **A** was equally popular as the correct answer. Candidates did not know that gas oil is used as a fuel in diesel engines.

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Question 28

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Question 34

Options **A** and **D** were as popular as the correct answer, **C**. Many candidates did not know how to interpret the wave diagram to identify the amplitude and wavelength.

Question 38

All options were chosen with equal frequency, indicating guessing and a lack of understanding that the combined resistance of two resistors in parallel is less than that of either resistor by itself.

Question 39

Option **B** was more popular than the correct answer, **A**, and options **C** and **D** were chosen with the same frequency. Candidates were not confident in working out which types of radiation are stopped by 20 mm thick aluminium.

Question 40

Options **A** and **D** were both more commonly chosen than the correct answer, **B**. Candidates either did not recognise the force keeping an object in orbit around the Sun or the force responsible for forming a protostar.

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

General comments

Candidates performed well on **Questions 2**, **6**, **9**, **11**, **13**, **15** and **31**.

Questions 18, **19**, **20**, **21**, **24**, **25**, **27**, **32**, **33**, **35** and **40** were found to be more challenging.

Comments on specific questions

Question 18

Option **A** was a popular incorrect choice. These candidates had reversed the oxides, incorrectly thinking sodium oxide is acidic and silicon dioxide is basic.

Question 19

Option **A** was chosen by some candidates. These candidates did not know how zinc sulfate is prepared.

Question 20

Option **C** was as popular as the correct answer, **B**. Option **C** is incorrect as magnesium would not react with cold water.

Question 21

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Option **D** was as popular as the correct answer, **A**. Candidates should know that the reactivity of elements in Group VII decreases rather than increases down the group.

Question 24

Option **C** was chosen by some candidates. This is incorrect because ethene does not react with steam to form ethane; ethanol is formed. Also, ethene is not a saturated hydrocarbon.

Question 25

Options **B** and **C** were sometimes selected, showing a lack of confidence in interpreting the repeat unit of a polymer.

Question 27

Option **B** was more popular than the correct answer, **A**. Test 1 identifies calcium ions and test 2 identifies bromide ions.

Question 32

Option **B** was chosen more frequently than the correct answer, **A**. These candidates could not calculate frequency from the information about the number of waves passing the rock in 20 s.

Question 33

Option **B** was more popular than the correct answer, **A**. These candidates did not know how to interpret the ray diagram to identify the lens being used as a magnifying glass.

Question 35

Option **B** was a common incorrect answer. Candidates confused the direction in which light passes as being from air into water rather than from water into air.

Question 40

Option **C** was more popular than the correct answer, **B**. These candidates could not use the radius and orbital period to calculate the orbital speed of the Moon.

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CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/22
Multiple Choice (Extended)

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

General comments

Candidates performed well on **Questions 1**, **4**, **5**, **8**, **11**, **12**, **18**, **24**, **31**, **37** and **39**.

Questions 10, **14**, **16**, **26**, **28** and **34** were found to be more challenging.

Comments on specific questions

Question 10

Option **B** was a common incorrect choice. These candidates did not recognise that high body temperature causes vasodilation of the skin arterioles.

Question 14

Option **C** was more commonly chosen than the correct answer, **D**. Option **C** is incorrect because 2,7 is the electronic configuration of a fluoride atom rather than an ion.

Question 16

Option **A** was more popular than the correct answer, **B**. Ions are not free to move in a giant metallic lattice.

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Question 26

Options **B** and **D** were selected more often than the correct answer, **A**. Candidates were either not familiar with addition reactions of alkenes or did not recognise ethene as an alkene.

Question 28

All options were chosen with equal frequency, indicating guessing and a lack of confidence in quantities that affect the acceleration of free fall of an object.

Question 34

Options **B** and **D** were common incorrect choices. Candidates were not confident in interpreting the ray diagram of a refracted ray to determine the angle of refraction.

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

General comments

Candidates performed well on **Questions 1**, **2**, **3**, **4**, **6**, **9**, **19**, **23**, **25**, **29**, **30**, **32**, **37** and **40**.

Questions 7, **14**, **15**, **21**, **22** and **35** were found to be more challenging.

Comments on specific questions

Question 7

Option **A** was sometimes selected. The correct blood vessel was the vena cava and not the aorta.

Question 14

Option **C** was more popular than the correct answer, **B**. These candidates did not appreciate that hydrogen is produced at the cathode.

Question 15

Options **A** and **B** were commonly chosen incorrect answers. These candidates were not confident in interpreting the reaction pathway diagram. They may also not have recognised that the reaction was exothermic.

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Question 21

All incorrect options were chosen, indicating a lack of confidence in the reactivity series and reactions of metals with cold water.

Question 33

Options **B** and **C** were popular incorrect answers. These candidates did not know the definition of the term critical angle.

Question 35

Options **A** and **B** were given by candidates who found determining time from speed and distance challenging.

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CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/31
Theory (Core)

Key messages

- Some candidates answered the questions confidently.
- A good standard of scientific knowledge was displayed by some candidates.
- Some candidates gave clear and accurate responses.
- Calculations were sometimes done well with working shown.

General comments

Most candidates attempted all the questions. Many candidates answered some of the questions well. There was a range of marks awarded on every question.

Some candidates only gained some of the marks available due to their responses not answering the question completely. In these cases, candidates should be reminded to read the stimulus material and each question carefully and complete all the instructions contained within the question to be able to access the maximum marks available.

The definitions from the syllabus appeared not to be well known.

There was a continued increase in the number of candidates who gave no response to questions.

Any formula quoted should be in a standard form and should use recognisable symbols.

Use of standard form in calculations appeared to be poorly understood by many candidates.

There was no evidence of candidates running short of time to complete the examination.

Comments on specific questions

Question 1

(a) Many candidates correctly identified the number of parents, but a few candidates confused sexual reproduction with asexual reproduction. Many candidates wrote numbers in the offspring row rather than completing the given phrases with the words identical and different.

(b) Some candidates gained two or three marks here. Part **E** was the most well known.

(c) Various parts of the flower or plant were suggested. Anther and stigma were often correctly suggested for the first two gaps, but ovule was rarely suggested for the third gap where the most popular incorrect suggestion was ovary.

Question 2

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(a)(i) Few candidates named any elements and those that did, named incorrect elements or missed one element out. Amino acid was often suggested for protein and glucose for glycogen.

(ii) Some candidates correctly suggested either glycerol or fatty acids, but few candidates suggested both. Amino acids and lipids were often suggested.

(iii) Many incorrect food tests or chemical tests were suggested. Candidates who correctly suggested biuret often gave an incorrect positive result.

(b)(i) The definition of a catalyst was not well known. Metabolic (reactions) was rarely seen; catalyst was seen more often.

(ii) Many candidates correctly identified the graph which showed the effect of temperature on enzyme activity.

Question 3

(a)(i) Part **Q** was sometimes identified correctly as the septum. There was lots of confusion about the sides and chambers of the heart. Left atrium was often suggested for **R** rather than right atrium.

(ii) There were many vague responses about arteries or veins being thick or thin. Many candidates discussed functional differences rather than structural differences.

(b)(i) There were very few correct responses to this question. The most common responses were red blood cell and aorta.

(ii) Candidates generally gained credit for answers related to diet, stress or smoking. Some candidates described the process of heart disease rather than the risk factors for it.

(iii) Most candidates calculated 64 as a percentage of 104 instead of the percentage change.

(c)(i) It was common to see responses the wrong way round.

(ii) For xylem, many candidates chose nutrients rather than minerals or salts. For phloem, a few candidates chose amino acids or sucrose. Very few candidates gained both marks.

Question 4

(a)(i) Farming, mining and infrastructure were common correct responses. Some candidates repeated housing or removal of trees which were given in the question. There were many vague references to pollution.

(ii) There were lots of vague examples of protecting habitats or protecting species. The best responses referred to the examples given in the syllabus.

(b)(i) A number of candidates incorrectly used the arrows in their food chain or did not use arrows at all. Many candidates did not add the hawk at the end of the food chain.

(ii) Grasses and snake were usually correct, but many candidates did not realise that more than one tick was required for the bird and the grasshopper.

Question 5

(a) Many candidates confused atomic number and atomic mass.

(b)(i) Few candidates were able to identify a diatomic gas from the Periodic Table.

(ii) Some candidates realised that the alkali metals are all solid at room temperature and so chose one of them here.

(iii) Many candidates were able to identify an alkali metal.

(iv) Many candidates were able to identify a noble gas.

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(v) Many candidates chose P (lithium) as the most reactive metal rather than R (potassium).

(vi) Many candidates chose W (bromine) as the most reactive halogen rather than T (fluorine).

Question 6

(a) (i) Some candidates chose to react carbon dioxide with methane.

(ii) Carbon monoxide was not well known. Carbon dioxide was often suggested.

(iii) It was a common misconception that saturated hydrocarbons contain a single bond rather than **only** single bonds.

(iv) The correct response is orange to colourless. A wide range of colours were mentioned.

(b) There were many incorrect responses given, usually 12 or 13.

(c) There were many very clear correct diagrams drawn. Most candidates were able to show at least one pair of bonding electrons.

(d) Specific fuels were commonly suggested. Petroleum and coal were both popular correct responses.

(e) A common error was to write ‘only one element’ in the first gap. More candidates correctly filled in the second gap with ‘two or more elements’.

Question 7

(a) (i) There were many vague responses about lead losing oxide or carbon gaining oxide. Few candidates were able to state which atoms gained or lost oxygen and how this showed that both oxidation and reduction occurred.

(ii) Few candidates mentioned thermal energy in their answers.

(b) (i) Diamond was the most popular and correct answer.

(ii) Cathode and anode were often correctly suggested. Some candidates mixed them up. Other candidates suggested cation and anion.

(iii) Lead and bromine were often given but not always in the correct order. Bromide was not accepted.

(iv) This was very rarely answered correctly. Many candidates talked about the movement of particles in liquids and solids. A common error was the idea that all the lead bromide had been used up.

(c) (i) This question was often well answered. Common errors were not mentioning metals or giving examples of the properties gained when making alloys.

(ii) This was well answered by most candidates.

(d) (i) Lead chloride was not well known. Lead bromide was often suggested.

(ii) The test for hydrogen was not well known, although many candidates suggested a pop sound in their response. Relighting a glowing splint was a common incorrect response.

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Question 8

(a) (i) Many candidates correctly determined the number of protons as 20. Common incorrect responses were 2 and 40.

(ii) Many candidates correctly determined the number of electrons lost as 2. Common incorrect responses were 20 and 40.

(b) (i) Water was correctly identified by many candidates as one of the products. Calcium sulfate was less well known. Many candidates attempted to make up a name such as calcium sulfuric oxide,

(ii) Many candidates correctly used the information in the question to determine the mass of calcium carbonate needed.

(c) Many candidates were able to identify all the changes that decrease the rate of reaction.

(d) Many candidates correctly identified the four properties.

Question 9

(a) (i) Uranium was correctly identified by most candidates as the metal that has the greatest density.

(ii) Many candidates explained that all the metals sank in water because they had a density greater than water.

(b) (i) Few candidates related both the melting point and boiling point to room temperature.

(ii) Some candidates did not understand the difference between arrangement and separation and chose to describe the bulk properties of a liquid or the motion of the particles in a liquid.

(iii) Many candidates described how the motion of the particles changed as the temperature increases.

(c) Many candidates did not appear to understand the question. Some candidates mentioned protons, neutrons or electrons but few mentioned any numbers.

(d) Some candidates gave very clear responses. Other candidates seemed to be confused by the reference to heat.

Question 10

(a) (i) Jupiter was correctly identified by most candidates as planet X.

(ii) A few candidates were able to show why the candidate was incorrect. Standard form appeared not to be well understood by many candidates.

(b) (i) This question was not well answered. Some candidates identified gas but few mentioned dust.

(ii) Very few candidates knew the life cycle of a small mass star.

(Sun) → red giant → white dwarf was rarely seen.

(c) Many candidates did not show an answer of approximately eight minutes. Standard form appeared not to be well understood by many candidates.

(d) There were some very clear ray diagrams drawn.

Question 11

(a) About half the candidates were able to place X-rays in the correct position. Some candidates did not place X-rays on the diagram at all but chose to fill in the electromagnetic spectrum with other waves.

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(b) (i) This was well answered.

(ii) This was well answered.

(iii) Many candidates chose a value of 20 000 kHz, which correctly answered the question. Other candidates did not appreciate the answer needed to be in kHz. Very few candidates gave a correct explanation.

(c) Some candidates were able to complete the calculation. Very few candidates were able to give a suitable unit for their answer.

(d) (i) Few candidates gave the definition of half-life from the syllabus.

(ii) Only a few candidates were able to determine that 31.8 years was six half-lives. Even fewer were able to work this through to twenty-five atoms remaining.

Question 12

(a) Many candidates were able to draw the circuit symbol for a motor. Few candidates were able to draw the circuit symbol for a variable resistor. Many candidates did not include the arrowhead on the symbol.

(b) Many candidates identified a disadvantage of solar power. Few were able to identify an advantage. Renewable was the expected answer.

(c) (i) This was well answered by many candidates. Common errors were using the wrong formula or not being able to rearrange the formula. Some candidates also rounded their answers incorrectly.

(ii) This was well answered.

(iii) Few candidates were able to describe the process of evaporation in terms of the most energetic or fastest molecules escaping from the surface of a liquid. Some candidates seemed to be describing diffusion.

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CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/32
Theory (Core)

Key messages

- Some candidates answered the questions confidently.
- A good standard of scientific knowledge was displayed by some candidates.
- Clear and accurate responses were given by some candidates.
- Calculations were sometimes done well with working shown.

General comments

Most candidates attempted all the questions. Many candidates answered some of the questions well. There was a range of marks on every question.

Some candidates only gained some of the marks available due to their responses not answering the question completely. In these cases, candidates should be reminded to read the stimulus material and each question carefully and complete all the instructions contained within the question to be able to access the maximum marks available.

The definitions from the syllabus appeared not to be well known.

There was a continued increase in the number of candidates who gave no response to many questions.

Any formula quoted should be in a standard form and should use recognisable symbols.

There was no evidence of candidates running short of time to complete the examination.

Comments on specific questions

Question 1

(a) (i) The gall bladder, **E**, was the least well known. Many candidates confused it with the pancreas.

(ii) Many candidates did not know the definition of egestion taken from the syllabus.

(iii) Few candidates were able to identify the hormone released by **B** as insulin. Several other hormones were suggested, most commonly adrenaline.

(b) (i) The food test for a reducing sugar was not well known, although many candidates remembered the colour change.

(ii) Some candidates confused water, oxygen and glucose when completing the word equation.

(iii) Most candidates ticked two boxes, but quite often only one of them was correct.

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Question 2

(a) 'Competition' was well known. 'Survived' and 'alleles' were less well known.

(b) (i) A wide range of answers was seen, including some vague answers relating to pollution. Candidates should be encouraged to give answers related to the syllabus content.

(ii) Most of the correct responses related to extinction and increasing carbon dioxide levels or global warming.

(iii) Many different ideas were given. Candidates should be encouraged to give answers related to the syllabus content.

Question 3

(a) (i) Neither rib nor alveolus were well known.

(ii) Few candidates correctly labelled the diaphragm.

(iii) Some candidates gave glucose rather than oxygen.

(iv) The most common correct response was movement. There are plenty of suitable examples in the syllabus.

(b) (i) Trachea and bronchi were not well known as parts of the gas exchange system where ciliated cells are found.

(ii) The Punnett square was completed correctly by many candidates.

(iii) Few candidates mentioned alleles and many circled homozygous.

Question 4

(a) (i) Most candidates correctly identified one herbivore.

(ii) Most candidates correctly identified a secondary consumer.

(iii) Most candidates correctly determined the number of producers as four. A common wrong answer was three.

(b) Many candidates identified all three flower parts. Some of the other candidates knew at least one part.

(c) Water was commonly given as one of the conditions needed for the germination of seeds.

Question 5

(a) (i) Few candidates knew the meaning of monatomic or that the noble gases are described as monatomic gases. Oxygen (O_2) and nitrogen (N_2) were frequently suggested.

(ii) Many candidates suggested that carbon dioxide is a toxic gas.

(iii) Both carbon dioxide and oxygen were frequently suggested rather than nitrogen.

(iv) Carbon monoxide (CO) was often suggested as an element.

(v) Water was commonly given as one substance needed to cause iron to rust. Carbon dioxide and nitrogen were often suggested rather than oxygen.

(b) Many candidates correctly showed a shared pair of electrons, but many added an extra electron to the hydrogen electron shell.

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(c) Many candidates correctly stated that the blue litmus indicator turns red. Several candidates offered no response to this question.

(d) Some candidates correctly identified oxygen as one of the gaseous elements used in fuel cells. Many candidates did not answer this question.

Question 6

(a) Most candidates did not gain credit for this question. The correct answers were single in the first sentence and double in the second sentence.

(b) Where a displayed formula was attempted, the candidates usually drew very clear diagrams.

(c) Many different numbers were seen but only a few candidates correctly determined the relative molecular mass as 30. Many candidates did not answer this question.

(d) (i) Very few candidates knew the chemical test for water. Many responses included milky or cloudy.

(ii) Candidates commonly had the idea that 100 °C is the boiling point of water but could not explain the increase in boiling point.

(iii) This was well answered. Planting trees and answers related to the use of fuels were often seen.

Question 7

(a) (i) Alloy was quite well known.

(ii) Many candidates correctly determined the percentage of magnesium atoms as 15%.

(b) Some candidates were able to select a correct metal, but fewer could explain their answer. Candidates often gave vague responses about reactivity but did not explain the significance of carbon.

(c) Few candidates were able to identify the metals from their reactions with dilute hydrochloric acid.

(d) (i) Most candidates could identify two out of the three missing substances.

(ii) Many candidates understood the meaning of (aq) in the symbol equation.

Question 8

(a) (i) Many candidates left the outer-electron shell of the chloride ion empty.

(ii) This was well answered by many candidates.

(b) Few candidates knew that chlorine is a gas. Many candidates suggested solid or liquid. Even fewer candidates knew that chlorine is a green gas.

(c) Few candidates were able to identify dilute hydrochloric acid as a suitable acid. Even fewer candidates were able to suggest a suitable alkali.

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Question 9

(a) (i) A number of attempts at a series circuit were seen. Most did not include a battery and many had gaps in the circuit.

(ii) The correct answer 2.0 Ω was seen frequently**.**

(b) (i) Many candidates did not attempt this question.

(ii) Very few candidates understood the need for the activity to remain fairly constant.

(iii) Many candidates determined that the nucleus contained 146 neutrons. Several candidates suggested 95, which was the proton number.

Question 10

(a) Conduction was a commonly seen incorrect answer. A few candidates answered correctly with convection.

(b) This question was well answered.

(c) (i) Some candidates answered this correctly. Many candidates did not use the correct formula.

(ii) Few candidates used the correct formula to answer this question.

(iii) Candidates who attempted the calculation generally determined the correct answer. Many others did not attempt the question.

(d) Many candidates correctly explained that the electrical hazard could lead to an electric shock. Fewer candidates were able to describe the electrical hazard.

Question 11

(a) (i) Many candidates did not attempt this question. The first part of the calculation was to determine the total time taken by the student as 15 s.

(ii) Many candidates were able to determine the work done by the student.

(b) (i) Some candidates knew that evaporation is the process responsible for cooling down by sweating. Transpiration and respiration were common incorrect responses. Many candidates did not answer this question.

(ii) Many candidates knew that the answer involved something being absorbed. Several candidates suggested heat and only a few mentioned radiation.

(iii) Many candidates answered correctly. Hydrogen was seen more often than helium.

(iv) Most candidates who answered this question suggested regions of the electromagnetic spectrum. Few candidates selected the correct three regions.

Question 12

(a) (i) **D** was well known as the force caused partly by air resistance.

(ii) Some candidates knew that the definition was the definition of mass not weight. Other candidates gave the correct definition of weight.

(iii) The term resultant force was not well known, although some candidates managed to successfully describe a resultant force. It was a common misconception for candidates to give 4000 N as an answer in an attempt to give more force in the direction of travel.

(b) (i) Decreases was slightly more popular than increases.

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(ii) Decreases was the most popular and correct answer.

(c) (i) The battery was not well known as the component in the circuit that causes a current to flow in the circuit. Switches and wires were more popular choices.

(ii) Many candidates correctly determined that the current was 8 A. Far fewer candidates were able to explain why.

(iii) The advantages of connecting the headlamps in parallel were well known.

(d) Candidates did not appear to know this section of the syllabus. Descriptions were confused and many candidates described the image appearing smaller or larger in the mirror.

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CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/33
Theory (Core)

Key messages

- Some candidates answered the questions confidently.
- A good standard of scientific knowledge was displayed by some candidates.
- Clear and accurate responses were given by some candidates.
- Calculations were sometimes done well with working shown.

General comments

Most candidates attempted all the questions. Many candidates answered some of the questions well. There was a range of marks on every question.

Some candidates only gained some of the marks available due to their responses not answering the question completely. In these cases, candidates should be reminded to read the stimulus material and each question carefully and complete all the instructions contained within the question to be able to access the maximum marks available.

The definitions from the syllabus appeared not to be well known.

There was a continued increase in the number of candidates who gave no response to many questions.

Any formula quoted should be in a standard form and should use recognisable symbols.

There was no evidence of candidates running short of time to complete the examination.

Comments on specific questions

Question 1

(a) (i) The gall bladder, **E**, was the least well known. Many candidates confused it with the pancreas.

(ii) Many candidates did not know the definition of egestion taken from the syllabus.

(iii) Few candidates were able to identify the hormone released by **B** as insulin. Several other hormones were suggested, most commonly adrenaline.

(b) (i) The food test for a reducing sugar was not well known, although many candidates remembered the colour change.

(ii) Some candidates confused water, oxygen and glucose when completing the word equation.

(iii) Most candidates ticked two boxes, but quite often only one of them was correct.

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Question 2

(a) 'Competition' was well known. 'Survived' and 'alleles' were less well known.

(b) (i) A wide range of answers was seen, including some vague answers relating to pollution. Candidates should be encouraged to give answers related to the syllabus content.

(ii) Most of the correct responses related to extinction and increasing carbon dioxide levels or global warming.

(iii) Many different ideas were given. Candidates should be encouraged to give answers related to the syllabus content.

Question 3

(a) (i) Neither rib nor alveolus were well known.

(ii) Few candidates correctly labelled the diaphragm.

(iii) Some candidates gave glucose rather than oxygen.

(iv) The most common correct response was movement. There are plenty of suitable examples in the syllabus.

(b) (i) Trachea and bronchi were not well known as parts of the gas exchange system where ciliated cells are found.

(ii) The Punnett square was completed correctly by many candidates.

(iii) Few candidates mentioned alleles and many circled homozygous.

Question 4

(a) (i) Most candidates correctly identified one herbivore.

(ii) Most candidates correctly identified a secondary consumer.

(iii) Most candidates correctly determined the number of producers as four. A common wrong answer was three.

(b) Many candidates identified all three flower parts. Some of the other candidates knew at least one part.

(c) Water was commonly given as one of the conditions needed for the germination of seeds.

Question 5

(a) (i) Few candidates knew the meaning of monatomic or that the noble gases are described as monatomic gases. Oxygen (O_2) and nitrogen (N_2) were frequently suggested.

(ii) Many candidates suggested that carbon dioxide is a toxic gas.

(iii) Both carbon dioxide and oxygen were frequently suggested rather than nitrogen.

(iv) Carbon monoxide (CO) was often suggested as an element.

(v) Water was commonly given as one substance needed to cause iron to rust. Carbon dioxide and nitrogen were often suggested rather than oxygen.

(b) Many candidates correctly showed a shared pair of electrons, but many added an extra electron to the hydrogen electron shell.

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(c) Many candidates correctly stated that the blue litmus indicator turns red. Several candidates offered no response to this question.

(d) Some candidates correctly identified oxygen as one of the gaseous elements used in fuel cells. Many candidates did not answer this question.

Question 6

(a) Most candidates did not gain credit for this question. The correct answers were single in the first sentence and double in the second sentence.

(b) Where a displayed formula was attempted, the candidates usually drew very clear diagrams.

(c) Many different numbers were seen but only a few candidates correctly determined the relative molecular mass as 30. Many candidates did not answer this question.

(d) (i) Very few candidates knew the chemical test for water. Many responses included milky or cloudy.

(ii) Candidates commonly had the idea that 100 °C is the boiling point of water but could not explain the increase in boiling point.

(iii) This was well answered. Planting trees and answers related to the use of fuels were often seen.

Question 7

(a) (i) Alloy was quite well known.

(ii) Many candidates correctly determined the percentage of magnesium atoms as 15%.

(b) Some candidates were able to select a correct metal, but fewer could explain their answer. Candidates often gave vague responses about reactivity but did not explain the significance of carbon.

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CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/41
Theory (Extended)

Key messages

- Candidates should read the stimulus material carefully and follow the guidance given. Questions with command words that require candidates, for example to complete, identify, draw, describe, state, name, explain, place, tick, suggest, complete, construct, calculate and define, all require different types of responses. Some questions also required candidates to use specific ideas, for example **Question 7(b)(iii)**, where candidates were asked to explain why, using collision theory. Candidates needed to include ideas about collision theory in their answers to gain full credit for this question. Some questions had further instructions, for example, **Question 5(a)**, where candidates are asked to draw a line from each substance to the definition. Therefore, only one line was needed from each box below the substance heading. Other questions with further instructions included **Question 2(a)**, where candidates were asked to draw a label line and the letter **L** to identify the larynx and draw a label line and the letter **B** to identify a bronchus, so lines with the correct letters were required to the exact parts on the diagram; **Question 5(c)**, where candidates were asked to include the charges on the ions and **Question 7(b)(i)**, where candidates were asked to include state symbols.

- Marks were often missed because candidates had not answered all aspects of the question using the required terminology. This was evident in **Question 10(a)(ii)**, where candidates were asked to state three ways the turning effect can be increased but many repeated the same idea, thinking these were different marking points, e.g. more current, more voltage, more potential difference, more batteries and more cells, so just one mark was awarded. This was also evident in **Question 7(b)(i)**, where candidates were asked to construct the balanced symbol equation for the reaction of dilute sulfuric acid and copper oxide but where some candidates did not give the state symbols or balance the equation. This was also seen in **Question 8(b)**, where candidates were asked to draw a diagram to show the displayed formula of propane, but many candidates did not include the H symbols.

- Candidates should try to match their answers with the number of marks available for that part of the question. A question worth [3] marks will require three separate marking points. For example, in **Question 10(b)(ii)**, which was worth [3] marks, candidates were required to explain why the use of this transformer means power losses in transmission cables are smaller. Many candidates just explained that a higher voltage results in a lower current and did not consider the power loss in their answer. This was also evident in **Question 2(b)(ii)**, where candidates were asked to describe two ways anaerobic respiration is different from aerobic respiration in the human body. Some candidates just gave reverse arguments, for example, anaerobic respiration does not require oxygen, and aerobic respiration does require oxygen and so only gained one mark for these answers. This was also seen **Question 3(b)(ii)**, where candidates only wrote about less water being absorbed by the roots of trees because there are fewer trees. Similarly, **Question 5(c)**, where candidates were asked to explain why molten sodium oxide conducts electricity, but solid sodium oxide does not conduct electricity for [2] marks. Candidates usually only wrote about the need for free moving ions and did not link this movement of ions to conduction.

- Candidates should attempt all questions even if they only know one part of the answer, for example, **Question 11(a)**. In this question, candidates were asked to complete the decay equation for a specified nuclear decay. Candidates should know the numbers required for alpha, beta and gamma radiation and so should be able to at least complete this part of the decay equation.

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- When completing calculations, candidates need to state the expressions or formulae required before attempting the calculation, to rearrange the equation as required and to show all their working. Even if full credit is not achieved for the final answer, some credit may still be available for the correct equation and any correct steps in the calculation if working is shown.

- Candidates should use correct scientific terminology and scientific language when describing phenomena and have a good understanding of the definitions and specific scientific terms used in the syllabus. This was particularly important for **Question 3(a)(v)**, where candidates were asked to describe what is meant by the term carnivore; **Question 9(a)(i)**, where candidates were asked to define the moment of a force and **Question 12(c)(i)**, where candidates were asked to define refractive index.

General comments

A high standard of vocabulary, legibility and scientific knowledge were displayed by the majority of candidates. The use of scientific knowledge and scientific terminology was usually good but recall of basic facts and definitions was often more challenging for candidates. Some candidates gave incomplete responses or just descriptions as answers to questions that required an explanation. Candidates appeared to have sufficient time to complete the question paper.

Most candidates completed the required calculations throughout the question paper, and these calculations were usually attempted in a logical manner, with clear steps including the use of expressions and formulae when required. An exception to this was **Question 8(c)(ii)**, where the calculations were often not set out logically. Some candidates also had difficulty with balancing chemical equations. Areas in which questions were less confidently answered included hormones involved in the control of blood glucose, aerobic respiration, definition of a carnivore, active immunity, mitosis, oxidation, tests to identify an ion, rate of reaction, moments, conditions for an object to be in equilibrium, transformers, nuclear decay and longitudinal waves.

Comments on specific questions

Question 1

(a) (i) The majority of candidates identified that the type of organ that produces a hormone is a gland and that hormones are transported in the blood plasma. However, some candidates thought that the gland was just an endocrine and that hormones are transported by red blood cells or transported in platelets. Few candidates identified that hormones alter the activity of one or more specific target organs with many candidates giving the answer as endocrine organ, hormone organ or gland organ.

(ii) In this question candidates were required to identify the organs in the diagram of the body and then name the hormones produced by these organs. Testicle and testosterone were generally well known by candidates, with adrenal gland and adrenaline being more challenging. Many candidates thought the adrenal gland was the pancreas or kidney or left this answer space blank in the table.

(b) (i) Candidates found this question about the hormones involved in the control of blood glucose concentration challenging. Many answers were seen including glucose, glycogen, glycerol rather than insulin and glucagon. Many candidates did not attempt this question.

(ii) Approximately half the candidates gave the answers of insulin and glucagon as the hormones involved in homeostatic control. Many answers were vague, just describing blood glucose control and others just repeating the idea of homeostasis from the question.

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Question 2

(a) (i) Most candidates followed the instructions given in the question to draw a label line with the letter **L** and draw a label line with the letter **B** on the diagram. Where candidates wrote the letter directly on the diagram, it was difficult to identify which part was being labelled. Candidates found it more difficult to identify the larynx than the bronchus.

(ii) The majority of candidates were able to identify at least one feature of the gas exchange surface in humans. The most common correct answers were large surface area and thin wall. A common incorrect answer was thin cell walls.

(b) (i) Candidates found this question about completing the balanced chemical equation for aerobic respiration challenging. Many candidates just wrote the word equation or wrote the word 'energy' as one of the products. Some candidates recognised CO_2 and H_2O as the products but did not balance the equation. The formula for glucose, $C_6H_{12}O_6$, was often incorrectly written as CH_2O or $C_6H_{12}O_2$.

(ii) Approximately half of all candidates described two ways anaerobic respiration is different from aerobic respiration in the human body. Common incorrect answers included respiration producing energy, respiration requiring or using energy, oxygen not being made, lactic acid not being used and anaerobic respiration only occurring in plants.

(c) (i) The majority of candidates identified the function of the part labelled **G** on the diagram as being for movement. A few candidates named this as the tail or flagellum rather that giving the function.

(ii) Candidates found this question about naming structure **H** on the diagram and stating its function very challenging. Few candidates named structure **H** as the acrosome, and few mentioned that it contained enzymes. Common incorrect answers included nucleus, head and tip as the name.

(iii) Candidates either gave a clear description of what is meant by a haploid nucleus or muddled this with a description of a diploid nucleus. Common incorrect answers included haploid cells having one nucleus, haploid cells having two nuclei or the chromosomes dividing in half.

Question 3

(a) (i) The majority of candidates correctly identified the type of diagram as a food web with a few candidates identifying the type of diagram as a food chain.

(ii) The majority of candidates correctly identified the producer as the phytoplankton.

(iii) Candidates found it challenging to identify the organism that occupies the second trophic level in the diagram as copepods, with shrimps a common incorrect answer.

(iv) The majority of candidates correctly identified the organism that is both a secondary and a tertiary consumer as either the little auk or the fish.

(v) Candidates found this question very challenging. The definition given in the syllabus, 'describe a carnivore as an animal that gets its energy by eating other animals', was rarely seen. Most candidates described carnivores as meat eaters or animals that eat animals.

(vi) Candidates found this question about explaining why the energy transfer from one trophic level to another is not efficient, very challenging. Some candidates gave vague answers about loss of energy without giving the mechanisms involved.

(b) (i) Approximately half of the candidates explained clearly how deforestation can increase the concentration of carbon dioxide in the atmosphere. Other candidates suggested there was less carbon dioxide because oxygen was being produced.

(ii) The majority of candidates gained only one mark for this question. These candidates recognised that less water is absorbed by the roots of trees because there are fewer trees. Fewer candidates made the link about there being fewer trees to hold the soil or bind the soil.

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Question 4

(a) (i) Candidates found this question challenging. Most candidates did not state the roles of mitosis in the human body. These candidates thought that cell division repairs cells, confused mitosis with meiosis or described the process of mitosis as nuclear division making the same cells.

(ii) Candidates found this question about describing what happens to the chromosomes before mitosis occurs very challenging. Many candidates wrote about splitting cells or stated that the chromosomes line up or that nothing happens to the chromosomes.

(b) The majority of candidates did not gain full credit for this question about the processes that occur in mitosis, in meiosis or in both mitosis and meiosis.

(c) Candidates found this question very challenging. Some candidates correctly described how active immunity is gained after an infection by a pathogen by stating that antigens stimulate lymphocytes to produce antibodies and that memory cells are produced to give long term immunity. Most candidates gave vague answers about blood cells or white blood cells producing antibodies or producing antibiotics.

Question 5

(a) The majority of candidates correctly linked element, compound and mixture to the correct definitions.

(b) Approximately half the candidates correctly ticked the correct box in each row of the table to show the trends of the Group I alkali metals.

(c) Most candidates gained at least one mark for this question with some clear answers seen with the correct use of dots and crosses and charges. Some candidates only drew the transfer of electrons rather than the final electronic structures of the sodium ion and the oxide ion in sodium oxide. Many candidates drew shared electrons, only seven electrons in the outer shell of the oxygen ion, the oxygen ion with a single negative charge or did not draw the inner shell electrons.

(d) Candidates found this question very challenging. The movement of ions in molten ionic compounds was not well known, with many explanations about the movement of electrons or delocalised electrons for conduction. When candidates did identify the need for free moving ions, they did not always clearly link this movement of ions to conduction.

Question 6

(a) (i) Approximately half of all candidates stated the name of the only chemical product in a hydrogen-oxygen fuel cell as water. A few candidates incorrectly gave hydrogen oxide as the answer.

(ii) Candidates found this question about explaining why the reaction between hydrogen and oxygen in a fuel cell involves oxidation challenging. Many candidates wrote about the gain of oxygen, oxygen being taken from hydrogen, the loss of electrons from oxygen and the gain of electrons.

(b) The majority of candidates suggested which fuel would be most suitable to power a car and gave suitable explanations for their choice. Some candidates misinterpreted the data about refuelling time and range.

(c) (i) Candidates found this question about stating an adverse effect of oxides of nitrogen challenging. Many candidates gave the vague answer of pollution or global warming.

(ii) Candidates found this question about explaining how oxides of nitrogen form in petrol car engines very challenging. Many candidates gave the answer of carbon dioxide or just described that nitrogen had been combusted. Many candidates did not attempt this question.

(iii) Candidates found this question challenging. Many candidates gave the products as N or NO rather than N_2 and H_2O rather than CO_2.

Question 7

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(a) Many candidates did not seem to be aware of the tests and observations to identify the ion in different solutions.

(b) (i) Approximately half of all candidates correctly constructed the balanced symbol equation for the reaction of dilute sulfuric acid with solid copper oxide. Some candidates gave water the (aq) symbol rather than the (l) symbol.

(ii) Approximately half the candidates identified the type of reaction that takes place as neutralisation. A common incorrect answer was combustion.

(iii) Candidates found this question about explaining why the reaction between dilute sulfuric acid and copper oxide is faster when more concentrated acid is used very challenging. Many candidates wrote about particles having more kinetic energy, which would occur with an increase in temperature and not an increase in concentration. Many candidates gave incomplete answers, for example, more collisions rather than an increase in the frequency of collisions of particles and more particles rather than more particles per unit volume. Some candidates incorrectly wrote about an increased surface area when concentration increases.

(iv) Candidates were usually able to state that diagram **A** represented the energy change for the reaction between dilute sulfuric acid and copper oxide. Few candidates then went on to explain the reasons why, with many candidates simply stating that the products were lower than the reactants without any reference to energy. Exothermic and endothermic were both seen.

Question 8

(a) The majority of candidates gave refinery gas as the name of the fraction that is obtained at the top of the fractionating column.

(b) The majority of candidates ticked C_7H_{14} and C_8H_{16} as the pair of hydrocarbon molecules which would both turn aqueous bromine colourless.

(c) (i) Most candidates stated that the bonding between carbon atoms in alkanes is single covalent but fewer candidates stated that alkanes are saturated hydrocarbons.

(ii) Candidates found this question about calculating the maximum volume of carbon dioxide, in dm^3 measured at room temperature and pressure, that is made from 6.4 kg of petrol very challenging. Most candidates did not work systematically through the calculation, and many answers were scattered throughout and beyond the answer space. Where one mark was awarded, this was usually for knowing that the moles of carbon dioxide calculated is multiplied by 24 to determine the volume of carbon dioxide.

(d) The majority of candidates were able to draw a diagram to show the displayed formula of propane. A few candidates only drew the three carbons each joined by a single bond but missed out the eight hydrogens and just drew the eight bonds as lines to where the hydrogens should be.

Question 9

(a) (i) Candidates found this question about defining the moment of a force very challenging. The syllabus states ‘define the moment of a force as moment = force × perpendicular distance from the pivot’ but nearly all candidates just described the moment of a force as the force × distance. A few candidates thought that the moment of a force was about time.

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(ii) Candidates found this question about the conditions for an object to be in equilibrium very challenging. Some candidates correctly stated that for an object to be in equilibrium, the clockwise moment must be equal to the anticlockwise moment. In the syllabus it has 'state that, when there is no resultant force and no resultant moment, an object is in equilibrium' but these conditions were rarely seen in the answers to this question. Many candidates wrote vague ideas about equal distance and equal force.

(b) (i) Candidates found this question about calculating the weight of the object challenging. Most candidates gained one mark for quoting the equation $W = mg$, but many of these candidates were unsure what the letter g represents or used the value of g as $10\,m/s^2$ rather than the value of g as $9.8\,m/s^2$ quoted on the front page of the examination paper. Very few candidates converted the mass of the object from 40 g to 0.04 kg.

(ii) Candidates found this question about calculating the weight of the metre ruler very challenging. Very few candidates appreciated that the weight was acting through the centre of the metre ruler and so did not attempt much of this question. Many candidates did not attempt this question.

Question 10

(a) (i) The majority of candidates were able to give three different ways the turning effect of a simple d.c. motor can be increased. Some candidates often repeated the same idea, thinking these were different marking points, e.g. more current, more voltage, more potential difference, more batteries and more cells.

(ii) Candidates found this question about identifying the name of component X as a split-ring commutator very challenging. Many candidates named it as just a split ring, a slip ring, a slip ring commutator or just a commutator.

(iii) Candidates found this question about describing how component X is used to give continuous rotation of the coil very challenging. Many candidates described component X being used to give a constant current or a continuous current rather than reversing the current.

(b) (i) Candidates found this question about the type of transformer used at power stations to supply power to the electricity network challenging. Typical incorrect answers included a step-down transformer, a powerful transformer, a large transformer, an electrical transformer and a current transformer.

(ii) Candidates found this question about explaining why the use of this transformer means power losses in transmission cables are smaller very challenging. A few candidates explained that as there is a higher voltage this means there is a lower current for the same power transferred. Very few candidates stated that the power loss or energy loss is proportional to the current squared.

(c) Less than half of all candidates calculated the number of turns on the primary coil. Some candidates used $(3.6 \div 230) \times 720$, giving the answer of 11 turns, rather than the correct relationship of $(230 \div 3.6) \times 720$, giving the answer of 46 000 turns.

Question 11

(a) In this question, candidates were asked to complete the decay equation for a specified nuclear decay. Candidates either completed the whole decay equation correctly or seemed to guess which numbers to write in the spaces provided, for example beta (β) given as 14 and 2.

(b) Candidates found this question about suggesting which type of radiation would be suitable for use in measuring and controlling the thickness of the aluminium foil very challenging. Many candidates named the radiation as thermal radiation, ultraviolet radiation or infrared radiation. Where candidates did identify the radiation as beta, their explanation was quite often muddled or just described the relative penetrating powers of each type of nuclear radiation rather than answering the specific question about measuring the thickness of aluminium foil.

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(c) Candidates found this question about calculating the age of the wood very challenging. Many candidates did not understand the concept of half-life and over complicated their calculations. Few candidates looked at the two activities given in counts per minute and realised that to go from 28 to 7 there are 2 half-lives (28 to 14 and then 14 to 7). Many candidates did not attempt this question.

(d) (i) Candidates found this question about the type of nuclear reactions that take place in a stable star challenging. Many candidates gave the answers of 'fission' or 'fiussion', which were not clearly the correct answer of fusion. Many candidates did not attempt this question.

(ii) Candidates found this question about what is produced in these nuclear reactions challenging. Some candidates gave the answer of helium, but hydrogen was also a common answer. This question had a relatively high omission rate.

Question 12

(a) (i) Candidates found this question about describing a longitudinal wave challenging. Many candidates did not refer to oscillations or vibrations in their answers and instead incorrectly described the waves as being parallel.

(ii) The majority of the candidates calculated the wavelength of the P-wave correctly.

(b) (i) Candidates found this question about naming the effect when waves spread out when they pass through a narrow gap challenging. Incorrect answers included refraction, reflection, spreading and dispersal.

(ii) Candidates found this question about what happens when a soundwave passes through a doorway with a width similar to the soundwave's wavelength very challenging. Most candidates thought that the wavelength of 1.2 m and the doorway's width of 1.0 m were very different lengths rather than being similar in size or order.

(iii) Candidates found this question about explaining why red light, with a wavelength of 700 nm, travels in a straight line through the doorway very challenging. The different units of nm and m were not considered by most candidates. Many candidates did not attempt this question.

(c) (i) Candidates found this question about the definition of refractive index very challenging. The syllabus states 'define refractive index, *n*, as the ratio of the speeds of a wave in two different regions', but most candidates thought that refractive index was an angle, the amount of bending in a ray of light or the incident angle divided by the refracted angle.

(ii) Approximately half of all candidates calculated the refractive index of the transparent material. Some candidates just divided the numbers given or took one number away from the other. Some candidates stated the equation but did not complete the calculation.

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CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/42
Theory (Extended)

Key messages

- Candidates should read the stimulus material carefully and follow the guidance given. Questions with command words that require candidates, for example, to state, describe, explain, suggest, complete, outline, calculate, write, draw, deduce, construct, continue, determine and define all require different types of responses. Some questions also required candidates to use specific ideas, for example, **Question 8(c)**, where candidates were asked to explain why, using collision theory. Candidates needed to include ideas about collision theory in their answers to gain full credit for this question. Some questions had further instructions, for example, **Question 1(a)**, where candidates were asked to draw one straight line from each level of organisation to the correct part of the organism. Therefore, only one line needed to be drawn from each box below the level of organisation heading. Other questions with further instructions included **Question 4(b)(i)**, where candidates were asked to draw a label line and the letter **S** to identify a sweat gland, so one line label was required to the exact part on the diagram; **Question 4(c)(iii)**, where candidates were asked to give their answer to 3 significant figures; **Question 6(b)**, where candidates were asked to include the charges on the ions, and **Question 7(b)(ii)**, where candidates were asked to include state symbols.

- Marks were often missed because candidates had not answered all aspects of the question using the required terminology. This was evident in **Question 1(c)(ii)**, where candidates were asked to state two other differences between the structure of a red blood cell and the structure of a plant leaf cell, but many candidates stated that red blood cells do not contain chloroplasts, which was already given in the question. This was also evident in **Question 7(b)(ii)**, where candidates were asked to construct the balanced ionic equation for the reaction, but where some candidates did not write an ionic equation and did not balance the equation. In **Question 10(b)(ii)**, candidates were asked to draw the refracted ray on the diagram, but many candidates drew a reflected ray rather than a refracted ray.

- Candidates should try to match their answers with the number of marks available for that part of the question. A question worth [3] marks will require three separate marking points. For example, in **Question 2(a)(i)** which was worth [3] marks, candidates were required to explain the effect that high wind speed conditions have on the rate of transpiration. Many candidates just wrote that high wind conditions increased the rate of transpiration rather than also explaining why there is an increase in the rate of transpiration. Similarly, **Question 3(c)**, where candidates were required to outline the role of bile in the digestive system for [2] marks, but many candidates just gave one role. Also, **Question 6(c)(iii)**, where candidates were asked to explain why graphite conducts electricity for [2] marks. In answering this question many candidates just wrote that there are electrons.

- Candidates should attempt all questions even if they only know one part of the answer, for example, **Question 12(b)(i)**. In this question, candidates were asked to complete the decay equation for a specified nuclear decay. Candidates should know the numbers required for alpha, beta and gamma radiation and so should be able to at least complete this part of the decay equation.

- When completing calculations, candidates need to state the expressions or formulae required before attempting the calculation, to rearrange the equation as required, to change the units of quantities and to show all their working. For example, **Question 8(b)(iii)**, where the volume of carbon dioxide gas is given in cm^3 but the volume of one mole of any gas is given in dm^3. Even if full credit is not achieved for the final answer, some credit may be available for the correct equation and any correct steps in the calculation if working is shown.

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- Candidates should use correct scientific terminology and scientific language when describing phenomena and have a good understanding of the definitions and specific scientific terms used in the syllabus. This was particularly important for **Question 12(b)(ii)**, where candidates were asked to define the term half-life. Also in **Question 1(d)**, where candidates were required to know how the sperm cell is specialised to penetrate the egg, so the full details of the sperm cell having a structure called an acrosome, which contains enzymes, was required for this marking point.

General comments

A high standard of vocabulary, legibility and scientific knowledge was displayed by the majority of candidates. The use of scientific knowledge and scientific terminology was usually good but recall of basic facts and definitions was often more challenging for candidates. Some candidates gave incomplete responses or just descriptions as answers to questions that required an explanation. Candidates appeared to have sufficient time to complete the question paper.

Most candidates completed the required calculations throughout the question paper, and these calculations were usually attempted in a logical manner with clear steps, including the use of expressions and formulae when required. An exception to this was **Question 7(c)(ii)**, where the calculations were often not set out logically. Some candidates also had difficulty with balancing chemical equations. Areas in which questions were less confidently answered included the appearance of phagocytes and lymphocytes in photographs of blood seen under a light microscope, single and double circulatory systems, the role of bile in the digestive system, how propene is made by cracking, rates of reaction, geothermal resources, transverse waves and half-life.

Comments on specific questions

Question 1

(a) The majority of candidates drew the correct single line from each level of organisation to the correct part of the organism.

(b)(i) This question about the function of the white blood cell labelled in the diagram was found to be challenging. Many candidates did not recognise this white blood cell as a phagocyte and therefore as having the function of phagocytosis. These candidates gave answers, for example, to kill bacteria, to eat bacteria, to produce antibodies or to produce antibiotics.

(ii) The majority of candidates were able to state the name of the pigment in red blood cells that binds to oxygen as being haemoglobin. A few candidates thought the pigment was chlorophyll.

(c)(i) The majority of candidates were able to state the name of the pigment in chloroplasts as being chlorophyll. A few candidates thought the pigment was green or photosynthesis.

(ii) The majority of candidates were able to state two differences between the structure of a red blood cell and the structure of a plant leaf cell. The usual correct answers were that the red blood cell does not have a cell wall and the red blood cell does not have a nucleus. Some candidates just repeated the information given in the question and explained that a red blood cell does not contain chloroplasts.

(d) Candidates found it challenging to describe how the sperm cell is specialised to swim to the egg and to penetrate the egg. Many candidates only described the sperm as having a tail rather than a flagellum to swim to the egg. Many candidates were also vague in their answers about how sperm cells penetrate the egg, including statements such as they have an enzyme, or they have a head, or they have a pocket on the head, or they push into the egg, or they have a nucleus that can fuse, rather than the complete answer of enzymes in the acrosome.

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Question 2

(a)(i) Candidates found this question about explaining the effect that high wind speed conditions have on the rate of transpiration very challenging. Many candidates repeated the question and added that high wind speed increases the rate of transpiration without explaining why it increases the rate of transpiration.

(ii) Candidates found this question about suggesting the effect on the distance moved by the air bubble at a temperature of 25 °C compared to a temperature of 15 °C challenging. Some candidates thought that the distance decreases rather than increases and were unable to explain why. Candidates that correctly described the effect on the distance as increases often thought this was linked to an increase in the rate of photosynthesis rather than an increase in the rate of transpiration.

(b)(i) Candidates found this question about naming a substance transported in xylem challenging. Many candidates gave incomplete or incorrect answers, including nutrients, minerals, sugar, glucose and starch.

(ii) This question required candidates to complete the sentence about translocation. Fewer than half the candidates gave the answers of sucrose, amino acids and the phloem. Some candidates gave the answer of glucose instead of sucrose and some candidates gave the answer of xylem instead of phloem.

(c)(i) Candidates found this question about describing the single circulatory system of a fish challenging. Many candidates just described the blood as moving in a single circuit rather than the idea that blood is only goes through the heart once for each circuit.

(ii) Candidates found this question about the advantage of a double circulatory system compared to a single circulatory system challenging. Many candidates just gave answers about there being a different pressure in the circulatory system rather than being more specific about the pressures being different in the blood flow to the lungs compared to the blood flow to the rest of the body, or that the blood pressure around the body is higher than the blood pressure to the lungs.

Question 3

(a)(i) Approximately half of all candidates stated two places in the digestive system where amylase is secreted. These candidates usually gave the answers of pancreas and small intestine. Other candidates were not specific about the salivary glands, giving a vague answer of the mouth instead.

(ii) The majority of candidates gave the answer of sugar to complete the sentence about amylase. Incorrect answers included carbohydrates, fats and proteins.

(b)(i) Candidates found this question about explaining why amylase breaks down the starch quicker as the temperature increases challenging. Most candidates gained one mark for stating that either the enzyme and substrate have more kinetic energy or that there is an increase in the frequency of effective collisions, but rarely both of these answers. Some candidates vaguely explained that there are more collisions but did not specify frequency in their description. Fewer candidates explained that there are more enzyme-substrate complexes formed.

(ii) The majority of candidates were able to explain why amylase does not break down any of the starch at 55 °C. These candidates gave clear explanations about the enzyme being denatured, causing the active site to change shape, so the enzyme is no longer complementary to the substrate.

(c) Candidates found it challenging to outline the role of bile in the digestive system. Some candidates could describe that bile emulsifies fats, but others thought that bile digests fats or digests proteins. Many candidates only described where bile is formed rather than the role of bile in the digestive system. A few candidates described bile as neutralising the acid from the stomach, but some candidates thought that bile made the contents of the intestine acidic.

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Question 4

(a) The majority of candidates were able to name the hormones released from the adrenal gland and the pancreas. These candidates named the hormones as adrenaline and usually insulin respectively. Candidates that tried to name the hormone glucagon as being released from the pancreas often confused this with glycogen or glycerol.

(b)(i) Candidates found it challenging to draw a label line and the letter **S** to identify a sweat gland on the diagram. Many candidates labelled the sebaceous gland as the sweat gland or the sweat duct as the sweat gland.

(ii) Approximately half of all candidates were able to describe how the body responds to reduce body temperature. These candidates clearly described how an increase in sweating, vasodilation and the hairs lying flat help to reduce body temperature. Other candidates confused vasodilation with vasoconstriction or thought that capillaries physically move upward towards the surface of the skin. The most common correct answer was there is an increase in sweating.

(c) (i) Approximately half of all candidates completed the reflex arc diagram with the missing words of relay and effector or muscle. Some candidates thought that the relay neuron was a connecting neurone or a nervous neurone. Some candidates thought that the effector was a reflex or a response.

(ii) Approximately half of all candidates were able to state the names of the two parts of the central nervous system as the brain and the spinal cord. Some candidates incorrectly thought that the spine was the same as the spinal cord.

(iii) Candidates found it challenging to calculate the speed of the nerve impulse in the motor neurone. Some of these candidates gave the answer as 49 rather than the required answer of 49.0, as 3 significant figures were required for this answer.

Question 5

(a)(i) The majority of candidates were able to write the molecular formula for butane as C_4H_{10}. A few candidates gave the molecular formula as C_4H_8.

(ii) The majority of candidates were able to explain the term hydrocarbon as propene only contains hydrogen atoms and carbon atoms, but fewer candidates could also explain the term unsaturated. Many candidates incorrectly described unsaturated as meaning a double bond rather than that propene contains a double carbon-carbon bond.

(iii) The majority of candidates completed the displayed formula for but-2-ene. A few candidates did not draw the double bond between the second and third carbons or missed out the eight hydrogens and just drew the eight bonds as lines to where the hydrogens should be.

(b) Just less than half of all candidates were able to complete the table to show the effect of propene on aqueous bromine. Incorrect answers included turns clear, light orange or brown.

(c) Candidates found this question about describing how propene is made by cracking challenging. Some candidates named a condition as being a high temperature, but these candidates usually did not describe cracking as large alkane molecules being broken down into smaller alkene molecules. The need for a catalyst was not well known. Many candidates did not attempt this question.

(d) Candidates found this question about completing the equation to show the formation of poly(propene) challenging. Some candidates drew a double bond between the carbon atoms. Many candidates did not attempt this question.

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Question 6

(a)(i) The majority of candidates were able to state the symbol of an element with 8 electrons in its outer shell as Ar.

(ii) The majority of candidates were able to state the symbol of an element that forms a positive ion as Na or K or A*l*.

(iii) The majority of candidates were able to state the symbol of the element with the electronic configuration 2,8,3 as A*l*.

(b) Most candidates gained at least one mark for this question, with some clear answers seen with the correct use of dots and crosses and charges. Some candidates only drew the transfer of electrons rather than the final electronic structures of the sodium ion and the chloride ion in sodium chloride. Many candidates drew shared electrons or only seven electrons in the outer shell of the chloride ion.

(c)(i) Candidates found this question about using the diagram to explain why carbon is in Period 2 challenging. Most candidates only explained that there are two shells or two layers of electrons rather than that carbon has two occupied electron shells.

(ii) The majority of candidates were able to explain why the isotopes carbon-12 and carbon-13 have the same chemical properties, because they have the same electronic configuration or the same number of electrons or the same number of protons.

(iii) The majority of candidates were able to explain why graphite conducts electricity, because it has electrons that can move. A few candidates only explained that graphite has electrons, but they did not specify that these electrons are able to move.

(iv) The majority of candidates were able to name the product of the electrolysis of aqueous copper(II) sulfate at the cathode as copper. Fewer candidates named the product at the anode as oxygen. Incorrect answers for the product at the anode included sulfate, bubbles, water and O.

Question 7

(a) Candidates found it challenging to deduce the formula of iron(III) sulfate using the information given in the question. Many candidates incorrectly wrote $Fe(SO_4)_3$ or $Fe_2(SO_4)$ or $Fe^2(SO^4)^3$.

(b)(i) Candidates found it challenging to state the colour of a precipitate of iron(III) hydroxide. Many different incorrect answers were seen, including orange, red, green, blue and colourless.

(ii) Candidates found this question about constructing the balanced ionic equation for the reaction given in the question very challenging. Many candidates did not give the correct formulae and often missed out the 3+ after the Fe, Fe^{3+} and the – after the OH, OH^-.

(c)(i) Just less than half the candidates correctly stated that iron(III) oxide is reduced in this reaction because the iron(III) oxide loses oxygen. Some candidates correctly identified that the iron(III) oxide is reduced but incorrectly stated that iron loses oxygen.

(ii) Candidates found this question about calculating the minimum mass of iron(III) oxide required to make 28 000 g of iron challenging. Most candidates gained one mark for calculating the M_r of Fe_2O_3 as 160 but then were not able to calculate the mass of Fe_2O_3. Many candidates did not work systematically through the calculation, and many answers were scattered throughout and beyond the answer space.

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Question 8

(a) The majority of candidates were able to describe the test for carbon dioxide gas and include the observation for a positive result. Some candidates described the test for hydrogen gas or the test for oxygen gas.

(b)(i) The majority of candidates were able to state the time when the reaction stops as 6 minutes.

(ii) The majority of candidates were able to calculate the average rate of the reaction during the first two minutes of the experiment as 15 cm^3 / minute.

(iii) Candidates found it challenging to calculate the amount of carbon dioxide gas made in moles, at room temperature and pressure. Most of these candidates did not convert the volume from 50 cm^3 to 0.050 dm^3.

(c) Candidates found this question about explaining why the reaction between calcium carbonate and dilute hydrochloric acid is faster if the concentration of the acid used is greater challenging. Many candidates wrote about particles having more kinetic energy, which would occur with an increase in temperature and not an increase in concentration. Many candidates gave incomplete answers, for example, more collisions rather than an increase in the frequency of collisions of particles, and more particles rather than more particles per unit volume. Some candidates incorrectly wrote about an increased surface area when concentration increases.

Question 9

(a)(i) Candidates found this question about how electrical power is generated from geothermal resources very challenging. The majority of candidates did not write about geothermal resources and instead wrote about hydroelectric dams, wind turbines or water waves.

(ii) Candidates found this question about naming energy resources for generating electrical power which do not rely on radiation from the Sun challenging. Some candidates gave the answer of nuclear, but very few knew that the other answer was tidal. Many different incorrect answers were seen, including fossil fuels, biofuels, thermal radiation and wind energy.

(b)(i) The majority of candidates were able to calculate the useful power output of the panel of solar cells.

(ii) Candidates found this question about calculating the area of the panel of solar cells required to supply a 2.5 kW oven challenging. Many candidates multiplied 2500 × 450 instead of dividing 2500 by 450.

(iii) The majority of candidates were able to calculate the gain in gravitational potential energy of the panel. These candidates clearly stated the equation for calculating gravitational potential energy before multiplying 8.4 × 9.8 × 6.0. Some candidates incorrectly used the value of g as 10 m / s^2 rather than the value of g as 9.8 m / s^2 quoted on the front page of the examination paper.

Question 10

(a)(i) The majority of candidates were able to state a use of microwaves, with the microwave oven to heat food being the most common answer.

(ii) Candidates found this question about describing a transverse wave challenging. Many candidates did not refer to oscillations or vibrations in their answers and instead incorrectly described the waves as being perpendicular.

(b)(i) Almost half the candidates were able to calculate the angle of refraction of the light ray. Some candidates stated the equation but were unable to complete the calculation.

(ii) The majority of candidates were able to draw the refracted ray on the diagram. Some candidates drew a reflected ray on the diagram or drew the ray refracted away from the normal.

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(c) Candidates found this question requiring them to continue the path of the light ray when the light is incident on the boundary between glass and air at an angle greater than the critical angle challenging. Many candidates drew a refracted ray rather than a reflected ray.

Question 11

(a)(i) Almost half of all candidates were able to calculate the charge which flows through the cell in 5.0 minutes. Some candidates did not multiply the answer by 60 and so only gained one mark for an answer of 1.25 C.

(ii) Almost half of all candidates were able to state the p.d. across the 20 Ω resistor as 3.0 V. A common incorrect answer was 6.0 V.

(iii) Approximately half of all candidates were able to calculate the current in resistor R. Common incorrect answers were 0.25 A and 0.15 A.

(iv) Candidates found it challenging to calculate the total resistance of the circuit. Many candidates did not recall and use the equation for resistance and tried unsuccessfully to use the equation to calculate the total resistance of resistors in parallel. These candidates often added 1/20 and 1/30 without then finding the reciprocal to give the correct answer of 12 Ω, but instead gave the answer as 0.833 Ω.

(b)(i) Candidates found this question about stating and explaining what happens to the current in the cell when resistor R is removed from the circuit very challenging. Many candidates thought the current increases as there are fewer wires and components. Many candidates did not attempt this question.

(ii) Candidates found this question about stating and explaining what happens to the current in the 20 Ω resistor when resistor R is removed from the circuit very challenging. Many candidates thought the current increases as there are fewer wires and components. Many candidates did not attempt this question.

Question 12

(a)(i) The majority of candidates were able to determine the number of protons in the nucleus of an atom of gold.

(ii) The majority of candidates were able to determine the number of neutrons in the nucleus of an atom of gold.

(iii) The majority of candidates were able to circle the word which describes the two gold atoms.

(b)(i) Candidates were asked to complete the decay equation for a specified nuclear decay. Candidates either completed the whole decay equation correctly or seemed to add random numbers in the spaces provided, for example, beta (β) given as 190 and 70. Many candidates did not attempt this question.

(ii) Candidates found this question about defining the term half-life challenging. The syllabus states ‘define the half-life of a particular isotope as the time taken for half the nuclei of that isotope in any sample to decay’, but most candidates thought that half-life is how long it takes to decay per unit time, half the time it takes an atom to decay, half the duration of its life, or when a radioactive atom becomes half as radioactive.

(iii) Approximately half of all candidates were able to calculate the mass remaining after 8.1 days. Some candidates were only able to determine that there were three half-lives but were unable to then use this information to calculate the mass remaining. Many candidates did not attempt this question.

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CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/43
Theory (Extended)

Key messages

- Candidates are reminded to apply their knowledge to the specific situation in each question rather than writing generic definitions or answers.
- Candidates should show all stages in their working in calculation questions so that if they get the wrong answer some compensatory method marks might still be awarded.
- Using correct scientific terminology in an answer is important. This was especially the case in **Questions 2(a)(ii)**, **4(b)**, **6(e)**, **8(b)(i)**, **8(b)(ii)** and **12(c)(iii).**
- Learning definitions and keywords from the specification is always very useful.
- Candidates are reminded to use the number of marks available as a guide to the level of detail required.

General comments

Most candidates showed good use of scientific knowledge and terminology, though some candidates would benefit from using more correct scientific words in their answers.

Candidates are reminded that in calculation questions they should always write down the formula they are using, show the full working and then the final answer with units. Many candidates just wrote the final answer and if this is wrong, they cannot be awarded any compensation marks for a correct method.

Candidates are advised not just to look for dotted answer lines and to read all parts of the question paper carefully. Some candidates missed the questions where they had to either annotate a diagram or draw one of their own.

Comments on specific questions

Question 1

(a) Most candidates were able to identify some similarities and some differences between bacterial cells and plant cells. Common errors included outlining similarities and differences between plant cells and animal cells rather than bacterial cells or stating that both types of cells had mitochondria or chromosomes. Some candidates did not state which type of cell they were writing about. Whilst this did not matter for the similarities, vague statements such as ‘one has a cell wall and the other one does not’ were insufficiently clear for credit in the differences section.

(b) (i) Stronger candidates were more likely to gain the mark for this question. DNA was a common acceptable answer, but ‘genetic material’ or ‘genes’ was considered insufficient.

(ii) Candidates found this to be a challenging question with many not using the word ‘genetic’ in their description of the advantage. The disadvantage mark was less commonly awarded as candidates did not write in terms of the development/gestation of the foetus and instead wrote about ‘it’ taking more time or ‘needing two parents’ or ‘having to expend energy in finding a mate’.

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(c) (i) This question about the parts of a flower was generally well answered. Common errors included the wrong parts: stamen, ovary and anther.

(ii) This question was well answered. Those who were not awarded credit either answered in terms of the petals being more colourful or larger, possibly indicating that they had not read the question properly. Some answers used vague terminology, such as 'longer' or 'bigger' rather than stating it would be outside of the flower.

(d) Most candidates correctly stated meiosis. Some candidates wrote an ambiguous word that could look like either meiosis or mitosis. This was not given credit.

Question 2

(a) (i) Stronger responses included a good description of active transport. Some candidates found this question more challenging and gave a description of osmosis instead or did not mention using energy. Other candidates incorrectly stated that active transport was the movement of particles from a low concentration gradient to a high concentration gradient.

(ii) The most common error for magnesium ions was to not use the word chlorophyll and instead mention chloroplasts or green pigment. The importance of nitrate ions was more commonly awarded. Vague incorrect answers about plant growth and strength of the plant were also common. A significant number of candidates did not attempt the question.

(b) (i) This question was mainly well answered. The idea of water entering cells was required. The most common mistake was saying that water entered the carrot itself, rather than entering the cell. Candidates usually identified osmosis and that this occurs through a partially permeable membrane. Many candidates correctly wrote about water potential, but some wrote about high water potential itself moving to low water potential. Descriptions in terms of concentration did not gain credit.

(ii) Most candidates were awarded some marks on this question but the comparative that was needed was commonly written in the absolute e.g. 'small cell' rather than 'smaller' or just 'turgid' rather than less turgid. Plasmolysis was rare to see, as was its description in terms of the cell membrane pulling away from the cell wall.

Question 3

(a) (i) This question was very well answered by candidates. The main error was in the labelling of the valve, with many candidates ending their line at a point that was not quite pointing at a valve.

(ii) In this question, an indication that the wall was made of muscle and that the blood was at high pressure was required. Many candidates just mentioned 'the pressure of the blood' without stating that it was high or just said that 'the wall was thick' without mentioning muscle.

(b) (i) This was a well answered question, with most candidates correctly stating that the blood clots to stop pathogens entering. Coagulation was an acceptable answer, as were descriptions of how this seals the wound, e.g. forming a scab or protective barrier. A common misconception was that a scab would stop diseases or infection from entering the blood rather than the pathogens.

(ii) This question was well answered, though many candidates wrote about the components of blood such as platelets or red or white blood cells or even fibres.

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(iii) Candidates found it challenging to achieve full credit and often did not give a comparative response, e.g. less energy or not enough oxygen. Many candidates did not identify that the cell was a red blood cell. Many candidates wrote about respiration but did not state the word 'aerobic'. Some candidates stated that the lack of oxygen causes anaerobic respiration and this was considered acceptable. Other candidates got the idea of there being less energy but did not state what this energy was used for.

(iv) The most common answer to this question was about white blood cells engulfing pathogens rather than producing antibodies.

Question 4

(a) This question was generally well answered, though some candidates ticked the wrong boxes for all three of the rows.

(b) The answer to this question required a high level of detail and understanding and so only a few candidates answered this correctly. Some candidates did not state that some bacteria 'mutate' and simply stated the bacteria 'changed' or 'had variation'. It was fairly common to see that the bacteria 'survive and divide' but candidates rarely referred to the idea of passing on alleles for antibiotic resistance to offspring.

(c) (i) This question proved to be difficult, as most candidates did not mention energy. The most common answers were in terms of feeding, rather than getting energy.

(ii) Candidates across the entire performance range gained partial credit here. Some went through the list of 'MRS GREN' without applying this to the situation, e.g. 'growth' was a common wrong answer. Some candidates just repeated the information from the question by stating urine was excreted. Others stated 'exercise', which was taken as a proxy for movement. Some candidates mentioned that not all of the organisms from a particular trophic level would be eaten and this was taken to mean 'uneaten body parts'.

Question 5

(a) Most candidates correctly identified compound **C** and were able to explain why it was not a hydrocarbon. The answer, 'it is an alcohol' did not meet the definition of why **C** is not a hydrocarbon.

(b) The correct answer of natural gas or methane was fairly common. Incorrect answers such as methene or ethene were also seen. Some candidates wrote a word that could have been either methane or methene and an ambiguity in answers such as this cannot be awarded credit.

(c) The correct answer of propane was commonly seen.

(d) (i) A single bond between the two carbon atoms was commonly seen. Some candidates incorrectly drew a double bond instead. The rest of the structure was rarely correct. When drawing polymers, candidates are reminded that brackets must be drawn around the monomer and that the bonds need to extend through the brackets. Some candidates did this question entirely correctly but instead of putting CH_3 at the end of one of their bonds, they put an H instead.

(ii) A large minority of candidates did not write an answer to this question. It was common for candidates who did answer to not write in terms of monomers or units and to also not make it clear whether they were writing about addition or condensation polymerisation. Answers such as 'one produces water and the other does not' were insufficient as the candidate did not specify which type of polymerisation they were referencing. The formation of water in condensation polymerisation was commonly seen.

(e) This question was well answered. Candidates should remember to use the correct form of capitalisation when writing formulae and that the numbers in formulae signifying the number of atoms in the molecule, e.g. the 2 in H_2O need to be noticeably smaller than the letters and that the numbers at the start (e.g. the 3 in $3CO_2$) need to be sufficiently large enough.

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Question 6

(a) This was a well answered question.

(b) Most candidates correctly recognised that there would be 12 neutrons, but many did not spot that the symbol was for a positive ion and that there would only be 10 electrons rather than 11.

(c) The overwhelming majority of candidates chose the correct option.

(d) This question was often well answered. Common errors involved only showing the shared pair of electrons and not completing the structure for the other electrons or attempting to draw a diagram that represented ionic bonding. Some candidates showed the inner-shell electrons despite this not being a requirement of the question.

(e) This question required specific terminology to be used correctly in the answer. Candidates often correctly identified the bonding in sodium chloride and chlorine but rarely went further to comment on the attractive forces. Confused answers, such as 'sodium chloride having strong intermolecular forces' rather than electrostatic forces, or 'chlorine having weak electrostatic forces rather than intermolecular forces were quite common. Some candidates answered in terms of bonds rather than in terms of forces, as directed by the question.

Question 7

(a) Only a minority of candidates were able to recall the test for oxygen, with many describing a squeaky pop. Other candidates wrote about a burning splint rather than one that was glowing.

(b) Many candidates answered in terms of a catalyst increasing the rate of a chemical reaction (thereby repeating the question), rather than explaining how it manages to do this in terms of an alternative pathway with a lower activation energy. Candidates are reminded that they need to apply their knowledge to the situation in the question.

(c) Most candidates correctly identified line **A** and explained this in terms of a faster reaction. Very few used the graph to explain that the line was steeper for **A**.

(d) (i) Completely correct diagrams were not common. Most candidates correctly drew the line for the reactants above that of the products. The arrow for activation energy was reasonably common, but some candidates invalidated this answer by drawing it in a downward direction. The energy change arrow was rarely correct, as an upward or double headed arrow was not accepted. Some candidates did not draw the 'hump' in the graph.

(ii) Most candidates selected the correct option.

Question 8

(a) Most candidates did not gain full marks for this question. Incorrect iron components included Fe_2O_3 and Fe_2.

(b) (i) In this question, candidates often did not use the word 'atom' when describing an element. Answers were given in terms of the same particles or molecules but not often in terms of the same type of atom. Completing the sentence about why the iron from the blast furnace is a mixture was rarely correct, despite many candidates saying that there were two different types of atoms or two different elements, they did not then specify that they were not chemically combined.

(ii) Most candidates did not say that there were different sized atoms in the iron from the blast furnace or that they were the same size in pure iron. The word 'layers' was commonly absent from answers.

(iii) The idea of some particles or layers sliding, moving or slipping over each other was required.

(c) (i) The correct answer was rarely seen, with common wrong answers being 'reduction', 'decomposition' (without thermal) and 'oxidation' or 'redox'.

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(ii) The correct final answer was commonly seen. Where candidates did not get the correct final answer, those who demonstrated a correct method were sometimes able to get partial credit.

(iii) Most candidates chose the correct answer.

Question 9

(a) (i) Most candidates gave the correct answer. The most common wrong answer was 'electrical'.

(ii) 'Work done' was rarely seen but current and other acceptable terms for current such as by 'electrons' or 'charge flow' or 'conduction' were quite common. Electricity was too vague and therefore, ignored.

(b) (i) This question was very well answered, though a small number of candidates used the value of g as $10\,m/s^2$ rather than $9.8\,m/s^2$, which is stated on the front cover of the question paper. Candidates who were unsuccessful in calculating the answer were usually able to gain some credit for correct working or the formula, though many did not show this.

(ii) Candidates who did not write down the formula for kinetic energy were unlikely to get the right answer for this question.

(c) (i) It was uncommon to see candidates going down the route of work done and compression for this question.

(ii) This question was well answered.

Question 10

(a) (i) Candidates generally had the right idea and expressed the idea of collisions in a suitable manner. It was less common to see the idea of the collisions being between the particles and the walls of the syringe.

(ii) This question was very well answered.

(iii) This question was challenging to many candidates. Answers in terms of faster collisions and more kinetic energy were classed as too vague. Only some candidates wrote about the idea of there being a larger force.

(b) (i) Most candidates selected the correct answer of solid.

(ii) The lower limit of ultrasound appears to not be widely known by candidates.

(iii) This was a well answered question, though a large number of candidates only got to the halfway point by finding the distance as 0.12 m. They did not then half this to get the correct answer. The time taken is for the pulse to get there and back.

Question 11

(a) (i) Candidates gave a wide variety of numbers for the age of the Universe ranging from thousands of years up to hundreds of billions of years. Some candidates wrote a correct number but did not write years as their unit and so were not awarded credit.

(ii) Most candidates did well on this question, correctly stating that the universe is expanding from a single point. Some candidates wrote just in terms of an explosion without mentioning that this is what caused the expansion and so explosion alone was not creditworthy.

(b) This question was attempted by most candidates, but the rearrangement was often not done correctly. The final correct answer was rare, but its inverse was common. Many answers were out by a factor of 10.

(c) (i) Common incorrect answers to this question involved writing the two and the four of the alpha particle the wrong way around, which then had the knock-on effect of producing the wrong

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numbers for the lead. One other common error was using the 0 and –1 associated with a beta particle instead of the 4 and 2 associated with an alpha particle.

(ii) This question was well answered, with most candidates ending up with the correct answer of 35 g. Common mistakes were only performing three half-life calculations, rather than four and so ending up with the final answer of 70. Other candidates correctly divided 12.4 by 3.1 to find that there were four half-lives but then did not complete the question.

Question 12

(a) (i) Many candidates did not attempt this question. Other candidates did not state which coil had fewer/more turns, e.g. 'one of the coils has more turns than the other', rather than saying 'the secondary coil has more turns'. Many candidates correctly stated the core was made of soft iron, others omitted the word soft.

(ii) It seems that many candidates are not familiar with the formula $P = I^2R$, with most just multiplying numbers together. Some candidates worked out the answer using a combination of $V = IR$ and $P = IV$, almost a derivation of $P = I^2R$, and this was awarded credit for getting the final correct answer.

(b) Only a few candidates were able to correctly define direct or alternating current. Some answers were not clear about which type of current candidates were describing.

(c) (i) Few candidates were able to explain the purpose of the slip rings. Most answers were vague. Some were able to give the idea of making sure the wires do not twist or tangle.

(ii) Most candidates made a good attempt at drawing a sine wave. Some candidates drew horizontal lines rather than sine waves, indicating that they thought that a direct current is coming out of the generator.

(iii) Virtually all candidates attempted the question but very few were awarded any credit. Candidates generally did not use the correct terminology associated with waves.

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CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/51
Practical Test

Key messages

- Candidates were generally familiar with several experimental techniques. Experiments were often carried out carefully and with some precision.
- Answers to the planning question were sometimes a little brief. Candidates found interpreting and evaluating experiments difficult.
- The term ‘proportional’ was not well understood by the majority of candidates.
- Biological diagrams should have a single continuous outline and should not be shaded.

General comments

Candidates generally demonstrated a good understanding of basic practical knowledge and techniques.

The standard of graph drawing was quite good. Candidates need to remember that axes need to 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.

Highlighting or 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.

Candidates appeared to have had sufficient time to complete the paper.

Comments on specific questions

Question 1

Food tests

(a) (i) The majority of candidates drew an appropriate table with columns and rows. The most common error was to draw a table with double columns for either reagents or foods or both, or to draw two tables.

(ii) Most candidates conducted the experiment carefully and produced the expected results.

(iii) The nutrients tested were well known.

(b) (i) Candidates found this a little challenging. Common non-creditworthy responses included sugar, glucose, sucrose and carbohydrate.

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(ii) Few candidates gave a temperature in the correct range. The most common incorrect responses were 20 to 25°C, 37 °C and 100 °C.

(iii) Better performing candidates calculated the averages correctly. The most common errors were adding the values together and omitting to divide by 3, not giving the final answer to two significant figures and truncating the answer instead of rounding.

(iv) Candidates found this exceptionally challenging. Most discussed method 1 having repeats and so being more accurate, although method 2 had just as many repeats. Some stated that the masses were measured, which was also not creditworthy.

(v) Candidates found this very challenging and a significant number omitted the question. Some thought it was for accuracy, described the nutrient dissolving in Benedict's solution or to get a better colour or better precipitate.

Question 2

Leaf drawing and detail

(a) Almost all candidates drew a leaf which corresponded to the Supervisors drawing and most gained at least partial credit with many gaining full credit. The most common errors were feathery outlines, gaps in the outline, shading the drawing and not using at least half of the box.

(b) All candidates answered the question, with most gaining partial credit and some gaining full credit. Some gave vague answers such as one is bigger, one is a different size, they are from different trees, or they are different shapes, all of which were non-creditworthy. Some discussed similarities or differences which could not be seen, such as photosynthesis, they are green or they have stomata, which was also not creditworthy.

Question 3

Effect of concentration of the rate of a reaction

(a) Most candidates conducted the experiment carefully and produced a full set of results. Some recorded times which increased down the table or did not give the times to the nearest second.

(b) (i) Most candidates gave the correct observation. Common non-creditworthy responses included no carbon dioxide made, no gas and the calcium carbonate dissolves.

(ii) Most candidates had read the stem of the question carefully and so gave a detailed response. Some incorrectly discussed dissolving rather than reacting.

(c) (i) The standard of graph drawing was quite good.

A significant number of candidates did not include the quantity and/or the unit on each axis or reversed the axes.

The scales were sometimes non-linear or quite often 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, suitable amounts.

The plotting of the points was quite good, except where the scales were awkward and candidates could not read their own scale accurately.

(ii) The line of best fit proved challenging. Many candidates simply joined the first and last point, which did not give an appropriate line. Some joined the points dot-to-dot or drew a curve.

(iii) Many candidates gave a relationship between volume and time, and not between concentration and rate as required by the question.

(iv) Many candidates read the value from their graph correctly. The most common error was to misread their scale.

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(d) (i) Candidates found this quite challenging and a significant number omitted the question. Many drew a line which intersected their plotted line, a horizontal line or a vertical line.

(ii) Stronger responses appreciated the increase in number of collisions. It was common for some or all of the question stem to be repeated or an increase in kinetic energy to be discussed.

(e) 'Syringe' was quite well known. Common incorrect responses included conical flask, burette, measuring cylinder and test-tube.

Question 4

Qualitative analysis

(a) Some candidates conducted the experiment carefully and gave the colour and state of the observation. Incorrect responses included cream precipitate, cloudy, milky and emulsion.

(b) Candidates found this question challenging. The use of nitric acid for the test was quite well known but its reason for use was not. Many discussed using excess barium nitrate to ensure that a precipitate was formed or using silver nitrate. The details of the sulfate test are on the qualitative analysis notes at the back of the paper.

(c) Candidates found this challenging with some obtaining the expected flame colour for one of the solutions and occasionally, for both solutions. Colours seen included blue, green, red and yellow. Candidates found the identification a little tricky; the qualitative analysis notes are printed on the back of the question paper.

Question 5

Focal length of a converging lens

(a) (i) The majority of candidates recorded both values correctly. The most common error was not recording the value to the nearest 0.1 cm.

(ii) Most recorded a value lower than that in **(a)(i)**.

(iii) Most recorded a value between that in **(a)(i)** and in **(a)(ii)**. A small number gave a value that was too high.

(iv) Candidates found this quite challenging. Incorrect responses included $u + v = p$, proportional and inversely proportional.

(v) Candidates found it challenging to explain how to overcome the difficulty. Many discussed not reading the ruler correctly, not taping the ruler and not being precise.

(b) (i) The majority of candidates multiplied the values correctly. The most common error was the misplacement of any decimal points.

(ii) The unit was deduced by stronger candidates. Common errors included cm, cm^3, mm and m.

(iii) The majority of candidates added the two values correctly. Some added $u \times v$ and u or $u \times v$ and u.

(iv) Most candidates calculated the values correctly. Stronger candidates obtained accurate values.

(c) Candidates found this very challenging, as they did not know the meaning of the term 'accuracy' and very few discussed closeness to the true value. Common non-creditworthy responses included the values are closer together, there is no anomaly and there is a smaller range.

(d) Candidates found this challenging. Many discussed parallax, poor reading of the ruler, not starting at 0 or confused cm with mm.

Question 6

Planning question

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Candidates were generally quite well prepared for this style of question, and few omitted the question.

Stronger candidates addressed the bullet points and gave a logical description of the investigation. The full range of marks was seen.

A list of apparatus is unable to gain credit unless the apparatus needed for the investigation is used in the method. Stop-watch and time measurement were seen quite often, and length was often measured with no mention of a ruler.

Many candidates did not include a table and those that did often omitted to include units for the quantities measured.

A small number of candidates had at least five lengths, many had only two or four. Some repeated each length and discussed averaging but very few linked repeats to identifying anomalies in the data. Use of a fiducial aid was not seen.

Some candidates suggested an alternative practical, varying the mass of the bob rather than the length of the string.

Control variables proved challenging, controlling the mass of the bob was seen most often, usually with no others. A common error was specifying different lengths and then describing length as a control variable.

Candidates continue to find processing results and reaching conclusions challenging. Citing 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. Almost no candidates explained how the shape of the best-fit line would lead to a conclusion. If a graph is not drawn, a conclusion should be drawn by looking at whether when the length of the string is increased, the period increases (hence a positive relationship), decreases (hence a negative relationship) or stays the same.

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CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/52
Practical Test

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

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CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/53
Practical Test

Key messages

- Candidates were generally familiar with several experimental techniques. Experiments were often carried out carefully and with some precision.
- Answers to the planning question were sometimes a little brief. Candidates found interpreting and evaluating experiments difficult.
- The term ‘proportional’ was not well understood by the majority of candidates.
- Biological diagrams should have a single continuous outline and should not be shaded.

General comments

Candidates generally demonstrated a good understanding of basic practical knowledge and techniques.

The standard of graph drawing was quite good. Candidates need to remember that axes need to 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.

Highlighting or 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.

Candidates appeared to have had sufficient time to complete the paper.

Comments on specific questions

Question 1

Food tests

(a) (i) The majority of candidates drew an appropriate table with columns and rows. The most common error was to draw a table with double columns for either reagents or foods or both, or to draw two tables.

(ii) Most candidates conducted the experiment carefully and produced the expected results.

(iii) The nutrients tested were well known.

(b) (i) Candidates found this a little challenging. Common non-creditworthy responses included sugar, glucose, sucrose and carbohydrate.

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(ii) Few candidates gave a temperature in the correct range. The most common incorrect responses were 20 to 25°C, 37 °C and 100 °C.

(iii) Better performing candidates calculated the averages correctly. The most common errors were adding the values together and omitting to divide by 3, not giving the final answer to two significant figures and truncating the answer instead of rounding.

(iv) Candidates found this exceptionally challenging. Most discussed method 1 having repeats and so being more accurate, although method 2 had just as many repeats. Some stated that the masses were measured, which was also not creditworthy.

(v) Candidates found this very challenging and a significant number omitted the question. Some thought it was for accuracy, described the nutrient dissolving in Benedict's solution or to get a better colour or better precipitate.

Question 2

Leaf drawing and detail

(a) Almost all candidates drew a leaf which corresponded to the Supervisors drawing and most gained at least partial credit with many gaining full credit. The most common errors were feathery outlines, gaps in the outline, shading the drawing and not using at least half of the box.

(b) All candidates answered the question, with most gaining partial credit and some gaining full credit. Some gave vague answers such as one is bigger, one is a different size, they are from different trees, or they are different shapes, all of which were non-creditworthy. Some discussed similarities or differences which could not be seen, such as photosynthesis, they are green or they have stomata, which was also not creditworthy.

Question 3

Effect of concentration of the rate of a reaction

(a) Most candidates conducted the experiment carefully and produced a full set of results. Some recorded times which increased down the table or did not give the times to the nearest second.

(b) (i) Most candidates gave the correct observation. Common non-creditworthy responses included no carbon dioxide made, no gas and the calcium carbonate dissolves.

(ii) Most candidates had read the stem of the question carefully and so gave a detailed response. Some incorrectly discussed dissolving rather than reacting.

(c) (i) The standard of graph drawing was quite good.

A significant number of candidates did not include the quantity and/or the unit on each axis or reversed the axes.

The scales were sometimes non-linear or quite often 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, suitable amounts.

The plotting of the points was quite good, except where the scales were awkward and candidates could not read their own scale accurately.

(ii) The line of best fit proved challenging. Many candidates simply joined the first and last point, which did not give an appropriate line. Some joined the points dot-to-dot or drew a curve.

(iii) Many candidates gave a relationship between volume and time, and not between concentration and rate as required by the question.

(iv) Many candidates read the value from their graph correctly. The most common error was to misread their scale.

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(d) (i) Candidates found this quite challenging and a significant number omitted the question. Many drew a line which intersected their plotted line, a horizontal line or a vertical line.

(ii) Stronger responses appreciated the increase in number of collisions. It was common for some or all of the question stem to be repeated or an increase in kinetic energy to be discussed.

(e) 'Syringe' was quite well known. Common incorrect responses included conical flask, burette, measuring cylinder and test-tube.

Question 4

Qualitative analysis

(a) Some candidates conducted the experiment carefully and gave the colour and state of the observation. Incorrect responses included cream precipitate, cloudy, milky and emulsion.

(b) Candidates found this question challenging. The use of nitric acid for the test was quite well known but its reason for use was not. Many discussed using excess barium nitrate to ensure that a precipitate was formed or using silver nitrate. The details of the sulfate test are on the qualitative analysis notes at the back of the paper.

(c) Candidates found this challenging with some obtaining the expected flame colour for one of the solutions and occasionally, for both solutions. Colours seen included blue, green, red and yellow. Candidates found the identification a little tricky; the qualitative analysis notes are printed on the back of the question paper.

Question 5

Focal length of a converging lens

(a) (i) The majority of candidates recorded both values correctly. The most common error was not recording the value to the nearest 0.1 cm.

(ii) Most recorded a value lower than that in **(a)(i)**.

(iii) Most recorded a value between that in **(a)(i)** and in **(a)(ii)**. A small number gave a value that was too high.

(iv) Candidates found this quite challenging. Incorrect responses included $u + v = p$, proportional and inversely proportional.

(v) Candidates found it challenging to explain how to overcome the difficulty. Many discussed not reading the ruler correctly, not taping the ruler and not being precise.

(b) (i) The majority of candidates multiplied the values correctly. The most common error was the misplacement of any decimal points.

(ii) The unit was deduced by stronger candidates. Common errors included cm, cm^3, mm and m.

(iii) The majority of candidates added the two values correctly. Some added $u \times v$ and u or $u \times v$ and u.

(iv) Most candidates calculated the values correctly. Stronger candidates obtained accurate values.

(c) Candidates found this very challenging, as they did not know the meaning of the term 'accuracy' and very few discussed closeness to the true value. Common non-creditworthy responses included the values are closer together, there is no anomaly and there is a smaller range.

(d) Candidates found this challenging. Many discussed parallax, poor reading of the ruler, not starting at 0 or confused cm with mm.

Question 6

Planning question

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Candidates were generally quite well prepared for this style of question, and few omitted the question.

Stronger candidates addressed the bullet points and gave a logical description of the investigation. The full range of marks was seen.

A list of apparatus is unable to gain credit unless the apparatus needed for the investigation is used in the method. Stop-watch and time measurement were seen quite often, and length was often measured with no mention of a ruler.

Many candidates did not include a table and those that did often omitted to include units for the quantities measured.

A small number of candidates had at least five lengths, many had only two or four. Some repeated each length and discussed averaging but very few linked repeats to identifying anomalies in the data. Use of a fiducial aid was not seen.

Some candidates suggested an alternative practical, varying the mass of the bob rather than the length of the string.

Control variables proved challenging, controlling the mass of the bob was seen most often, usually with no others. A common error was specifying different lengths and then describing length as a control variable.

Candidates continue to find processing results and reaching conclusions challenging. Citing 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. Almost no candidates explained how the shape of the best-fit line would lead to a conclusion. If a graph is not drawn, a conclusion should be drawn by looking at whether when the length of the string is increased, the period increases (hence a positive relationship), decreases (hence a negative relationship) or stays the same.

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CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/61
Alternative to Practical

Key messages

- Answers to the planning question were often very brief. Candidates found interpreting and evaluating experiments difficult.
- Candidates need to read questions carefully so that they answer what is being asked, e.g. **Question 1(a)(ii)**, where the final colours of the tests were required in the table, **Question 1(b)(iii)**, where the question asked for the answers to two significant figures and **Question 3(c)(iii)**, where the incorrect variables were chosen for the relationship.
- The term 'proportional' was not well understood by the majority of candidates.
- Biological diagrams should have a single continuous outline and should not be shaded.
- Some candidates need reminding that the qualitative analysis notes are printed at the back of the question paper.

General comments

Undertaking practical work helps candidates to interpret and evaluate experimental methods and results and also to describe experiments, such as those required by the planning question.

The standard of graph drawing was quite good. Candidates need to remember that axes need to 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.

Highlighting or 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.

Candidates appeared to have had sufficient time to complete the paper.

Comments on specific questions

Question 1

Food tests

(a) (i) The majority of candidates drew an appropriate table with columns and rows. The most common error was to draw a table with double columns for either reagents or foods or both, or to draw two tables.

(ii) Many candidates did not read the question carefully and so wrote positive and negative into the table instead of the final colours requested. Some also gave one colour for each food with no link to

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which test it was for. Of those that gave the colours, the positive test colours were much better known than the negative.

(iii) The nutrients tested were well known. Common incorrect responses included carbohydrate, sugar and protein for potato and amino acid, sugar and fats for milk.

(b) (i) Candidates found this a little challenging. Common non-creditworthy responses included sugar, glucose, carbohydrate, protein and fats.

(ii) Few candidates gave a temperature in the correct range. The most common incorrect responses were 20 to 25 °C, 37 °C and 100 °C.

(iii) Stronger candidates calculated the averages correctly. The most common errors were adding the values together and omitting to divide by 3, not giving the final answer to two significant figures and truncating the answer instead of rounding.

(iv) Candidates found this exceptionally challenging. Most discussed method 1 having repeats and so being more accurate, although method 2 had just as many repeats. Some stated that the masses were measured, which was also not creditworthy.

(v) Candidates found this very challenging and a significant number omitted the question. Some thought it was for accuracy, described the nutrient dissolving in Benedict's solution or to get a better colour.

Question 2

Leaf drawing and detail

(a) Almost all candidates drew the leaf and most gained at least partial credit, with many gaining full credit. The most common errors were feathery outlines, gaps in the outline, shading the drawing, not using at least half of the box and not including the details of the veins.

(b) All candidates answered the question with most gaining credit and some gaining full credit. Some gave vague answers, such as one is bigger, one is a different size, they are from different trees or they are different shapes, all of which were non-creditworthy. Some discussed similarities or differences which could not be seen, such as photosynthesis, they are green or they have stomata, which was also not creditworthy.

Question 3

Effect of concentration of the rate of a reaction

(a) (i) Stronger candidates appreciated that an observation was needed. Common non-creditworthy responses included no carbon dioxide made, no gas, calcium carbonate dissolves or when the stop-watch stops.

(ii) Many candidates had read the stem of the question carefully and so gave a detailed response. Some incorrectly discussed dissolving rather than reacting. Other incorrect responses included the stop-watch not measuring 0, not accurate and it is less reactive.

(iii) Candidates found this very challenging, with very few discussing precision. The most common non-creditworthy responses were too big, too hard to read and not accurate.

(b) Many candidates gave correct times. Common incorrect responses included 17 and 156 for 5 cm^3 and 45 and 50 for 15 cm^3.

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(c) (i) The standard of graph drawing was quite good.

A significant number of candidates did not include the quantity and/or the unit on each axis or reversed the axes.

The scales were sometimes non-linear or quite often the plotted points did not cover at least half of the grid. It is expected that linear scales will be appropriate, e.g. increasing in regular, suitable amounts.

The plotting of the points was quite good, except where the scales were awkward and candidates could not read their own scale accurately.

(ii) The line of best fit proved very challenging. Many simply joined the first and last point, which did not give an appropriate line. Some joined the points dot-to-dot, drew a curve or drew a line through the origin, not heeding the points at all.

(iii) Many candidates gave a relationship between volume and time, and not between concentration and rate as required by the question.

(iv) Many candidates read the value from their graph correctly. The most common error was to give the value for 11 cm^3.

(v) Candidates found this challenging, with stronger responses discussing anomalies. Non-creditworthy responses included to verify results, gets more accurate the more times repeated, check results, accuracy, stops errors and to calculate an average.

(d) (i) Candidates found this quite challenging and a significant number omitted the question. Many drew a line which intersected their plotted line, a horizontal line or a vertical line.

(ii) More successful responses appreciated the increase in number of collisions. It was common for some or all of the question stem to be repeated or an increase in kinetic energy to be discussed.

(e) **‘**Syringe’ was quite well known. Common incorrect responses included conical flask, burette, measuring cylinder and gas cylinder.

Question 4

Qualitative analysis

(a) (i) Many candidates gave both correct responses. Some gave the observations for **Y** as a cream or yellow precipitate or bubbles. The qualitative analysis notes are printed on the back of the question paper.

(ii) Candidates found this challenging and a significant number omitted the question. The use of nitric acid for the test was quite well known but its reason for use was not. Many discussed using excess barium nitrate to ensure that a precipitate was formed or using silver nitrate. The details of the sulfate test are on the qualitative analysis notes.

(b) Candidates found this challenging. Many chose lilac, not appreciating that this is the flame colour for potassium. Of those that chose yellow, most discussed the solution being sodium although the question stem stated that both solutions contained the potassium ion.

(c) The use of universal indicator was not well known. Incorrect responses included litmus, methyl orange and phenolphthalein.

Question 5

Focal length of a converging lens

(a) (i) The majority of candidates read the scale correctly and correctly calculated the value of *v*. Common incorrect responses were 60 and 63 from the ruler and unrelated values for *v*.

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(ii) Many gave the correct values, but candidates found reading the second ruler more challenging than in **(a)(i).**

(iii) Candidates found this very challenging and a significant number omitted the question. Incorrect responses included not putting the ruler in the correct place, having someone to help, wearing goggles, with the most common being parallax error and dead space on the ruler.

(b) (i) The majority of candidates multiplied the values correctly. The most common error was the misplacement of any decimal points.

(ii) The unit was quite well deduced by stronger candidates. Common errors included cm, cm^3, mm and m.

(iii) The majority of candidates added the two values correctly.

(iv) Stronger candidates calculated the values correctly. Some quoted them to different numbers of significant figures or rounded their values incorrectly.

(v) Candidates found this challenging and a significantly large number omitted the question. Citing $u + v = p$ or they are proportional were seen commonly.

(c) (i) Candidates found this very challenging, as they did not know the meaning of the term 'accuracy' and very few discussed closeness to the true value. Common non-creditworthy responses included the values are closer together, there is no anomaly and there is a smaller range.

(ii) Candidates found this very challenging. Many discussed parallax, poor reading of the ruler, not starting at 0 or confused cm with mm.

(d) Some candidates struggled with the terms used and so could not translate these into diagrams. **C** was frequently upright and **D** the same size or larger.

Question 6

Planning question

Many candidates did not answer this question confidently and a significant number omitted the question.

Stronger candidates addressed the bullet points and gave a logical description of the investigation. The full range of marks was seen.

A list of apparatus is unable to gain credit unless the apparatus needed for the investigation is used in the method. Stop-watch and time measurement were seen quite often and length was often measured with no mention of a ruler.

Many candidates did not include a table and those that did, often did not include units for the quantities measured.

A small number of candidates had at least five lengths, many had only two or four. Some repeated each length and discussed averaging but very few linked repeats to identifying anomalies in the data. Use of a fiducial aid was not seen.

Some candidates suggested an alternative practical, varying the mass of the bob rather than the length of the string.

Control variables proved challenging, controlling the mass of the bob was seen most often, usually with no others. A common error was specifying different lengths and then describing length as a control variable.

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Candidates continue to find processing results and reaching conclusions challenging. Citing 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. Almost no candidates explained how the shape of the best-fit line would lead to a conclusion. If a graph is not drawn, a conclusion should be drawn by looking at whether when the length of the string is increased, does the period increase (hence a positive relationship), decrease (hence a negative relationship) or stay the same.

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CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/62
Alternative to Practical

Key messages

- Diagrams of apparatus should be drawn in pencil and using a ruler. Labels should be included on the diagrams.
- Answers to the planning question were sometimes detailed and logical. Candidates found interpreting and evaluating experiments difficult.
- Highlighting or 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

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

The standard of graph drawing was generally quite good. Candidates need to remember that axes need to 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.

Candidates appeared to have had sufficient time to complete the paper.

Comments on specific questions

Question 1

Osmosis

(a) Most candidates recorded the temperature correctly. Incorrect responses included 21.6 °C, 20 °C and 22 °C.

(b) (i) Most candidates recorded the masses correctly. Incorrect responses included not quoting the values to 0.1 g, e.g. 74.91 g and 75 g, 48.27 g, 48 g and 49 g.

(ii) Most candidates subtracted the values correctly. The most common error was the omission of the + and – signs.

(iii) Most candidates calculated the percentages correctly. The most common error was dividing by the final mass.

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(c) (i) Stronger candidates appreciated the difference in the starting masses. Non-creditworthy responses included different masses, more accurate and easier to see the change.

(ii) Many answers to this question were vague, including it will change the experiment, change the measurements, affect the mass, more accurate and more precise.

(iii) Candidates found this very challenging, as the size of the apparatus needed to be included; small and medium were too vague. Other common incorrect responses included measuring cylinder with no size, 100 cm^3 measuring cylinder, beaker, test-tube and flask.

(iv) Identifying anomalies was a common answer given by stronger candidates. Non-creditworthy responses included accurate, precise, reduces errors, reduces anomalies, checks results and to calculate an average.

(d) Stronger candidates appreciated that water was entering the potato. The most common error was to discuss the salt moving either into or out of the potato. Some repeated the stem of the question.

(e) Candidates found this very challenging. Many thought the change in mass would increase. Those that knew it decreased, often repeated the stem of the question in terms of the particles moving slower or having lower kinetic energy with no reference to the entry into the potato being slower.

Question 2

Planning question

Candidates were generally quite well prepared for this style of question; many addressed the bullet points and gave a logical description of the investigation.

A small but significant number omitted the question. The full range of marks was seen, and some candidates gave detailed answers gaining full or almost full credit.

A list of additional apparatus is unable to gain credit unless the apparatus needed for the investigation is used in the method. Thermometer and stop-watch were seen more often than apparatus to measure volume. Many cited measuring temperature or volume or time but did not specify the apparatus they would use to make their measurements.

Quite a few candidates added the DCPIP to the yeast and then heated the mixture to the temperature required instead of heating the reagents to the required temperature and then mixing them. Few used a water-bath, with most opting for a Bunsen burner.

Some timed the reaction without specifying how they would know when to stop timing including waiting for the reaction to finish and measure the rate of respiration. A significant number added the reagents together and after a specific time recorded the colour of the mixture. Some used five different temperatures, but many only did the experiment at one or two temperatures.

Many repeated the experiment for each temperature without explaining why it should be repeated.

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 that specifying the temperatures to be used was controlling the temperature.

Candidates continue to find processing results and reaching conclusions challenging. Citing 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. Very few candidates appreciated that they had measured time and so rate would then need to be calculated. Almost no candidates explained how the shape of the best-fit line would lead to a conclusion. If a graph is not drawn, a conclusion should be made by stating whether, when the temperature is increased, the rate of respiration increases (hence a positive relationship) or decreases (hence a negative relationship) or stays the same.

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Question 3

Chromatography

(a) Many candidates gained some credit with some gaining full or almost full credit. The baseline drawn in ink was the most well-known. Incorrect responses included baseline should be at the water level, putting all the spots on the same piece of paper, do not take the paper out, solvent front not marked, have not dried the paper, took paper out too early and there is no glass rod at the top of the paper.

(b) (i) Almost all candidates chose black. Blue was the more popular incorrect choice.

(ii) Almost all candidates chose black. Blue was the more popular incorrect choice.

(iii) Stronger candidates appreciated that the solvent needed to change. Incorrect responses included change the blue dye and fractional distillation. A significant number of candidates omitted the question.

(c) The majority of candidates measured the distances and divided them correctly. Some inverted the fraction of measured distances incorrectly.

(d) The majority of candidates measured the distance and manipulated the equation and showed the colour to be green. Some did not gain credit, as they did not show any working. Orange was a popular incorrect colour, usually with no working shown.

Question 4

Preparation of copper sulfate crystals.

(a) (i) Candidates found this very challenging. Incorrect responses included no more gas formed, no more effervescence, no more reaction, colour stops changing, stops dissolving and a precipitate is formed.

(ii) Stronger candidates drew a clear and labelled diagram. Incorrect responses included filter paper with no funnel, using a strainer, filter paper laid flat across the top of a beaker, a hole in the base of the filter paper, no labels and the labels reversed. A significant number omitted the question. Diagrams should be drawn in pencil with a ruler where appropriate.

(iii) This diagram was slightly better drawn than that in **(a)(ii)**. Common errors included no gauze, no Bunsen burner and either no labels or too few labels. Diagrams should be drawn in pencil with a ruler where appropriate.

(b) Candidates found this challenging and a significant number omitted the question. The mistake was known by the better performing candidates and very few could explain the change that needed to happen. Non-creditworthy mistakes included heating and evaporating water without referencing ‘all of the water’. Non-creditworthy changes included do not heat, leave, do not evaporate the water or only evaporate some of the water, with no description of what to do next. A significant number omitted the question.

(c) The chemical test for water was not well known, and many candidates omitted the question. Incorrect responses included litmus, universal indicator, ammonia, sodium hydroxide, hydrogen test, copper chloride, cobalt sulfate, copper cobalt and checking the boiling point. Of those that had the correct reagent, many confused the colours of copper sulfate and cobalt chloride, reversed the correct colour change or only gave the final colour.

Question 5

Efficiency of a bouncing ball.

(a) (i) Many candidates recorded the height correctly. The most common incorrect responses were 25.6 cm and 26 cm.

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(ii) Almost all candidates calculated the percentage correctly. The most common errors were not following the pattern in the table and giving the value to the nearest whole number or incorrect rounding.

(b) (i) The standard of graph drawing was generally good.

A significant number of candidates did not include the quantity and/or the unit on each axis or reversed the axes.

The scales were sometimes non-linear or quite often 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, suitable amounts.

The plotting of the points was quite good, except where the scales were awkward and candidates could not read their own scale accurately.

(ii) The curve of best fit proved challenging. Some joined the points dot-to-dot, had feathery lines or multiple lines and some drew a straight line. A significant number did not draw the curve.

(c) (i) Candidates found this extremely challenging. Many laid the ruler against a wall, with no check that the wall was vertical, or used a clamp and stand again with no check that the ruler was vertical or put the base of the ruler on the ground with no check that the ground and the ruler were at 90°. Stronger candidates used a protractor at the base of the ruler to check the angle

(ii) Stronger candidates appreciated the difficulty of determining the maximum height of the bounce and most used a video. Incorrect responses included repeat and average and have another person to help.

(d) Whilst the decrease in efficiency was well deduced, many did not explain this in terms of the lower drop height. Some had increased efficiency or just gave the relationship between efficiency and drop height.

Question 6

Resistance

(a) (i) Most candidates recorded the voltage correctly. The current was frequently recorded as 0.6 A instead of 0.60 A.

(ii) Ammeter was quite well known. The most common incorrect response was ampmeter. Voltmeter and current meter were also seen.

(iii) Candidates found this very challenging and only the stronger candidates appreciated that the wire heats up, changing the resistance. Common non-creditworthy responses included the readings change with time, current is lost, voltage is lost, power runs out, resistance changes (no heating) and the meters reset when it is turned on.

(iv) Most candidates calculated the value correctly; a small number misplaced the decimal point. Units were well known. Common errors included R, volt and V ÷ A.

(b) Stronger candidates gained credit. Non-creditworthy responses included length changes the resistance, current moves either faster or slower through different diameters, fair test and repeating the question stem.

(c) Many candidates calculated the value correctly or stopped after calculating 10%. Some thought 9% would give the correct value. Many did not show their working and, where the final answer was incorrect, could not be awarded any error carried forward marks. A significant number omitted the question.

(d) The majority of candidates appreciated the smaller range of results. Non-creditworthy responses discussed two results being the same or cited anomalies.

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CO-ORDINATED SCIENCES (DOUBLE AWARD)

Paper 0654/63
Alternative to Practical

Key messages

- Diagrams of apparatus should be drawn in pencil and using a ruler. Labels should be included on the diagrams.
- Answers to the planning question were sometimes detailed and logical. Candidates found interpreting and evaluating experiments difficult.
- Highlighting or 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 terms proportional and inversely proportional are not well understood.

General comments

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

The standard of graph drawing was generally quite good. Candidates need to remember that axes need to 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 to describe methods such as those required by the planning question.

Candidates appeared to have had sufficient time to complete the paper.

Comments on specific questions

Question 1

Uptake of water by plants

(a) (i) Candidates found this quite challenging. Non-creditworthy responses included so that the bubble can move, for transpiration to begin, more accurate and more valid.

(ii) Almost all candidates read the scale correctly. A small number read to the right-hand side of the bubble.

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(b) (i) The standard of graph drawing was generally good.

A significant number of candidates did not include the quantity and/or the unit on each axis or reversed the axes.

The scales were sometimes non-linear or quite often 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, suitable amounts.

The plotting of the points was quite good, except where the scales were awkward and candidates could not read their own scale accurately.

(ii) The majority of candidates drew a line of best fit. A small number had multiple or feathery lines or used a ruler to draw a dot-to-dot line.

(iii) Most candidates extended the line and read the value correctly from their graph. A significant number did not show their working on the graph. It was expected that a horizontal line should be drawn from 9.5 cm to the line of best fit, and then a vertical line drawn from there to the horizontal axis to show the time. Marking a cross on the line or marking the axes is not sufficient for showing working.

(iv) Candidates found this challenging and a significant number omitted the question. It is expected that a triangle should be drawn to the line which is at least half of the length of the line between the first point and the last. Many candidates drew a triangle that was far too small. Many candidates inverted the division or gave a fraction as their answer instead of an evaluated answer.

(v) Stronger candidates gave the correct unit. Incorrect responses included cm, cm^3 and cm / s.

(c) Candidates found this challenging. Incorrect responses included accurate, fair test and repeating the question stem.

Question 2

Effect of solutions on the heart rate of *Daphnia*

(a) (i) The majority of candidates circled the anomalous result. Some circled pond water but no value within the results, other responses were scattered around the table.

(ii) Many candidates calculated correctly the average for the trials they had highlighted in **(a)(i)**. A common error was to add the trials without dividing by the number of trials and to add the two remaining trials and then divide by 3.

(b) The majority of candidates gave a correct suggestion. Incorrect responses included safety, accuracy, identifying anomalies and to explain any differences.

(c) (i) Candidates found this challenging. Whilst many gave a correct effect, few used the data to support their answer.

(ii) Better performing candidates appreciated that the claim was incorrect and used the result in pond water and in coffee **X** to explain their answer. Many thought the claim to be true because the heart rate was lower than coffee **X** without considering the *Daphnia's* heart rate in pond water.

(iii) The use of different *Daphnia* was quite well known. Accuracy and to avoid anomalies were the most popular incorrect responses.

Question 3

Neutralisation reaction

(a) (i) Many candidates read the burettes correctly. The most common error was to read the scale from the bottom upwards, hence 2.75 cm^3 and 16.3 cm^3 were seen frequently.

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(ii) Almost all candidates subtracted their values in **(a)(i)** correctly. A very small number added the values.

(iii) Many candidates did not appreciate that trial 1 was the rough titration and should be excluded from the average and so calculated the average of all four results.

(iv) Candidates found this a little challenging. Common non-creditworthy responses included accuracy, reliability, prevent anomalies, reduce errors, check results, verify results and practice makes the results more correct.

(v) Candidates found this very challenging. Incorrect responses included conical flask, beaker, test-tube, measuring cylinder and syringe.

(b) Candidates found this very challenging and a significant number omitted the question. Those that calculated the 2 : 1 ratio then often doubled the 2 M rather than halving it. The most common incorrect response was 2 M as they react in a 1 : 1 ratio.

(c) Many candidates gave yellow. The most common incorrect response was green.

(d) Many candidates drew a clear and labelled diagram. Common errors included no gauze, no Bunsen burner and either no labels or too few labels. Diagrams should be drawn in pencil with a ruler where appropriate.

Question 4

Planning question

Candidates were generally quite well prepared for this style of question. Many addressed the bullet points and gave a logical description of the investigation.

A small but significant number omitted the question. The full range of marks was seen, and some candidates gave detailed answers gaining full or almost full credit.

A list of additional apparatus is unable to gain credit unless the apparatus needed for the investigation is used in the method. Many used masses of **X** but did not specify using a balance and litmus was quite often used to measure pH.

Quite a few candidates suggested a different relationship be investigated and so heated **X** and timed a reaction.

Some timed the reaction without specifying how they would know when to stop timing, including waiting for the reaction to finish and measuring the rate of respiration. A significant number added the reagents together and, after a specific time, recorded the colour of the mixture. Some used five different temperatures, but many only did the experiment at one or two temperatures.

Very few appreciated that the raw data collected was the colour of the universal indicator solution and then that colour needed to be used alongside the pH colour chart to determine the pH of the resulting solution.

Many repeated the experiment for each mass of **X** used without explaining why it should be repeated. Few suggested that at least five different masses of **X** needed to be 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 that specifying the masses to be used was controlling the mass.

Candidates continue to find processing results and reaching conclusions challenging. Citing 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. Almost no candidates explained how the shape of the best-fit line would lead to a conclusion. If a graph is not drawn, a conclusion should be made by stating whether, when the mass is increased, the pH of the resulting solution increases (hence a positive relationship) or decreases (hence a negative relationship) or stays the same.

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Question 5

Determining mass using a balancing method

(a) (i) Almost all candidates recorded the two distances correctly. Incorrect responses included 29.5 cm, and 30.6 cm, 30.7 cm and 30.9 cm.

(ii) Most candidates calculated *p* correctly. Incorrect responses gave whole number answers instead of following the pattern in the table and quoting to one decimal place.

(iii) Almost all candidates used their value of *p* from **(a)(ii)** correctly. A small number used a reading from **(a)(i)**.

(iv) The ball rolling was quite well deduced. The most common incorrect responses were balancing the ruler, which was a repeat of the question and the object moving.

(b) (i) Almost all candidates quoted the value to the nearest 0.1 g. Common errors included 54.70 g and 54.68 g.

(ii) There were several methods of calculating whether the values are considered equal within the limits of experimental error and all were seen. Candidates calculated 90% and 110% of one of the values and showed that the other does or does not appear in the range. Non-creditworthy responses tended to just state whether the value was within 10%, with no calculation.

(c) (i) Candidates do not generally understand the terms proportional and inversely proportional and so found this very challenging. The most popular non-creditworthy response was as mass increases the distance decreases.

(ii) Candidates found this challenging and a significant number omitted the question. Non-creditworthy responses included repeat the experiment, increase the distance from the pivot and rounding the values.

Question 6

Effect of surface area on cooling of water

(a) (i) The vast majority of candidates calculated the surface area correctly. Some did not give their answer to 2 significant figures and rounding caused some issues. Common incorrect responses included 67 °C, 67.8 °C and 67.9 °C.

(ii) Most candidates recorded 93.5 °C; many recorded 87 °C instead of 87.0 °C.

(iii) Almost all candidates subtracted their values correctly.

(iv) Candidates found this challenging. Many described as surface area increases, the temperature decreases instead of the decrease or change in temperature increases. Proportional was also a popular incorrect response. Almost no candidates appreciated that the temperature change became larger as the surface area became larger.

(v) Stronger candidates appreciated the temperature being the same throughout the water. Non-creditworthy responses included mixing and the movement of heat particles.

(vi) Most candidates did not appreciate that the larger diameter would mean that not all of the bulb of the thermometer would be in the water. Common non-creditworthy responses included the temperature would not be even and there is no way to mix the water.

(b) Stronger candidates discussed heat loss through the sides of the beaker. Many repeated the stem of the question stating that the beaker would be more insulated. A small number discussed heat particles leaving the beaker.

(c) Candidates found this very challenging. Some appreciated that the value would be smaller but did not explain their answer, repeated the question stem or stated that the room was warmer. Many thought the value would increase.

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