CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice (Core)

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

General comments

There were several questions on this paper that the candidates struggled with. There was a strong suggestion in some cases of guessing between two possible answers. Many candidates appeared to struggle with interpretation of diagrams.

No question proved to be particularly easy for the candidates. **Questions 16**, **29**, **32**, **38** and **40** proved most difficult for the candidates.

Comments on specific questions

Question 2

This question asked candidates for the formula for magnification The responses suggested a degree of guesswork, with the largest proportion deciding on the answer that contained $\times100$ rather than the correct answer.

Question 4

This two-step question required candidates to know that an enzyme is a protein and that proteins contain nitrogen as well as carbon and oxygen. The majority did not include nitrogen as one of the elements. This suggests that candidates did not draw the two parts of the syllabus together.

Question 7

Candidates were not confident identifying where different parts of the vascular bundles were found in plants.

Question 8

This question asked about the colour of an indicator before and after contact with carbon dioxide in a respiration experiment. While almost all the candidates realised it would change colour, fewer knew what this colour change would be. This suggests that either they did not read the question carefully, which told them which way the change took place, or they did not interpret the apparatus diagram correctly.

Question 14

Candidates who performed well overall tended to choose option **D** rather than the correct answer. Candidates should know that flammability is not a distinguishing characteristic of solids and gases.

Question 16

Candidates chose option **C** more often than the correct answer. Candidates are expected to know the formulae of molecular elements as well as simple compounds and to be able to use these in equations.

Question 18

Candidates who performed well overall tended to choose option **A** rather than the correct answer. Candidates should understand that the least endothermic reaction results in the smallest decrease in temperature.

Question 21

There was evidence that many candidates had guessed at the answer. Candidates who performed well overall tended to choose option **B** rather than the correct answer. Candidates should know the general properties of the halogens and be able to identify trends in colour and physical state within Group VII.

Question 23

There was evidence that many candidates had guessed at the answer. Candidates are expected to know that alloys are mixtures containing at least one metal and therefore they all conduct an electric current.

Question 24

Candidates who performed well overall tended to choose option **A** rather than the correct answer. Although carbon is a non-metal, candidates should understand that it reacts with some metal ores because it is more reactive than the metal.

Question 27

Some candidates were unable to recognise saturated and unsaturated hydrocarbons from molecular structures.

Question 28

This question on speed−time and distance−time graphs was quite well answered. The most common incorrect choice was option **C**; a graph that is identical to the speed−time graph provided.

Question 29

The topic here was density; many candidates chose either option **A** (not noticing that there were five balls) or option **C** (dividing the final water level by the mass).

Question 30

A popular choice to find the moment of a force was to divide the force by the distance to the pivot, rather than multiplying it.

Question 32

The energy transfer involved in a hydroelectric power station was not well known. A significant number of candidates opted for options **A** or **D**, believing the energy source to be either chemical potential or nuclear energy.

Question 33

A large majority knew that the thermometer at Q would show the higher reading; some of these candidates believed this was because infrared rays always carry heat upwards, leading them to select option **D**.

Question 38

This question on resistors in parallel was found to be very challenging for all abilities. Most candidates thought that the addition of the second resistor in circuit 2 would increase the total resistance of the circuit, causing them to choose either options **A** or **B**.

Question 39

A significant number of candidates chose option **B**; this was a fuse rating just below the normal operating current of the heater, so would blow in normal use.

Question 40

This question concerned isotopes. Some candidates chose option **D** which shows two nuclei of the same isotope, whereas the question asks for different ones.

CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice (Core)

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

General comments

This paper was generally well answered, but the cohort consisted of only 30 candidates, so statistical conclusions are hard to draw. Candidates appeared to struggle with interpretation of diagrams when these were used to ask a straightforward question in a different way.

No questions proved to be particularly easy for the candidates. **Questions 21**, **23**, **28**, **32**, **34** and especially **38** proved to be the most difficult for candidates.

Comments on specific questions

Question 5

Candidates were asked about the production of starch by a variegated leaf in the light and dark. While almost all knew that starch would not be produced in the dark, the majority believed that the white part of the leaf would produce starch in the light. It is important that candidates know the relationship between leaf colour and chlorophyll distribution.

Question 6

This question on the human alimentary canal was correctly answered by all candidates.

Question 8

This question asked about movement of substances into and out of cells during the process of aerobic respiration. Candidates appeared unable to interpret the diagrams.

Question 11

Candidates were asked what term describes a range of phenotypes between two extremes. The question concerned tomatoes. A large number of candidates appeared to interpret this as being what could cause an overall change in size, giving the answer as selective breeding rather than continuous variation.

Question 15

Candidates that performed well overall tended to choose option **B** rather than the correct answer. Candidates should understand that the nucleon number is the total number of protons and neutrons in the nucleus of an atom.

Question 20

Many candidates chose option **C** than the correct answer. Candidates should recognise that substances with pH values greater than 7 neutralise acids.

Question 21

Candidates chose options **B**, **C** and **D** more often than the correct. Candidates are expected to be able to describe the physical characteristics of the halogens and to know the trend in colour and physical state within Group VII.

Question 23

Candidates chose options **A**, **B** and **D** more often than the correct answer. Candidates should know that alloys are mixtures containing at least one metal and therefore they all conduct an electric current.

Question 24

Candidates that performed well overall tended to choose option **A** rather than the correct answer. Although carbon is a non-metal, candidates should understand that it reacts with some metal ores because it is more reactive than the metal.

Question 25

Candidates that performed well overall tended to choose option **D** rather than the correct answer. Candidates are required to know the composition of clean air.

Question 26

Candidates that performed well overall tended to choose option **D** rather than the correct answer. Candidates are expected to know the uses of limestone as well as how the water supply is treated.

Question 28

Most candidates either misread the question or confused acceleration with speed, leading them to select option **B**.

Question 32

Option **A** was a popular choice. Candidates believed that chemical potential energy is transferred in a hydroelectric power station.

Question 34

The topic of this question was converging lenses. Although a large majority knew that the image formed is inverted, most of these believed that it is enlarged rather than diminished. These candidates did not consider that the object was more than two focal lengths from the lens.

Question 37

All three of the statements about electrostatic charging were correct. Some candidates might have thought this unlikely and, as a result, tried to determine which one was false.

Question 38

Combinations of resistors in series and parallel caused great difficulty. The popularity of option **C** might indicate that candidates saw three resistors in arrangement Z and considered this must have the greatest resistance.

Question 39

Option **B** was often chosen here. This was a fuse rating just below the normal operating current of the heater, so would blow in normal use.

Question 40

This question concerned isotopes. More candidates chose option **D** than the correct answer. Option **D** showed two nuclei of the same isotope, whereas the question asked for different ones.

CO-ORDINATED SCIENCES

Paper 0654/13
Multiple Choice (Core)

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

General comments

There were a number of questions on this paper that the candidates struggled with, with a strong suggestion in some cases of guessing between two possible answers. Candidates appeared to struggle with interpretation of diagrams.

Question 32 was particularly well answered. **Questions 14**, **18**, **23**, **25**, **27**, **31**, **34** and **40** proved to be the most difficult for the candidates.

Comments on specific questions

Question 1

In this question about characteristics of living organisms, candidates confused excretion with respiration.

Question 3

Many candidates believed that glycerol is a component of glycogen rather than fats.

Question 7

Candidates were not confident identifying where different parts of the vascular bundles were found in plants.

Question 14

Candidates chose options **A** and **C** more often than the correct answer. Candidates are expected to know the physical states of common substances and that in solids the particles are closer than in gases.

Question 18

There was evidence that many candidates had guessed at the answer. Candidates are expected to be able to identify exothermic reactions and neutralisation reactions using relevant information.

Question 20

Candidates chose option **D** more often than the correct answer. Candidates are required to describe the characteristic properties of acids, including their reactions with metals.

Question 23

There was evidence that many candidates had guessed at the answer. Candidates are expected to know that alloys are mixtures containing at least one metal and therefore they all conduct an electric current.

Question 25

Candidates chose options **B** and **D** more often than the correct answer. Candidates are required to know the simple chemical tests for water, including the colour changes that occur.

Question 27

There was evidence that many candidates had guessed at the answer. Candidates are expected to know the use of alkanes as fuels, and to distinguish between alkanes and alkenes by their chemical properties.

Question 29

Although a large majority of candidates knew that the object was moving from the start and that it then accelerated, many confused acceleration with speed, leading them to select option **B**.

Question 30

A significant proportion chose option **C**; this is found by multiplying mass by volume to find density.

Question 31

Options **A** and **B** were both more popular choices than the correct answer. The energy source for a hydroelectric power station was not widely known.

Question 33

Many candidates believed that wood conducts heat sideways to raise the temperature of the thermometer at P more than that at Q.

Question 34

The topic here was refraction of light. Many candidates thought angle **D** was the angle of refraction.

Question 36

Some candidates selected option **B**, the exact opposite of the correct answer. It is possible that this mistake was a result of misunderstanding the meaning of a switch being closed (turned on) and open (turned off).

Question 39

Candidates were required to choose a fuse as the device with a thin wire that melts and cuts off the supply. Almost as many chose a resistor as chose the correct answer.

Question 40

This question concerned isotopes. Many candidates chose option **D** rather than the correct answer. Option **D** showed two nuclei of the same isotope, whereas the question asked for different ones.

CO-ORDINATED SCIENCES

Paper 0654/21
Multiple Choice (Extended)

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

General comments

There were a number of questions on this paper that the candidates struggled with, with a strong suggestion in some cases of guessing between two possible answers. Candidates appeared to struggle with interpretation of diagrams.

Questions 13 and **28** were particularly easy for candidates. **Questions 23** and **37** proved to be the most difficult for the candidates.

Comments on specific questions

Question 1

When asked what plants need for their nutrition, most candidates realised that light and water were necessary. They were less clear on whether they needed ions or organic compounds as well.

Question 5

Candidates were given a cross sectional diagram of a plant cell and asked which cells do not require magnesium ions for the synthesis of chlorophyll. Most candidates believed this was the guard cells rather than the upper epidermis cells, which do not contain chlorophyll.

Question 10

The function of the placenta was not well understood, with the majority of candidates thinking it allowed exchange of blood between fetus and mother.

Question 11

There was strong evidence of guessing on this question about cell division by meiosis, which asked how the cells produced should be described.

Question 17

Candidates chose option **D** more often than the correct answer. Candidates should be able to use the Avogadro constant, 6×10^{23}, and relative atomic mass to determine the number of atoms in a given mass of a substance.

Question 18

Candidates chose option **D** more often than the correct answer. Candidates are expected to describe electrolysis in terms of the ions present, the reactions at the electrodes and consequently any changes to the concentration of the ions present in the electrolyte.

Question 23

There was evidence that many candidates had guessed at the answer. Candidates are expected to know that alloys are mixtures containing at least one metal, and therefore they all conduct an electric current.

Question 24

Candidates chose option **A** more often than the correct. Candidates are expected to be able to identify the relative position of different metals in the reactivity series and then use this knowledge to describe the reaction that occurs, if any, when a metal is mixed with an aqueous solution of another metal compound.

Question 31

Although this was generally well answered, some candidates chose option **C**, possibly because it contained the word ‘electric’.

Question 32

The energy transfer involved in a hydroelectric power station was not very well known. A significant number of candidates chose options **A** or **D**, believing the energy source to be either chemical potential or nuclear energy.

Question 34

The topic of this question was refraction of light. The majority was aware that the light would be totally internally reflected for an angle of incidence greater than the critical angle (options **A** and **C**). However, many of these thought that the ray would bend towards the normal rather than away from it, therefore choosing the option **B**.

Question 37

This was a challenging question about electrical power and energy for two lamps in parallel. Candidates had difficulty in working with the information given, either treating both lamps as if they were identical (option **C**) or taking the power of lamp Y as double that of X (option **B**).

Question 38

Some candidates chose option **B**; this was a fuse rating just below the normal operating current of the heater, so would blow in normal use.

Question 39

Candidates appeared to be guessing here, with all options being popular.

Question 40

This question about isotopes was quite well answered. The popularity of option **D** might indicate that some candidates had not read the question carefully. This option showed two nuclei of the same isotope, whereas the question asked for different ones.

CO-ORDINATED SCIENCES

Paper 0654/22
Multiple Choice (Extended)

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

General comments

This paper was generally well answered.

Candidates performed very well on **Questions 2**, **12**, **14**, **15**, **22**, **26** and **28**. **Question 37** was challenging for some candidates.

Comments on specific questions

Question 14

Most candidates identified the change illustrated by the particle diagrams without any difficulty. However, some candidates thought that evaporation, rather than diffusion, was occurring. This would have been more understandable had the black spots been drawn to represent a liquid, but in the diagram, only gaseous particles are represented.

Question 31

Although this was generally well answered, several candidates chose option **C**, possibly because it contained the word ‘electric’.

Question 32

The energy transfer involved in a hydroelectric power station was not very well known. A significant number of candidates chose options **A** or **D**, believing the energy source to be either chemical potential or nuclear energy.

Question 34

The topic of this question was refraction of light. The majority was aware that the light would be totally internally reflected for an angle of incidence greater than the critical angle (options **A** and **C**). However, many of these thought that the ray would bend towards the normal rather than away from it, therefore choosing the option **B**.

Question 37

This was a challenging question about electrical power and energy for two lamps in parallel. Many candidates had difficulty in working with the information given, either treating both lamps as if they were identical (option **C**) or taking the power of lamp Y as double that of X (option **B**).

Question 38

Some candidates chose option **B**; this was a fuse rating just below the normal operating current of the heater, so would blow in normal use.

Question 39

Candidates appeared to be guessing here, with all options being popular.

Question 40

This question about isotopes was quite well answered. The popularity of option **D** might indicate that candidates had not read the question carefully. This option showed two nuclei of the same isotope, whereas the question asked for different ones.

CO-ORDINATED SCIENCES

Paper 0654/23
Multiple Choice (Extended)

Question Number	Key
1	C
2	B
3	A
4	D
5	C
6	B
7	A
8	C
9	D
10	C

Question Number	Key
11	D
12	A
13	B
14	D
15	B
16	B
17	A
18	D
19	D
20	C

Question Number	Key
21	D
22	A
23	C
24	B
25	C
26	C
27	A
28	C
29	A
30	B

Question Number	Key
31	C
32	C
33	D
34	D
35	A
36	A
37	D
38	A
39	B
40	B

General comments

This paper was generally well answered.

Candidates performed well on **Questions 9**, **10**, **12**, **13**, **15**, **30**, **33** and **35**. **Questions 8**, **31** and **34** were found to be more challenging.

Comments on specific questions

Question 8

Candidates were asked to interpret graphs of breathing rate and carbon dioxide concentrations during and after a run. Almost all were agreed that carbon dioxide rises and then levels off, but a majority also believed that breathing rate continued to increase until the exercise stopped.

Question 20

Candidates chose the option **D** more often than the correct answer. Candidates are expected to understand that when metals react with non-metals, the formation of ions is due to electron transfer, and that is one definition of redox.

Question 23

Candidates who performed well overall tended to choose the option **D** rather than the correct answer. Candidates are expected to know that alloys are mixtures containing at least one metal, and therefore they all conduct an electric current.

Question 29

Almost as many candidates chose option **C** as the correct option. This wrong answer was found by dividing the mass, rather than the weight, by the area of contact.

Question 31

This question on power was found to be quite challenging and led to widespread guessing between options **A** (treating kJ as J), **B** (the same as in option **A** but also multiplying energy by time) and the correct answer.

Question 32

The energy transfer involved in a hydroelectric power station was not particularly well known. A significant number of candidates chose options **A** or **B**, believing the energy source to be either chemical potential or elastic potential energy.

Question 34

The topic of this question was refraction of light. The majority of candidates did not appreciate that total internal reflection occurs if the angle of incidence is greater than the critical angle (options **A** and **C**). Many others thought that the ray would bend towards the normal rather than away from it, therefore choosing option **B**.

Question 36

Almost as many candidates chose option **C** as the correct answer. These candidates made the common mistake of not converting the time from minutes to seconds.

CO-ORDINATED SCIENCES

Paper 0654/31
Theory (Core)

Key messages

- Candidates generally showed a good standard of scientific knowledge. Many candidates should be commended for their clear use of scientific language and vocabulary and for well-drawn diagrams.
- Calculations were frequently done correctly and often the working out was shown clearly, which is good practice.

General comments

Far too many candidates left questions unanswered, attempts to answer should always be encouraged. Some candidates only gained part of the marks available due to their responses not answering the question fully. In these cases, candidates should be reminded to read the stimulus material and the question carefully and complete all the instructions contained within the question to be able to access the maximum marks available.

There was a good range of marks on questions with more than one mark, with candidates generally scoring at least a mark. It was, however, rare that full marks were achieved on a question. Performance depended not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

Any formula quoted should be in a standard format and use recognisable symbols. Formulas consisting of units should be avoided. Similarly, formulas consisting of a mixture of words, symbols and units should also be avoided.

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

Comments on specific questions

Question 1

(a) (i) Some candidates identified food items which were not shown in Fig. 1.1.

(ii) Many candidates suggested hydration. A common error was to suggest that water is used to help digestion.

(b) (i) Blue-black was frequently suggested as the colour iodine solution turns when added to starch. Red- brown was the most popular wrong answer.

(ii) Glucose was often correctly circled as the component from which starch is made. Some candidates circled two components.

(iii) Many candidates correctly suggested prevention of constipation. Growth and repair and strong bones were common errors.

(c) Few candidates correctly identified all three chemical elements present in all cooking oils. Many candidates suggested calcium, iron or magnesium or in a few cases all three of them.

Question 2

(a) (i) Chlorination was the correct response. Fractional distillation was sometimes suggested incorrectly.

(ii) Chromatography was the correct response. Electrolysis and crystallisation were sometimes suggested.

(iii) Electrolysis was not well known as the process used to extract aluminium from bauxite.

(iv) Polymerisation was well known.

(b) (i) A burette was not well known as apparatus A. A pipette was often incorrectly suggested.

(ii) Many candidates misunderstood the question and suggested 13.8 as the pH because this was the value shown in Fig. 2.1. They needed to state the reading on the pH meter when the dilute hydrochloric acid exactly neutralises the aqueous sodium hydroxide i.e. 7.

(iii) Water and sodium chloride were often correctly suggested. However sodium hydroxide, hydrochloric acid, sodium and hydrogen were also suggested by a number of candidates.

(c) Few candidates were able to state that a pale blue precipitate is observed when aqueous sodium hydroxide is added to blue copper(II) sulfate solution.

Question 3

(a) (i) Most candidates suggested that nuclear power stations produced carbon dioxide.

(ii) Most candidates found this difficult and gave unspecific answers. A non-renewable energy source is being used up at a faster rate that it can be replaced.

(iii) Few candidates gave an acceptable response to this question. Reference could have been made to dangerous nuclear waste produced or nuclear accidents.

(b) (i) The nucleus splitting was quite well known.

(ii) The safest way of storing a small sample of radioactive material is in a lead lined container.

(c) Few candidates were able to state that 24 hours was 4 half-lives and that therefore the percentage of technetium-99 remaining after 24 hours would be 6.25%.

Question 4

(a) Both gland and organ were not known by many candidates.

(b) Plasma was quite well known.

(c) (i) Many candidates misunderstood the graph and suggested 5 minutes as the time when the scary event takes place.

(ii) The maximum heart rate was usually correctly determined as 109 beats per minute.

(iii) Adrenaline was well known as the hormone that causes an increase in heart rate.

(iv) Many candidates were able to state two other effects of adrenaline. A number of candidates suggested increased heart rate, which had already been mentioned.

(d) Peripheral was not well known about the nervous system but many candidates knew the two parts of the central nervous system.

Question 5

(a) (i) Many candidates drew clear and accurate diagrams.

(ii) Carbon dioxide and carbon monoxide were usually given as answers. A number of candidates suggested methane, but this was molecule C.

(b) Exothermic reactions releasing thermal energy was well known.

(c) Some candidates were able to explain why molecule B was ethane.

(d) (i) Few candidates suggested that molecule A was unsaturated.

(ii) Few candidates were able to identify the orange solution used to test for unsaturation as aqueous bromine.

(iii) Very few candidates knew the colour change that is observed when aqueous bromine is reacted with an unsaturated hydrocarbon.

Question 6

(a) (i) Evaporation was well known.

(ii) Few candidates were able to describe the process of evaporation in terms of the fastest moving molecules escaping from the surface.

(b) Force C was usually identified as weight, gravity or gravitational.

(c) (i) Most candidates correctly determined the speed of the boat as 4.4 m / s. A few candidates misread the scale on the graph and suggested 4.2 m / s

(ii) Most candidates correctly determined the distance travelled by the boat as 880 m.

(d) (i) Few candidates were able to use the graph to determine the wavelength of the wave as 8. More common answers were 0.4, 2, 4, and 16.

(ii) Some candidates managed to show the amplitude of the wave. Many candidates were careless when drawing the double-headed arrow and were out by a number of squares.

(iii) A few candidates were able to calculate how many wavefronts passed a fixed point in 25 seconds.

Question 7

(a) (i) Most candidates correctly suggested that the two conditions needed for synthesis were light and chlorophyll.

(ii) Most candidates explained that an excess of carbon dioxide was required for photosynthesis.

(iii) Many candidates correctly stated the word equation for photosynthesis. A few confused the reactants with the products.

(b) Many candidates incorrectly suggested leaves as the cell structures where photosynthesis occurs rather than chloroplasts.

(c) All the candidates followed the instructions and drew three lines to link the boxes. Almost all candidates were given at least one mark.

(d) Nitrate ions were not well known as the principal ions required to make amino acids in a plant.

Question 8

(a) (i) The number of electrons in an atom of copper was usually stated as 29.

(ii) Some candidates correctly stated that number of neutrons in this copper atom was 34. Some candidates reversed their answers for **(a)(i)** and **(a)(ii)**

(b) (i) Most candidates wrote the correct word equation. A number of candidates attempted to write a fully balanced symbol equation and were unable to. When asked to do a word equation, candidates are expected to write in words and not use the chemical formulas of the reactants and products.

(ii) Many candidates suggested the loss of something but few suggested loss of oxygen. A few candidates answered in terms gaining electrons, which was accepted.

(iii) The term basic oxide was not known. A basic oxide is a metal oxide that either reacts with an acid to make a salt and water or reacts with water to make a base or neutralises an acid.

(c) The properties of transition elements were quite well known.

(d) (i) Alloy was quite well known as a mixture of metals.

(ii) Some candidates knew that malleable means that a metal can be beaten into shape.

(iii) Most candidates were able to state the symbols of both copper and zinc. Candidates should be encouraged to use lower case letters if these appear in the symbol rather than a small upper case letter. For example Zn rather than ZN.

(e) (i) Approximately half the candidates correctly suggested cathode. The other half suggested anode.

(ii) Any soluble copper salt would have been an acceptable answer. A number of candidates suggested copper as the electrolyte.

Question 9

(a) (i) Most candidates were only awarded one mark for their circuit diagram. Some did not know the correct symbols for a switch or lamp. Others failed to put a switch in their circuit or put it in the wrong position. Many candidates drew a series rather than parallel circuit.

(ii) Many candidates used R = **I** / V rather than R = V / **I**. The ohm was not well known as the unit for resistance.

(b) (i) Many candidates seemed confused with the idea of expansion closing the gap and suggested that the gap would become wider.

(ii) Many candidates suggested a number of incorrect ideas such as so that the bridge can open and close or for ventilation or to slow the cars down rather than to allow for expansion and contraction caused by temperature change.

(c) (i) Many candidates correctly determined that amplitude increases.

(ii) Many candidates correctly determined that frequency increases.

(iii) Many candidates correctly suggested kinetic energy and gravitational potential energy.

Question 10

(a) (i) Most candidates were able to construct the correct food chain but a number of candidates reversed the arrows.

(ii) Most candidates correctly completed at least one row.

(b) Decomposer was not well known as the type of organism that gets its energy from dead and waste organic matter.

(c) The Sun was well known as the principal source of energy for all food chains. Producer and plants were often suggested.

(d) Almost all candidates were awarded full marks. A few candidates suggested nutrition but this was given in the question.

(e) Cells were the correct answer which was known by some candidates. A common wrong answer was reproduction.

Question 11

(a) Most responses were very unclear or inaccurate. An element contains only one type of atom. A compound contains two or more elements chemically combined.

(b) Most candidates were able to correctly balance the symbol equation.

(c) Few candidates were able to determine that the electron configuration of a sodium ion is 2.8 and the electron configuration of a chloride ion is 2.8.8.

(d) Some candidates were able to describe the solubility of ionic compounds as greater than the solubility of covalent compounds. A number of candidates referred to the solubility of water in an ionic or covalent compound.

(e) The test for chloride was not known to most candidates.

(f) The definition of electrolysis was not well known. A few candidates knew that the ionic compound needed to be molten and a few candidates knew that electrolysis happened due to the passage of electricity. The gases released at the electrodes were not known.

Question 12

(a) Many candidates were awarded at least one mark here. Some candidates did not answer this question.

(b) A number of candidates incorrectly suggested that the person's weight or density increased. A correct response needed to mention that the area in contact with the sand decreased leading to an increase in pressure.

(c) (i) Most candidates correctly determined the volume of the sand sample as $5\,m^3$.

(ii) Most candidates correctly showed that 8000 multiplied by 10 equalled 80000.

(d) (i) Most candidates were able to show how the rays of light are focused by the lens.

(ii) Point F is called the principal focus. Focal point was also accepted but not focus point.

(iii) Some candidates were able to indicate the focal length of the lens. The double-headed arrow needed to be drawn from F to the optical centre of the lens.

CO-ORDINATED SCIENCES

Paper 0654/32
Theory (Core)

Key messages

- Candidates generally showed a good standard of scientific knowledge. Many candidates should be commended for their clear use of scientific language and vocabulary and for well-drawn diagrams.
- Calculations were sometimes done correctly and often the working out was shown clearly, which is good practice.

General comments

Far too many candidates left questions unanswered, attempts to answer should always be encouraged. Some candidates only gained part of the marks available due to their responses not answering the question fully. In these cases, candidates should be reminded to read the stimulus material and the question carefully and complete all the instructions contained within the question to be able to access the maximum marks available.

There was a good range of marks on questions with more than one mark, with candidates generally scoring at least a mark. It was, however, rare that full marks were achieved on a question. Performance depended not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

Any formula quoted should be in a standard format and use recognisable symbols. Formulas consisting of units should be avoided. Similarly, formulas consisting of a mixture of words, symbols and units should also be avoided.

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

Comments on specific questions

Question 1

(a) (i) This question was quite well answered. Some candidates gained full marks and most gained at least one mark. The least well-known part of the plant cell was the one that controls what substances that enter the cell. The correct answer was D, the cell membrane, but many candidates suggested F, the cell wall.

(ii) Some candidates correctly suggested that part B was cytoplasm.

(iii) Many candidates were awarded full marks. Chlorophyll was not accepted as an alternative to chloroplast.

(b) (i) Most candidates correctly determined the change in length of the potato as +1.1 mm.

(ii) Few candidates were able to identify the process as osmosis. The most common incorrect response was absorption.

Question 2

(a) Many candidates gained full marks.

(b) (i) The measuring cylinder was not well known as apparatus A.

(ii) Few candidates suggested calcium chloride as the salt made.

(iii) The use of limewater as the chemical test for carbon dioxide was not well known. A number of candidates did not attempt this question

(iv) Many candidates correctly determined the rate at which carbon dioxide was made as $1.8\,cm^3/s$.

(v) Some candidates did not specify that the temperature change needed to be a reduction. Some candidates confused reduction in surface area with reduction in particle size.

(vi) Most candidates were able to determine the number of different elements present as 3.

Question 3

(a) Candidates found this question particularly challenging. Very few candidates attempted this question.

(b) Few candidates were able to state an advantage of a nuclear power station. Some candidates were able to state a disadvantage in terms of nuclear waste and nuclear accidents but many responses were unclear.

(c) (i) Few candidates were able to state that 21 years was 4 half-lives and therefore the mass of cobalt-60 remaining after 21 years would be 0.125 g. There were many incorrect answers given such as 2 g, 4 g, 8 g, 16 g and 32 g.

(ii) The charge on a beta particle was quite well known

(iii) Many candidates correctly placed alpha, beta and gamma in the correct order.

(iv) The safest way of storing a small sample of cobalt-60 is in a lead lined container.

Question 4

(a) (i) Many candidates referred to the lumen and artery walls in their answers but some found it difficult to describe the differences in appearance.

(ii) Some candidates correctly suggested valves as the structures not visible in Fig. 4.1.

(b) The pulmonary vein and vena cava were quite well known as the two veins that transport blood to the heart.

(c) Some candidates knew that capillaries transfer something. Few were able to suggest that capillaries transfer oxygen or nutrients and very few that capillaries transfer oxygen to the cells or tissues.

(d) White and red blood cells were well known. Few candidates correctly identified platelets and plasma.

Question 5

(a) Few candidates were able to determine the number of neutrons and the number of electrons but many were able determine one of these quantities.

(b) This question was well answered by many candidates, who were able to use the data provided in the question.

(c) (i) Most candidates wrote the correct word equation. A number of candidates attempted to write a fully balanced symbol equation and were unable to. When asked to do a word equation, candidates are expected to write in words and not use the chemical formulas of the reactants and products.

(ii) Exothermic reactions releasing thermal energy was well known.

(d) Few candidates knew the properties of transition metals. Many candidates suggested some of the general properties of all metals.

(e) Few candidates were able to determine the percentage by mass of magnesium as 91.5%. Consequently most candidates failed to calculate the mass of magnesium in 1.0 kg of the alloy as 0.915 kg.

Question 6

(a) (i) Force and distance were the two quantities needed to calculate the work done by the elephant on the log. A common error was to suggest the weight of the elephant or log.

(ii) Kinetic energy was a common error here. Gravitational potential energy was the correct answer.

(b) (i) Many candidates divided the mass by 10 instead of multiplying the mass by 10.

(ii) Most candidates correctly determined the density. A common error was to use an incorrect formula i.e. density = volume / mass rather than density = mass / volume.

(c) Some candidates completed the table correctly. However, a few found it difficult finding suitable units for the measurement of area and length.

Question 7

(a) (i) This question was well answered.

(ii) Most candidates correctly ticked the second and fourth statement indicating that sheep have the same number of pre-molar and molar teeth and humans have twice the number of molar teeth than sheep.

(b) The functions of all the types of teeth were known by many candidates.

(c) Many candidates knew both dentine and enamel. A common wrong answer was bone.

(d) Mechanical digestion was not well known. Ingestion was often suggested.

Question 8

(a) Fractional distillation and cracking were not well known as process X and process Y.

(b) A few candidates correctly suggested steam or water as the substance added to ethene to make ethanol.

(c) Some candidates were able to describe a hydrocarbon as a substance containing only carbon and hydrogen atoms. A number of candidates did not include the word only in their description.

(d) A few candidates knew that two products of the complete combustion are carbon dioxide and water. Many candidates suggested carbon, hydrogen or oxygen.

(e) Many candidates drew very clear diagrams to show the structure of ethanol. A common error was to attach the hydrogen atom of the -OH group to a carbon atom.

Question 9

(a) (i) Many candidates were able to calculate the resultant upward force on the rocket.

(ii) Only a few candidates were able to explain that the resultant force cannot be zero because the rocket would not move.

(iii) This question was well answered, with many candidates managing to convert the units of time from hours to seconds.

(b) (i) The principal focus was correctly identified by many candidates.

(ii) Some candidates were able to indicate the focal length of the lens. The double-headed arrow needed to be drawn from the principal focus to the optical centre of the lens.

(iii) More candidates correctly gave refraction as their answer rather than reflection.

(c) (i) Some candidates correctly placed radio waves in the electromagnetic spectrum.

(ii) Many candidates correctly suggested gamma rays as the part of the electromagnetic spectrum having the greatest frequency.

(iii) Some candidates attempted this and gained at least one mark by referring to the absence of a medium in outer space or to sound being unable to travel through a vacuum.

Question 10

(a) (i) Many candidates gained at least two marks here. Many candidates correctly identified the stigma as the part where pollination occurs. Many candidates correctly identified the ovule as the part where fertilisation occurs. Fewer candidates were able to label and name the anther as the part that produces pollen.

(ii) Some candidates were able to name either the stigma or ovary as parts of the carpel, but few knew both.

(iii) Many candidates correctly described the function of the petals.

(b) All four words were well known to many candidates. The oviduct was the least well known.

Question 11

(a) The process of diffusion was not described correctly by many candidates.

(b) Fluorine and iodine were both popular answers.

(c) Some candidates described how the reactivity changes across Period 3.

(d) Many candidates correctly suggested that drinking water is treated with chlorine to kill microorganisms or bacteria.

(e) Some candidates managed to draw a shared pair of electrons between the two chlorine atoms but few could correctly complete the outer shell electrons around the two atoms.

(f) (i) Many candidates correctly balanced the equation.

(ii) Some candidates were able to explain why hydrogen chloride is a covalent compound.

Question 12

(a) Convection was not well known.

(b) (i) Many candidates correctly showed the arrangement of particles in a gas. A few drew far too many particles in the box.

(ii) The changes of state were well known.

(iii) Less than half of the candidates were able to answer this part correctly.

(c) (i) The ammeter was well known but the voltmeter was not. Volts or voltage were often suggested,

(ii) This calculation was not done well. Most candidates used an incorrect formula either $R = V \times I$ or $R = I / V$ rather than $R = V / I$.

CO-ORDINATED SCIENCES

Paper 0654/33
Theory (Core)

Key messages

- Candidates generally showed a good standard of scientific knowledge. Many candidates should be commended for their clear use of scientific language and vocabulary and for well-drawn diagrams.
- Calculations were regularly done correctly and often the working out was shown clearly, which is good practice.

General comments

Far too many candidates left questions unanswered, attempts to answer should always be encouraged. Some candidates only gained part of the marks available due to their responses not answering the question fully. In these cases, candidates should be reminded to read the stimulus material and the question carefully and complete all the instructions contained within the question to be able to access the maximum marks available.

There was a good range of marks on questions with more than one mark, with candidates generally scoring at least a mark. It was, however, rare that full marks were achieved on a question. Performance depended not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

Any formula quoted should be in a standard format and use recognisable symbols. Formulas consisting of units should be avoided. Similarly, formulas consisting of a mixture of words, symbols and units should also be avoided.

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

Comments on specific questions

Question 1

(a) (i) Most candidates correctly predicted that the pea seeds will germinate in test-tube A.

(ii) A few candidates correctly stated that a suitable temperature is another requirement for germination. Almost all the candidates incorrectly suggested light.

(b) (i) Very few candidates were able to define photosynthesis correctly.

(ii) The two raw materials needed for photosynthesis are carbon dioxide and water. Glucose and soil were common wrong answers.

(c) Few candidates were able to identify amino acids as the smaller molecules from which protein is made.

Question 2

(a) Coal and natural gas were frequently suggested as fossil fuels. Gas was not accepted, nor was oil because petroleum is given in the question.

(b) There were few correct answers. Some candidates attempted to use the words physical and chemical in their answers but not accurately. A correct response would explain that a physical change is reversible.

(c) The use for bitumen was usually correct but few candidates knew that gas oil is used as fuel in diesel engines.

(d) (i) Some candidates knew that ethene is described as unsaturated because it contains a double covalent bond.

(ii) Very few candidates attempted this question. The use of aqueous bromine to test for unsaturation was not known. The only answers given referred to universal indicator or litmus.

(iii) Most candidates correctly stated that there are 6 atoms in one molecule of ethene.

(iv) Some very clear diagrams were drawn by some candidates. Many candidates gained full marks.

(v) Few candidates knew that poly(ethene) is the polymer made from ethene.

Question 3

(a) Most candidates correctly identified force C as the weight of the submarine. A common incorrect answer was force A.

(b) Many candidates gained at least one mark. The calculation involved two conversions of the units, from kilometres to metres and from hours to seconds. Some candidates gained full marks.

(c) (i) There were a number of uncertain responses such as harming the body. A correct response needed to refer to cell mutation or cancer.

(ii) Lead was often suggested as a material that can be used to shield a nuclear reactor.

(d) A few candidates were able to state that 96 000 years was 4 half-lives and that therefore the mass of plutonium–239 remaining after 96,000 years would be 0.0625 g.

(e) There were some excellent ray diagrams to show the ray of light passing through the periscope.

Question 4

(a) (i) Many candidates appeared not to understand the meaning of the word trend and described only differences between the two lines.

(ii) Many candidates correctly calculated the average rate of diffusion of dye Y as 0.2 mm / s.

(b) Few candidates referred to the particles moving from a region of higher concentration to a region of lower concentration.

(c) (i) Some candidates knew that it is the cell membrane that controls the movement of substances in and out of the cell. Many candidates suggested cell wall.

(ii) Glucose and oxygen were not well known as the substance that diffuse into cells for respiration. Many candidates suggested carbon dioxide and water, which are the products of respiration.

(d) The vacuole was not known as the cell component that contains cell sap to support the plant cell.

Question 5

(a) (i) NH_3 was frequently identified as an ammonia molecule.

(ii) Cl_2 was frequently identified as the molecule used in the treatment of water. O_2 was a popular incorrect answer.

(iii) CO was frequently identified as a molecule formed during the incomplete combustion of carbon-containing substances. Cl_2 and CH_4 were common incorrect answers.

(iv) N_2 was frequently identified as the gas that is 78% of clean dry air. O_2 was a popular incorrect answer.

(v) CH_4 was frequently identified as a molecule that contains four covalent bonds. NH_3 was a popular incorrect answer.

(b) (i) Few candidates suggested that carbon dioxide is the other product of the thermal decomposition of limestone.

(ii) Using calcium carbonate to neutralise acidic soil was not known.

(iii) Nitrogen, phosphorus and potassium were not well known as the three essential elements needed in a fertiliser.

Question 6

(a) An echo was not well known as a reflected sound wave.

(b) (i) Some candidates placed ultraviolet in its correct position. Many others placed it incorrectly in the gamma rays or the microwaves position.

(ii) Radio waves was the most popular and correct response.

(c) (i) Most candidates scored at least one mark on this question and many gained full marks.

(ii) Candidates needed to refer to the maximum human audible frequency.

(iii) The relationship between frequency and pitch was well known.

Question 7

(a) (i) Most candidates were able to determine which hand-span category had the most candidates.

(ii) Most candidates were able to determine the number of candidates with a hand-span of 19.0 – 19.9 m.

(iii) Although many candidates attempted this question, very few were able to provide other evidence to show that hand-span is an example of continuous variation.

(iv) Height was the most popular and the correct response.

(b) (i) Many candidates gained at least one mark here.

(ii) Many candidates answered this well.

(c) Few candidates were able to place the structures in order of size. Many candidates suggested that the nucleus was the smallest structure rather than the largest.

Question 8

(a) Many candidates knew that potassium is in group 1 and that a potassium atom has a total of 19 electrons. However, most candidates could not determine the correct positive charge on a potassium ion. Candidates appeared to equate charge on the potassium ion with number of protons in the atom.

(b) This question was not well answered. Many candidates did not attempt it. A few candidates drew clear and accurate diagrams.

(c) (i) Most candidates correctly labelled the electrolyte. Many candidates got the anode and the cathode the wrong way round, a common error.

(ii) Some candidates did not attempt this question. Very few candidates knew that the product at the other electrode is chlorine.

(iii) Very few candidates knew the chemical test for hydrogen gas.

Question 9

(a) Many candidates divided the mass by 10 instead of multiplying the mass by 10.

(b) (i) Some candidates multiplied the two numbers together. Some candidates divided one number by the other. Others added the numbers together. The resultant horizontal force is calculated by subtracting 500 000 N from 1 200 000 N.

(ii) A correct response needed to explain that the aircraft accelerates when the resultant force is not zero.

(c) (i) Few candidates were able to use the data shown in Fig. 9.2 and calculate the number of joules of sound energy transferred per second.

(ii) The unit of potential difference was not well known.

(iii) Few candidates selected the correct fuse rating. The correct fuse rating is 100 mA because it must be higher than the maximum current but not too much higher.

Question 10

(a) (i) This question was well answered with some candidates gaining full marks.

(ii) The pancreas was identified by a number of candidates but the gall bladder was less well known.

(b) Few candidates were able to describe the features of absorption and assimilation.

(c) Few candidates knew the dietary importance of vitamin D.

Question 11

(a) (i) Filtration was the most popular and correct answer. Distillation was a common incorrect response.

(ii) Few candidates suggested that copper sulfate was the salt made in the experiment.

(iii) Few candidates attempted this question. Responses that were given did not explain that covalent bonding occurs between two non-metals

(iv) Exothermic was quite well known but some candidates did suggest endothermic.

(v) Many candidates correctly suggested that the rate of reaction decreases.

(b) A number of candidates suggested general properties of metals

(c) (i) Few candidates knew that an alloy is a mixture of metals. Many candidates suggested metallic bonding.

(ii) Some candidates suggested a suitable advantage of brass compared to copper. There were a number of unclear answers referring to brass as being more resistant.

Question 12

(a) Many candidates were awarded at least one mark here. Both upright and same size were equally well known.

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

(ii) Kinetic energy was quite well known as the form of energy lost by the meteorite as it slows down.

(iii) Many candidates used information from Fig. 12.2 to determine the maximum speed of the meteorite.

(c) (i) Some candidates correctly determined the volume of the meteorite as $5\,m^3$. A common error was to use an incorrect formula i.e. volume = mass × density rather than volume = mass / density.

(ii) Few candidates suggested using a magnet to test for iron.

(d) (i) Some candidates correctly suggested conduction. Convection and evaporation were popular errors.

(ii) Few candidates were able to describe the process of evaporation in terms of the fastest moving molecules escaping from the surface.

(iii) Some candidates were able to show the arrangement and separation of particles in a solid. Few candidates correctly showed the arrangement and separation of particles in a liquid. The most common error was to show the liquid particles not touching each other.

CO-ORDINATED SCIENCES

Paper 0654/41
Theory (Extended)

Key messages

- Candidates should read each question carefully to check what information has been provided in the form of numerical data, units, chemical formulas and command words.
- Make sure that all questions have been attempted, they should try not to omit any parts of questions.
- Make use of the Periodic Table printed on the back of the paper for symbols, atomic numbers and relative atomic masses.

General comments

The standard of English and legibility were good. Most candidates expressed their ideas well. They appeared to have enough time to complete the paper. Calculations were often attempted in a logical manner which were easy to follow. Some candidates had difficulty rearranging mathematical formulas. Many candidates could have increased their marks by checking that their answers matched the requirement of the questions and that they had made use of the information provided. The most successful candidates demonstrated sound knowledge of the statements provided by the syllabus and showed an understanding of the key principles of the course.

Comments on specific questions

Question 1

(a) The majority of candidates could state the functions of some of the parts of the male reproductive system. The part where meiosis occurs was the most difficult to locate.

(b) Most labelled the flagellum or tail as a feature that adapts sperm for reproduction. Some also identified enzymes, the acrosome or mitochondria. Those labelling the head needed to show that it is the streamlined shape that adapts it for its role. Some candidates just drew label lines with no labels.

(c) Some candidates correctly described the difference in the nuclei of sperm as being unpaired and those in the nuclei of a zygote as being paired. Many others simply compared the number of chromosomes.

(d) There were many good attempts at matching the specialised cells to their functions.

Question 2

(a) Many candidates knew that a hydrocarbon contains hydrogen and carbon and some made it clear that no other elements are present. Marks were not awarded when a hydrocarbon was described as an element or atom.

(b) (i) Those who realised that the trend in energy released by burning alkanes could be found from the table usually correctly described it as decreasing.

(ii) The molecular formula of tetradecane was often correct.

(iii) Many candidates showed that decene is not an alkane by using the general formula for alkanes; this would incorrectly give 22 hydrogens in the molecule.

(c) Some candidates could write the symbol equation for the combustion of butane. Some equations did not always show understanding of the involvement of oxygen in combustion. Balancing the equation also was found to be challenging but there were a considerable number of correct answers.

(d) (i) The meaning of an exothermic reaction often correctly included the fact that energy or heat is given out of the system. The suggestion that energy is created was not appropriate.

(ii) There were some well-drawn energy level diagrams. A common misunderstanding was to show the activation energy drawn from the product level rather than the reactant level.

Question 3

(a) (i) Those who knew the formula for momentum usually found the correct answer. Use of the wrong expression, *momentum = force/distance*, was a common error.

(ii) Those who knew that the clockwise moment equals the anticlockwise momentum for a system in equilibrium, correctly copied their answer to **part (a)(i)**.

(b) There were some correct, well explained, solutions to this problem. Incorrect rearrangement of the formula and failure to convert the energy value to joules was seen frequently.

(c) (i) There were very few candidates who identified the split-ring commutator.

(ii) The direction of the magnetic field was sometimes correctly shown as a straight line from the north pole to the south pole. This question was often omitted.

(iii) Two ways to increase the speed of rotation of the motor were often suggested. The use of a bigger magnet was not accepted. There was some confusion about use of a generator.

Question 4

(a) The conditions for germination were quite well known. Common misconceptions included the need for sunlight and the involvement of carbon dioxide rather than oxygen. High humidity was not regarded as implying the need for moisture in the growing medium.

(b) (i) The name gravitropism or geotropism was known by some. Phototropism was the most common response.

(ii) There were a few complete explanations of gravitropism. Growing away from the direction of the ground did not recognise the role of gravity. There was often confusion with phototropism.

(c) (i) The correct equation for photosynthesis was often provided.

(ii) The role of chlorophyll was occasionally explained as being the transfer of light energy to chemical energy however, less often for the synthesis of glucose.

Question 5

(a) The representation of the arrangement of particles of a gas was usually drawn well. The diagram of a solid was most successful when the candidate did not attempt to fill the box, which is not required.

(b) (i) The best descriptions of what happens to water particles during boiling, stated that the particles become further apart and move more freely around the container. Statements that the particles move more randomly or increase in speed were not helpful.

(ii) Most explanations of why bonds between atoms are not broken, included a statement about the strength of the bonds or their covalent nature. Marks were not awarded when reference was made to intermolecular or ionic bonds between atoms.

(iii) There were many good diagrams showing the bonding in water.

(c) (i) Explanations of the increased rate of reaction between magnesium and hot water often referred to the increased energy of water molecules. Credit was given when candidates inferred that the rate of reaction increases because of the increased rate of collision between particles. A few realised that the main cause of the increase in the rate of reaction is the greater number of particles achieving the activation energy.

(ii) Some candidates correctly explained that the rate of reaction increased when powdered magnesium is used because of the increased rate of collision between particles. Others referred to more collisions and were not given credit. Some also correctly stated that a greater surface area of magnesium is exposed to collision by water particles.

Question 6

(a) (i) The cause of the counter force was sometimes correctly stated as friction, drag, air resistance or water resistance. Current and wind were not acceptable alternatives.

(ii) Those who arrived at the correct value for the acceleration, correctly calculated the resultant force, rather than using the driving force or the sum of the forces. They rearranged the formula F = ma, rather than using $a = \Delta v/t$.

(b) (i) A minority of candidates used their understanding of the term frequency to obtain the correct value of 0.25 Hz. A more common answer was 15 Hz.

(ii) The best candidates used $v = f\lambda$ to calculate the wave speed. Some attempted to use $v = d/t$, dividing the wavelength by the time taken for one wave to pass, with varying success.

(iii) Those who showed waves passing through the gap between the rocks often drew circular wavefronts, spreading out. Others just showed reflection back from the rocks.

(c) Very few candidates stated nuclear fusion as the process in the Sun that releases energy. Other suggestions included fission, radiation, combustion and photosynthesis.

Question 7

(a) (i) Those who read the question carefully stated vitamin D as the vitamin which causes rickets. Others stated calcium or another dietary deficiency.

(ii) The best responses avoided repeating vitamin supplements mentioned in the question. They named a necessary inclusion in the diet and exposure to sunlight.

(b) (i) Many candidates correctly calculated the percentage of children of 4 and under with kwashiorkor.

(ii) Most stated that children need more protein for growth.

(c) Marasmus was known by some as a disease caused by protein-energy malnutrition.

(d) Some knew that proteins contain the four elements, hydrogen, carbon, oxygen and nitrogen. A considerable number of candidates misinterpreted the question and provided a list of nutrients.

(e) Protease was quite well known as an enzyme that breaks down enzymes.

Question 8

(a) (i) Some candidates gave a good explanation of why car A makes the most nitrogen monoxide by comparing their calculated values of nitrogen monoxide emissions.

(ii) The balanced equation for the catalytic conversion of nitrogen monoxide was sometimes correct. A common misconception was to write the nitrogen product as 2N rather than N_2.

(iii) Suggested methods of reducing sulfur emissions were usually sensible, including the use of low sulfur fuels, the use of electric cars and reducing the use of cars.

(b) A few candidates could calculate the volume of carbon monoxide. They knew to divide the mass by the relative molecular mass. Others seemed to have difficulty obtaining relative atomic masses from the Periodic Table at the end of the paper.

(c) Several candidates made good suggestions for the temperature and pressure used in the Contact Process and appreciated the need for a catalyst.

Question 9

(a) Most circuit diagrams showed a series circuit. The symbol for a thermistor was not well known.

(b) Successful calculations of the time taken for the charge to flow included; substitution into the correctly rearranged formula and used current converted from mA to A.

(c) (i) The few good descriptions of how thermal energy is transferred through glass mentioned conduction and stated that the increased vibrations pass from particle to particle. Less successful responses involved convection in alcohol and transfer by free electrons. Mention of the transfer of thermal energy between particles did not add enough information to that given in the question.

(ii) The best explanations of why ethanol expands included the idea that the increase in kinetic energy of particles causes them to move further apart.

(iii) There were a few well-presented attempts at this calculation showing how the formula $d = m/V$ can be used to obtain the mass of ethanol from the data at 25 °C, and substituting it again into the formula to find the density at 3 °C.

Question 10

(a) The majority of candidates could show the functions of some of the parts of the structure of the skin. Hair, rather than fatty tissue, was sometimes suggested as providing insulation and the functions of the hair erector muscle and sweat gland were often imprecisely described as moving hair and producing water.

(b) Very few candidates showed understanding of the role of arterioles in reducing body temperature by vasodilation. Some correctly mentioned the increased blood flow to skin surface capillaries but others stated that there is movement of blood vessels. Another common misconception was that arterioles have a role in the production of sweat.

(c) (i) Some candidates could explain the meaning of negative feedback as involving an action in opposition to a change returning a system back to its normal state. Others gave the definition of homeostasis instead as the maintenance of a constant internal environment. This was not regarded as adequate.

(ii) Many candidates could give an example of negative feedback such as the control of blood glucose concentration. Others just suggested a mechanism of control, such as sweating.

Question 11

(a) The meaning of reduction was usually correct and explained as the loss of oxygen or the gain of electrons.

(b) (i) The electrolyte was sometimes named correctly as copper sulfate solution. Non-ionic, insoluble and solid substances were also suggested.

(ii) The cathode was sometimes named as pure copper. Graphite and other metals were also suggested.

(c) Some candidates could construct the balanced half-equation for the discharge of copper ions.

(d) (i) Many knew that aluminium is made at the cathode. Iron and oxygen were also suggested.

(ii) The discharge of oxide ions was often correctly named oxidation.

(e) A few candidates could use the unitary method to calculate the mass of aluminium. Others apparently had difficulty obtaining relative atomic masses from the Periodic Table or could not use them to find the relative formula mass.

Question 12

(a) Most candidates could state an effect of ionising radiation on living things.

(b) Those who knew the nuclide notation of an alpha particle could usually deduce that of the thorium nuclide.

(c) (i) Even when the value of the speed of gamma radiation was known, units were seldom provided.

(ii) The forms of electromagnetic radiation were usually matched correctly to their uses.

(d) (i) There were some well-drawn ray diagrams showing the formation of an image by a converging lens. The image was sometimes omitted from an otherwise perfect diagram.

(ii) Those who knew the difference between a real and a virtual image usually compared whether they could be projected onto a screen. Some had difficulty in describing rays converging on or passing through the image. Others attempted to compare the size or position of the images and did not score the mark.

CO-ORDINATED SCIENCES

Paper 0654/42
Theory (Extended)

Key messages

- A high standard of scientific knowledge and understanding was displayed by many of the candidates.
- Calculations were generally well done. Candidates should practise the conversion of units in calculation questions. **Questions 5(e)** and **6(a)(i)** are examples where this skill would have been particularly beneficial.
- Learning the definitions of keywords outlined in the syllabus is a useful tool for answering questions. This can be used to answer questions directly and to form part of longer answer responses. **Questions 4(a)(ii)**, **4(b)**, **4(c)(i)**, **7(a)** and **8(b)** are examples where recall of the meaning and definitions of keywords would have been helpful.
- Candidates should practise balancing equations. Often candidates completed the correct formulae but neglected to balance the equation. This was shown particularly in **Questions 8(a)(iii)** and **8(d)(i)**.

General comments

Some areas of the syllabus were better known than others. Candidates should be reminded to revise all the material detailed in the syllabus. Better performing candidates often use the syllabus as a revision guide and going through it, ensuring that they have covered each learning objective in their revision.

When completing calculations, candidates should remember to state the formula used, show the working, express the value to an appropriate number of significant figures and include units where instructed.

It is particularly important for candidates to read questions carefully and use their knowledge to give a response to the context of the question. Often candidates gave scientifically accurate answers but did not answer the question posed. Candidates also omitted part or all of the instructions contained within the question.

Comments on specific questions

Question 1

(a) (i) There was some confusion about the difference between calculating a percentage and calculating a percentage decrease. A number of candidates calculated the number of new infections of HIV in 2010 as a percentage of the number of new infections of HIV in 2000, giving an incorrect value of 68.75%. Some candidates calculated the difference in the number of new infections of HIV between the years 2000 and 2010 but did not use this value to calculate the percentage change. Nearly all the candidates were able to read the correct values from the graph.

(ii) A number of vague responses were seen. References to ‘safe sex’ and ‘using protection’ were ignored, as were references to better medication or vaccination. Responses required precise examples of methods that reduce the transmission of HIV, such as using barrier contraception, or sterilising needles.

(b) (i) The functions of the different components of blood are listed in the syllabus. Few candidates gave two correct functions, with phagocytosis being the least common correct answer seen. Common incorrect functions included blood clotting. Credit was given to an overarching statement about white blood cells protecting the body from pathogens.

(ii) Most candidates could name two components of blood, with haemoglobin being the most common incorrect response.

(c) The correct response of placenta was commonly seen. Incorrect responses included amniotic sac, amniotic fluid and umbilical cord.

Question 2

(a) (i) Most candidates identified that Group III elements have three electrons in their outer shell. Some candidates identified the presence of three electrons but did not specify that it would be the outer shell that contained these three electrons.

(ii) The correct element **E** was commonly identified. Some candidates stated **B** or **C**.

(iii) This question was well answered, with the majority of candidates identifying the correct electronic structure. Very occasionally the total number of electrons of element **E** was seen.

(iv) Almost all candidates identified the correct element **D**.

(v) The key to this question was recognising that element **A** has a full outer shell, as the first shell only contains two electrons. Some candidates were not precise enough in their responses and simply stated that element **A** has two electrons without linking this idea to the outer shell being full.

(vi) The biggest misconception was that the diagram drawn should represent the bonding process rather than the resultant ions. Occasionally, an attempt at covalent bonding was seen. It was common to see the correct charges written even if the number of electrons on each ion was inaccurate.

(vii) This question proved problematic for candidates. The ions were often identified as atoms, protons, electrons and particles. Metallic bonding was commonly described, with mention of delocalised electrons. Some candidates described the ionic bonding process in terms of loss and gain of electrons. This did not answer the question, which asked candidates to describe the lattice structure.

(b) This question was generally very well answered. A minority of candidates gave the relative mass of a neutron as 0.

Question 3

(a) (i) Candidates that recognised this was a distance–time graph rather than a speed–time graph, generally performed well. The most common misconception was that acceleration was increasing for 50 s before slowing to a steady speed. A minority of candidates read the graph inaccurately, giving the change in speed occurring at 45 s.

(ii) The majority of candidates were able to show the speed of the boat.

(iii) Calculations of kinetic energy were generally well done. Common inaccuracies included using the formulae kinetic energy = mv^2 or kinetic energy = ½ mv.

(b) This question proved problematic for many candidates. A very common inaccuracy included dividing the weight of 600 N by the distance to the pivot and then multiplying this by 100 to give a value of 1500 N. Candidates who performed well recognised that it was not necessary to convert the distances given from cm to m.

Question 4

(a) (i) Almost all candidates identified the correct antibiotic disc as **B**.

(ii) Most candidates could describe some aspects of the development of antibiotic resistance in bacteria. There was some confusion between the development of antibiotic resistance and immunity. These two processes are not linked.

(b) Evolution was generally linked to the correct statements. Occasionally, candidates thought that evolution brings about a change in an individual organism rather than a change over time in a species.

(c) (i) Most candidates could define the term mutation. It is useful for candidates to learn the definitions of keywords as stated in the syllabus.

(ii) The response of ionising radiation was commonly seen. Correct examples such as X-ray and gamma rays were also acceptable.

Question 5

(a) Calculating the R_f value was completed successfully by most candidates.

(b) Rearrangement of the equation to give the distance travelled by the dye was generally successful.

(c) Almost all candidates identified the correct food colouring **A**.

(d) Some candidates tried unsuccessfully to relate the purity of a substance with having a high or low melting point. A number of candidates only identified one of the substances or the wrong substance. A minority of candidates did not read the stimulus material carefully and referred to boiling point.

(e) This was a three-step calculation. Most candidates were able to divide 4.8 by 192 to give the correct number of moles. The next steps of the calculation proved more challenging. The conversion of cm^3 to dm^3 was commonly omitted, giving the value of 0.0001. In addition to this, a number of candidates multiplied the volume by the number of moles, giving a concentration of $6.25\,mol/dm^3$. Candidates should be reminded to check the units required and convert their values accordingly.

Question 6

(a) (i) The majority of candidates could divide the potential difference by the current to give a resistance. Far fewer converted the current from 80 mA to 0.08 A, resulting in a value of 25.

(ii) The most common misconception was to calculate the total resistance rather than the resistance of one of the cables. This commonly resulted in a value of half the resistance given in **(a)(i)** rather than double.

(iii) There were some imprecise responses, simply stating the resistance increases rather than doubled.

(b) (i) A number of candidates described a longitudinal wave without referring to compressions and rarefactions. Some candidates described vibration of air particles but did not describe how the waves were transmitted.

(ii) This question was very well answered with nearly all the candidates calculating the correct distance of 120 m.

(c) Many candidates talked about the colour black as being an absorber and the colour white as being a reflector of heat. There were some responses that referred to light being absorbed and reflected. The best responses compared the amount of emission of radiation of the colour black and the colour white and related this to the temperature that would be recorded.

Question 7

(a) Candidates should be reminded to read the question carefully. The question asked for two words to be circled. A variety of words were circled. Key scientific definitions and terms are stated in the syllabus and are useful for candidates to learn.

(b) (i) Almost all candidates identified the correct country as **C**.

(ii) Almost all candidates were able to calculate the average mass as 0.75 kg.

(c) (i) The topic of eutrophication is often misunderstood. However, candidates generally showed reasonable knowledge of the processes involved. Many could link the ideas of the surface producers blocking light, which in turn prevents photosynthesis and leads to death of underwater plants. A minority of responses tried to explain this in terms of toxicity.

(ii) This question was set in the context of eutrophication and was generally answered less successful than **(c)(i)**. A number of candidates tried to explain the death of animals in terms of the effect of a reduction of underwater producers on the food chain, rather than a reduction of dissolved oxygen content in the water.

Question 8

(a) (i) Almost all candidates gave a reasonable pH value.

(ii) The majority of candidates stated a correct colour change to blue. A very small number of responses suggested the litmus paper becomes bleached.

(iii) The equation was generally well done. Some candidates had issues with the balancing, most commonly omitting the 2 in front of the H_2O.

(b) Candidates should not rewrite the question. In this case, referring to the transfer of protons was not appropriate as this was in the question. The most successful responses referred to acids being proton donors.

(c) A number of candidates struggled to calculate the relative molecular mass of sulfuric acid, with a variety of values given. Some candidates also tried to include the molar gas volume. However, many candidates were successful in calculating the correct concentration.

(d) (i) The balancing of equations is an area that some candidates need to practise more. A few candidates did not appreciate that oxygen is a diatomic molecule.

(ii) Many reasonable conditions were seen. It was clear that on occasion the Contact process had been confused with the Haber process as an iron catalyst was suggested.

Question 9

(a) Nearly all candidates could state a disadvantage of using coal. These commonly included reference to the emission of greenhouse gases or that coal is a finite resource. Fewer were able to identify an advantage, with many vague responses including ‘they generate a lot of electricity’ and ‘they are efficient’.

(b) (i) Some candidates misinterpreted the question and did not compare a gas to a liquid. It was important that candidates were clear in their responses either by using comparative language or stating the forces, distance and motion for both liquids and gases. The description of the motion of the molecules was less successful with many descriptions of the speed of the molecules, which were ignored.

(ii) The effect of temperature on the volume of a gas was more well-known than the effect of volume.

(c) (i) This was generally very well answered, with most candidates calculating the correct number of turns on the secondary coil.

(ii) A number of candidates tried to explain this in terms of creating more power to travel longer distances rather than in terms of maintaining a constant power or the prevention of energy loss. Few linked the ideas of a high potential difference to a low current or referenced the equation $P = IV$.

Question 10

(a) (i) The most common misconceptions were the misidentification of the spongy mesophyll tissue as being the site of most photosynthesis and the lower epidermis as providing structural support for the leaf. Candidates should be reminded that although the main function of xylem is to transport water, it also provides structural support and transports mineral ions.

(ii) This question was often omitted. Candidates should read all the questions carefully.

(b) (i) Amino acids were often identified as one of the substances transported during translocation. Glycogen or starch were often given in the place of sucrose.

(ii) Very occasionally candidates tried to give examples of sources and sinks instead of writing these terms in the spaces provided. The region of growth in a plant was often incorrectly described as a source.

(c) (i) It was important to read the question carefully. Many candidates gave the full balanced symbol equation for photosynthesis, which was ignored. The question asked for the formula of the gas required for photosynthesis; CO_2 being the only correct response.

(ii) Many candidates could state two features of gas exchange surfaces. Some of the less able candidates misinterpreted the question and attempted to describe two functions of exchange surfaces.

Question 11

(a) The structure of ethane was generally drawn correctly. Some candidates correctly identified that the double bond would become a single bond but omitted the additional two hydrogen atoms in the structure.

(b) This was generally well answered, with many candidates identifying two correct similarities. Occasionally, candidates simply gave variations of a single idea. For example, ‘containing a double bond’ and ‘being unsaturated’ does not constitute two separate points. A number of responses repeated information given in the stem such as ‘they are hydrocarbons’, which did not provide any additional information.

(c) The most common misconception was to try and include a double bond in the structure. Candidates generally drew the correct number of carbon, hydrogen and oxygen atoms in the correct places.

(d) Better performing candidates were able to answer this question successfully. Many candidates were able to recognise that the monomer would only contain single bonds. Far fewer were able to draw the correct structure, often omitting the CH_3 group or omitting the bond between the two central carbons.

(e) A significant number of candidates chose not to answer this question. Those that did generally described the number of molecules each type of polymerisation produces. Fewer candidates described the differences in the number of monomers required for each type of polymerisation.

Question 12

(a) (i) Better performing candidates answered this successfully. Commonly, candidates stated that a small number of alpha particles were able to travel around the lead shield to hit the detector. Some candidates were able to identify that background radiation was the cause of a count rate. Fewer also stated that lead blocks the alpha particles.

(ii) Most candidates were able to state that gamma radiation is more penetrating than alpha radiation.

(b) (i) Some good diagrams were seen. Occasionally, the direction of the path of light was reversed. The majority of candidates recognised the angle of incidence is equal to the angle of reflection.

(ii) There were some vague responses that omitted reference to vibrations or oscillations of particles. Very occasionally candidates attempted to describe a longitudinal wave. It was sometimes unclear whether candidates were talking about the direction of particle movement or the direction of wave travel. Candidates should be reminded to reread their responses, to check they make sense.

(iii) This question was generally well answered. Occasionally, the velocity and frequency were multiplied rather than divided.

CO-ORDINATED SCIENCES

Paper 0654/43
Theory (Extended)

Key messages

A high standard of scientific knowledge and understanding was displayed by many of the candidates.

- Candidates are reminded to use the number of marks available for questions to gauge the level of detail to include in their response. Longer responses should be arranged in a logical way, showing a clear line of reasoning where possible in relation to the context of the question. **Questions 1(d)(iii), 5(c)(ii), 9(a)(ii)** and **12(c)(ii)** would have been beneficial.
- Learning the definitions of keywords outlined in the syllabus is a useful tool for answering questions. This can be used to answer questions directly and to form part of longer responses. **Questions 3(c)(iii) and 7(d)** are examples, where recall of the meaning and definitions of keywords would have been helpful.
- Candidates should practise the construction and balancing of both symbol and ionic equations. Often candidates completed the correct formulae but neglected to balance the equation, or missed out state symbols where they had been specifically requested. This was shown particularly in **Questions 2(c)(i)** and **5(b)(ii)**.

General comments

Some areas of the syllabus were better known than others. Candidates should be reminded to revise all the material detailed in the syllabus. Better performing candidates often use the syllabus as a revision guide by going through it, ensuring that they have covered each learning objective in their revision.

When completing calculations candidates should remember to state the formula used, show the working, express the value to an appropriate number of significant figures and include units where instructed.

All questions should be attempted. Particular attention should be paid to questions that involve annotating a diagram, where an answer line is not typically provided, as these can be easily missed.

Comments on specific questions

Question 1

(a) Many candidates were able to identify a large surface area as one adaptive feature of gills, however fewer were able to give a second explanation.

(b) (i) The majority of candidates were able to correctly calculate the percentage difference using data from the table provided.

(ii) Some candidates were able to explain the difference in oxygen percentages in terms of its use in respiration, however the full explanation involving energy release by respiration was not seen often.

(iii) The correct response, that the water vapour content is different in inspired and expired air, was rarely seen. Incorrect responses included reference to nitrogen or other gases.

(c) This question was generally well answered, with most candidates being able to identify at least one adaptive feature of red blood cells. The most common responses referred to the biconcave shape of cells, using the correct scientific terminology.

(d) (i) Most candidates could correctly identify the diseases caused by smoking.

(ii) A small number of candidates were able to identify that tar is the component of tobacco smoke that causes cancer. Many candidates incorrectly identified nicotine.

(iii) The role of mucus and ciliated cells in the protection of the gas exchange system was generally well understood. Fewer responses also included details of the role of the goblet cells in producing mucus.

Question 2

(a) (i) Most candidates were able to link the greater temperature rise for fuel B, to the fuel which releases the most energy.

(ii) Only a few candidates ticked the correct description for an exothermic reaction.

(b) (i) Some candidates were able to interpret the energy level diagram correctly and state that the energy given out by the reaction was 100 kJ. The most common incorrect response was 150 kJ, where the activation energy had not been correctly applied.

(ii) Some candidates were able to interpret the energy level diagram correctly and state that the activation energy was 50 kJ.

(c) (i) The mark for correctly identifying the formula of ethene was commonly awarded, however fewer candidates were able to complete the chemical equation to gain full marks.

(ii) Most candidates were awarded at least one mark for including reference to yeast in their response. Few candidates mentioned that yeast needs glucose for respiration and very few stated that anaerobic conditions are required. This question was not attempted by a minority of candidates.

Question 3

(a) (i) Most candidates could recall the formula for kinetic energy and substituted the correct values given in the question. Common inaccuracies included using the incorrect formulas; kinetic energy = mv^2 or kinetic energy = ½ mv.

(ii) Candidates who correctly calculated the change in speed were usually then able to recall the formula for acceleration and obtain full marks. Those that failed to recognise the change in speed as being 3.5 m / s were often still awarded a mark for recalling the formula for acceleration, even when this was incorrectly applied to the question.

(iii) The speed-time graph was generally completed well.

(b) This question proved challenging for all but the better performing candidates. A very common error was the failure to convert mass into weight or using the gravitational field strength in place of the force. The formula for pressure was generally well known but not always correctly rearranged.

(c) (i) Most candidates showed some understanding of the term wavelength, however diagrams were regularly completed imprecisely and without enough care given to ensure that the arrowheads lined up with the wave.

(ii) Most candidates were able to select the correct words to complete the sentences describing waves. Few candidates were able to identify a water wave as a transverse wave, with many selecting longitudinal.

Question 4

(a) (i) Many candidates were able to describe the general relationship between the rate of photosynthesis and the light intensity. Far fewer candidates realised that the light intensity stopped affecting the rate of photosynthesis at the shortest distances.

(ii) Many candidates correctly stated that carbon dioxide was required for photosynthesis. The most able candidates expanded their response to include a description involving limiting factors, although this level of detail was not required.

(b) Most candidates were able to state that light energy is transferred into chemical energy for the synthesis of carbohydrates. Fewer knew that a deficiency of magnesium ions causes leaves to turn yellow or that magnesium is required for the synthesis of chlorophyll.

(c) Most candidates could state that proteins are made from amino acids.

Question 5

(a) (i) The vast majority of candidates were able to identify the structure of a group I metal.

(ii) Some candidates were able to recall that potassium gives a lilac flame. Similar colours such as purple or violet were also accepted.

(b) (i) Only a small percentage of candidates could recall that the precipitate of iron(II) hydroxide is green in colour. The most common incorrect response seen was orange/brown.

(ii) Candidates found this question particularly challenging. Most were not able to construct an ionic equation and the majority of those that could, did not include the correct state symbols.

(c) (i) Almost all candidates were able to draw the correct electronic structure for an oxygen atom.

(ii) The majority of candidates were able to draw the correct electronic structure for a magnesium ion and included the correct charge.

(iii) Candidates were required to link the high melting point of magnesium oxide to the strong attraction between oppositely charged ions found in ionic bonding and the large amount of energy required to overcome this attraction. When an answer was given many did not use the correct terminology, often referring to just ‘a strong bond’.

(d) Some candidates could determine the formula for potassium oxide.

Question 6

(a) (i) The majority of candidates could calculate the volume of the marble step and recall the formula for density leading to a correct answer.

(ii) Most candidates were able to state that the density of a material will decrease as it expands.

(iii) Many candidates gave responses in terms of the increased vibrational movement of particles in a solid as it is heated, without then going on to describe how this causes the particles to move further apart. A small number of candidates incorrectly stated that the particles themselves expand as they are heated.

(b) (i) This question proved challenging for candidates. Most candidates failed to describe the process of conduction, instead giving responses related to energy transfer. A number of candidates described the particle vibrations involved in conduction, without describing how these vibrations are passed on between particles.

(ii) This question was not well answered with many candidates failing to realise the significance of thermal energy transfer from the skin to the marble. Many incorrect responses stated that heat is conducted away from the marble implying that this reduces the temperature of the marble.

Question 7

(a) (i) Almost all candidates were able to use the graph to identify the day with the greatest rate of anaerobic respiration.

(ii) While the better performing candidates were able to give a full explanation of the decrease shown on the graph, most candidates incorrectly attempted to explain the reduction in respiration rate as being caused by the yeast being used up.

(b) The topic of enzymes was generally well understood by candidates, with the majority of responses correctly identifying that the enzymes will become denatured at high temperatures. A relatively small number of candidates were awarded full marks for this question, not because of a lack of understanding, rather a lack of detail in written responses; It was common to see responses referring to the changing shape of an active site or the active site no longer being complimentary to substrate, but it was much rarer to see both these pieces of information. Candidates are reminded to check the number of marks available for a question to ensure they provide a suitable level of response.

(c) While some candidates were able to identify all the correct products of the three different forms of respiration, many neglected to include water as a product of aerobic respiration in humans.

(d) Most candidates could correctly identify the incorrect words in the definition of diffusion.

Question 8

(a) Almost all candidates knew that chlorination kills microbes, however fewer identified that filtration traps finer particles using sand. Any line drawn indicating that filtration allows larger solid particles to settle out was ignored.

(b) Many candidates found this question challenging, often not being able to identify which test was for chloride ions and which was for sulfate ions as well as being unclear on whether the results given in the question demonstrated positive results.

(c) This question represented the most straightforward balancing equation question on the paper, as all the necessary chemical formulas were provided. As a result the majority of candidates were able to successfully construct the equation and also balance it.

(d) Most candidates suggested an appropriate pH value.

(e) (i) The majority of candidates could identify the structure of carbon dioxide from the options available.

(ii) The majority of candidates could identify the covalent nature of bonding in carbon dioxide.

(f) The vast majority of candidates knew that carbon dioxide is a greenhouse gas and that this contributes to climate change.

Question 9

(a) (i) Most candidates could identify the inverse proportion shown by the graph, and stated that as the distance increases, the count rate decreases. Far fewer candidates were able to fully describe the shape of the curved line in terms of the largest decrease happening at the shortest distances.

(ii) The context of this question was found to be challenging for candidates. While some candidates identified that beta particles are ionising or can cause cancer, only a small number were able to explain that the number of the beta particles will be extremely low or zero having travelled 2 m through the air.

(iii) The curve for an alpha source was generally drawn well when this question was attempted. A large number of candidates failed to answer this question. Candidates are reminded to read the question paper carefully to avoid accidently missing out questions without answers lines.

(b) (i) This was generally very well answered with most candidates calculating the correct power output for the laptop.

(ii) Some candidates correctly stated that the device that changes the voltage of a supply is a step-down transformer. The most common response was simply transformer which was acceptable. The most common incorrect response was a resistor.

Question 10

(a) (i) This question was generally well answered. A few candidates drew more than 4 lines, despite the question clearly stating two lines should be drawn from each person.

(b) (i) Most candidates correctly answered this question.

(ii) Most candidates correctly identified that sperm cells contain 23 unpaired chromosomes.

(iii) Only some candidates were able to state that human body cells contain 2 sex chromosomes. This question was likely misread as the answer 46, the number of chromosomes, was given often.

(iv) Almost all candidates knew that asexual reproduction requires only 1 parent.

Question 11

(a) (i) Some candidates could identify a correct form of carbon, with answers of graphite and graphene often seen. The most common incorrect response was coal.

(ii) Many candidates did not use technical language precisely here, referring to diamond as being tough or strong without describing it correctly as hard.

(b) While a large number of candidates were able to state that the bonding shown was covalent, fewer could describe silicon dioxide as having a macromolecular structure.

(c) Many candidates recognised that the carbon-14 isotope must contain a different number of neutrons to the carbon-12 isotope. They did not always ensure that both isotopes contained the same number of protons.

(d) Almost all candidates could correctly select words to complete the definition of relative atomic mass.

(e) Only some candidates were able to correctly calculate the number of moles in 0.6 g of carbon. Some candidates were unsure which formula to use when given the mass and relative atomic mass.

Question 12

(a) (i) Some candidates were able to correctly calculate the total resistance of two resistors in parallel. The majority of incorrect responses involved candidates treating the resistors as being in series, resulting in an answer of 18 Ω.

(ii) Most candidates could recall Ohm's law to calculate the current. Only some candidates recognised that the question asked for the current through one of the resistors, rather than through the battery leading to incorrect resistance values being put into the formula.

(b) (i) Most candidates were able to put components into a series circuit, however only some could correctly draw all of the required circuit symbols. The most common error was drawing the variable resistor. Some candidates used the symbol for a fixed resistor, while others used the symbol for a thermistor.

(ii) This question was regularly omitted. Where it was attempted, very few candidates could correctly draw the required graph. Most incorrect responses suggested that the current was directly proportional to the potential difference, as would be the case for a fixed resistor.

(c) (i) Very few candidates could correctly identify that as the temperature of the thermistor increases, the current will increase and the potential difference will decrease.

(ii) Most candidates who attempted this question could identify that the resistance of the thermistor would decrease, but few could go on to explain how this affects the rest of the circuit.

CO-ORDINATED SCIENCES

Paper 0654/51
Practical Test

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

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Paper 0654/61
Alternative to Practical

Key messages

Candidates were generally well prepared for this examination and were familiar with several experimental techniques.

Answers to the planning question were often lacking in detail. Candidates found interpreting and evaluating experiments difficult.

Candidates found rounding and significant figures particularly difficult.

General comments

Candidates generally demonstrated good understanding of basic practical knowledge and techniques. The standard of graph drawing was generally good. Candidates do need to remember that axes need to be labelled with the quantity and unit and a line of best fit needs to be a single line. Candidates had sufficient time to complete the paper.

Undertaking as much practical work as possible would help the candidates to interpret and evaluate experimental methods effectively. This would also allow them to describe better the experimental methods required by the planning question.

Comments on specific questions

Question 1

(a) Many candidates read the thermometer correctly. Common errors included 20.05, 20, 21.0 and 2. A small number gave 50.

(b) (i) Many candidates measured the length correctly. Common incorrect responses included 30.3, 330, 33.0, 30 and the width 10.

(ii) Candidates found this difficult with many simply repeating the introduction and adding ‘fair test’. Accuracy was also a common incorrect response.

(iii) Candidates found this difficult. They needed to focus specifically on this experiment therefore answers like cleaning, removing impurities or contaminants was not sufficient.

(iv) Candidates found this difficult. Few appreciated that the water was a darker red and so either the cylinders had the red colouring from the cutting on them or they had been left for too long.

(c) Most candidates calculated the average correctly. Common incorrect responses included 1.5, 1.9 and 3.2.

(d) (i) The standard of graph drawing was generally quite good. Some candidates reversed the axes and many omitted the label and/or the unit on the axes. Whilst most scales were linear some were less than ideal, which often led to poor plotting of points. Plotting of points was generally good. A small number used a scale where the points did not cover at least half of the grid.

(ii) Some candidates gave a smooth curve close to all of the points. Many drew dot-to-dot lines using a ruler between points or drew multiple lines.

(iii) Many candidates read the value from the graph correctly but did not mark the graph to show how they had arrived at their answer. Two lines from the axes to the point is the best method of showing this.

(e) (i) The majority of candidates gave a relationship between temperature and colour number. Some thought the variables were proportional to each other, not appreciating that proportional results must go through the origin. Some gave an incomplete answer, such as 'when the temperature is high the colour number is high' rather than giving the comparative relationship and some did not use the variables given in the question.

(ii) Candidates found it difficult to relate the temperature to the number of damaged cells. Some did not use the variables in the question or thought the variables were proportional. A large number omitted the question.

Question 2

(a) Most candidates appreciated that the experiment showed the presence of carbon dioxide in exhaled air. A small number also gave oxygen which was not shown to be present.

(b) (i) Candidates found this very difficult. Incorrect responses included breathing in, breathing out, sealing the apparatus or repeating and averaging.

(ii) Many candidates did not appreciate that this was an anomalous result. Insufficient answers were common including it is lower than the others, does not fit trend and does not match.

(iii) The majority of candidates chose the largest value. Common incorrect answers included adding all of the values together, 18.6 or adding the values without the anomaly, 16.4, 4.1 or 4.2.

(c) Most candidates appreciated the need to sterilise or disinfect the mouthpiece to prevent the spread of bacteria.

Question 3

(a) (i) Most candidates used the scale correctly. Red was sometimes given for vinegar and pale was often omitted from green.

(ii) Candidates found this very difficult. Many stated that different milks have different pH's, milk is acidic or neutral and that UI would not work on milk.

(iii) The majority of candidates used the scale and gave an accurate description, a small number had pH 4 as a strong acid.

(b) Whilst many candidates appreciated that a gas was given off, few completed the table with the observation of bubbles/effervescence or no bubbles/effervescence.

(c) (i) Most candidates quoted the values to two significant figures.

(ii) Better performing candidates appreciated that the solid was still wet. Too much milk, too much vinegar and rounding were common incorrect responses.

(iii) Better performing candidates correctly stated repeating and averaging. Increasing the amount of milk or vinegar were common incorrect responses.

(iv) Candidates found this difficult with many repeating the question introduction and stated the mass of the solid stays the same.

(v) Candidates found this very difficult. Some gave the relationship between volume and mass and some gave the upper limit as $4\,cm^3$ instead of $5\,cm^3$. A significant number omitted the question.

Question 4

Candidates found this plan quite difficult and a sizeable number omitted the question.

Successful candidates addressed the bullet points and gave a logical description of the investigation.

The full range of marks was seen and some candidates gave detailed answers, gaining full or almost full credit.

A considerable number did not name the extra apparatus they were using, scale is insufficient for balance. Many stated that they timed the experiment but did not state the name a timer.

Many candidates gave a general method of electrolysis rather than of electroplating specifically. The key needed to be weighed, left to plate for a measured amount of time, dried and then reweighed. The voltage also had to be set to less than 20 V for safety reasons. Repeating at a variety of voltages was mentioned by the better performing candidates.

It is not possible to scrape the coating off the key and weigh it. Measuring the mass of the key at the start and the end and then subtracting them is the preferred method.

Control variables were identified well. However, many candidates controlled the voltage even though in the method they had changed the voltage as a variable.

Candidates continue to find processing the results and drawing conclusions a challenge. Where a graph is to be drawn, five values of the variable need to be taken and the quantities for each axis need to be specified. The possible results also need to be described, for example, a straight line through the origin means the variables are proportional.

Stating a conclusion from prior knowledge or 'look for a pattern in the results' is insufficient.

Question 5

(a) (i) The majority recorded the temperature correctly. 84, 80.4, 85 and 86.5 were common incorrect responses.

(ii) Candidates found this quite challenging with most giving more accurate, or to get an average temperature.

(iii) Many candidates gave one safety precaution, usually using goggles, with many explaining the choice to avoid hot water going into the eyes. Few gave a second precaution. Not going near the apparatus, wearing a lab coat, standing up and not touching the experiment were not creditworthy.

(iv) Most candidates calculated the decrease correctly.

(v) Whilst most candidates calculated the rate correctly, many did not give their answer to two significant figures. Dividing the final temperature by 180, 0.07 and 0.1 were common incorrect responses.

(b) (i) The better performing candidates appreciated that in both beakers the rate of cooling was the greatest at the beginning of the experiment, when the temperature of the beakers was higher. Decreasing at a similar rate was a common incorrect response.

(ii) Most candidates calculated the decrease correctly.

(iii) Many candidates calculated the rate correctly. Dividing the final temperature by 180, 7.5 and 61 were common incorrect responses.

(c) Whilst most candidates chose lid as the most effective method, few used the rates in **(a)(v)** and **(b)(iii)** to explain their answer. The temperature decreasing more and the lowest final temperature were common uncreditworthy responses.

(d) Better performing candidates chose a factor which was controlled. Time and temperature were common incorrect responses.

(e) Better performing candidates chose extra insulation. Creating a vacuum, putting in a thermos or putting in a box were common incorrect responses.

Question 6

(a) (i) Most candidates recorded the position correctly. A small number gave 29.1 or 0.29.

(ii) Many candidates calculated the distance correctly. 15, 1.4 and 14 were common incorrect responses.

(b) Candidates found this very difficult. Many discussed parallax error or just ‘put it on 15 cm by eye’.

(c) (i) Many candidates calculated the value correctly. Not deducting d from the denominator was a common error.

(ii) Many candidates chose a top pan balance. Scale is not sufficient as most measuring devices have a scale. Vernier, beaker and metre rule were common incorrect responses.

(d) Most candidates calculated the value correctly. A small number gave a random number.

(e) Most candidates calculated a value for density correctly but the unit was not given correctly very often. Common incorrect units included cm^3, g, cm^3/g and kg/m^3.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

Key messages

Candidates were generally well prepared for this examination and were familiar with several experimental techniques.

Drawing skills were quite good and answers to the planning question were often detailed and logical. Candidates found interpreting and evaluating experiments difficult.

General comments

Candidates generally demonstrated good understanding of basic practical knowledge and techniques. The standard of graph drawing was generally high. Candidates do need to remember that axes need to be labelled with a quantity and unit and a line of best fit needs to be a single line.

Undertaking as much practical work as possible would help the candidates to interpret and evaluate experimental methods effectively. This would also allow them to describe better the experimental methods required by the planning question.

Comments on specific questions

Question 1

(a) (i) Candidates found this quite difficult with a significant number choosing the right-hand side of the coloured liquid. Answers lacked clarity, including front, back, start and finish.

(ii) Many candidates recorded the value correctly. Common incorrect responses were 7.2 and 6.7.

(iii) Candidates found this difficult with most giving accuracy, fair test and precision.

(b) (i) Most candidates subtracted the values correctly. Common incorrect responses were 5 and 4.

(ii) Almost all candidates calculated the rate correctly.

(c) Better performing candidates discussed the results of the experiment. It was common to discuss the rate rather than the experimental results.

(d) Candidates found this very challenging. Common incorrect responses included, oxygen used up, carbon dioxide absorbed and vacuum created.

(e) Many candidates appreciated the need for oxygen of the animals. Releasing the pressure and letting out carbon dioxide were some incorrect responses.

Question 2

(a) (i) Most candidates named a suitable piece of apparatus. Ruler was insufficient.

(ii) Most candidates calculated the area correctly. There was no pattern to the incorrect responses.

(b) (i) Almost all candidates recorded the correct number of daisy plants.

(ii) All candidates calculated the average correctly.

(c) Many candidates estimated the total number of daisy plants correctly. Some added the number of daisies and which gave 27 and some multiplied by 10 which gave 90.

Question 3

Candidates were generally well prepared for this style of question and many addressed the bullet points and gave a logical description of the investigation. Very few omitted the question and almost all candidates gained some credit.

The whole range of marks was seen and some candidates gave detailed answers gaining full or almost full credit.

A significant number of candidates did not name either key piece of apparatus they required, even though they were measuring a volume and a time.

Most candidates mixed all of the solutions together and timed the solution to go from blue-black to brown, although a significant number had this the wrong way round and timed the reaction to turn blue-black. They then repeated the experiment for several different volumes of amylase. A smaller number set up the experiment without the iodine solution and used a spotting tile to take samples every minute and then repeated for different volumes of amylase. Both methods were creditworthy.

Safety proved to be difficult with few candidates appreciating that getting the enzyme into the eyes would cause a problem. Using gloves to prevent staining the hands was not creditworthy.

Control variables were generally well known. However, a significant number of candidates controlled the volume of amylase in contradiction to the method where they had varied its volume.

Candidates continue to find processing results and drawing conclusions a challenge. Where a graph is to be drawn then five values of the variable need to be taken, the quantities for each axis need to be specified and then the possible results explained, for example, a straight line through the origin means the variables are proportional, a straight line cutting the axis means there is a linear relationship and a positive gradient on a curve means that as one variable increases so does the other.

Citing a conclusion from prior knowledge or simply looking for a pattern in the results is insufficient

Question 4

(a) (i) The standard of diagram drawing was quite good, the best diagrams were drawn with a ruler and pencil. Common errors included missing the gauze, an empty evaporating basin and drawing a beaker instead of an evaporating basin.

(ii) Candidates found this very difficult with speeding up the reaction being the most common incorrect response.

(iii) Most candidates quoted the values to two decimal places. Some copied the calculator and gave three decimal places and 25.22 was also common.

(iv) Many candidates appreciated that the carbon dioxide is lost from the solid to the air. Common non-creditworthy responses included forms carbon dioxide, something escapes, it makes a gas, it does not burn, it melts and it forms a solution.

(v) Most candidates appreciated the change in colour but some did not state that it would all be black or none of it would be green.

(b) (i) Most candidates subtracted correctly.

(ii) Almost all candidates calculated the expected mass correctly. A small number gave 2.2 or 2.45.

(iii) Almost all candidates calculated the actual mass correctly. A small number gave 2.24.

(iv) Most candidates calculated the value correctly. Some did not give the value to three significant figures or inverted the fraction.

(c) Candidates found this difficult with many thinking that more copper oxide was made or that more copper carbonate was used.

(d) Many candidates appreciated the need to repeat and average. The most common incorrect response was using less copper carbonate.

Question 5

(a) Many candidates chose the correct test but the explanation was incomplete as it did not give the results for S and T. A significant number omitted the question.

(b) Many candidates chose the correct test but the explanation was again incomplete as it did not give the results for R and T. A significant number omitted the question.

(c) Candidates found this difficult with many repeating the introduction of the question. A considerable number omitted the question.

Question 6

(a) (i) Most candidates measured the height of the object correctly. A common response was 1.5.

(ii) While most candidates measured the height of the object correctly, a substantial number gave the value as 4.

(iii) Many candidates gave a correct difference. A different size or height were common non-creditworthy responses.

(b) Most candidates calculated the value correctly. 3.07 was a common incorrect response.

(c) (i) The standard of graph drawing was generally very good. Some candidates got the axes the wrong way round and a significant number omitted the label and/or the unit on the axes. Many scales were non-linear often beginning 0, 20, 30. Plotting of points was very good with the common error of plotting 3.08 as 3.8. A very small number used a scale where the points did not cover at least half of the grid.

(ii) The line drawn was often good. Many candidates drew multiple lines or used a ruler to draw dot-to-dot lines.

(d) (i) Almost all candidates used the graph correctly. A small number did not read the value correctly.

(ii) Almost all candidates calculated the value correctly.

(e) Candidates found this difficult. Misreading, parallax and repeating the question introduction were common responses.

Question 7

(a) (i) The voltmeter was frequently in series or in parallel in the wrong place. Many candidates omitted the question.

(ii) Almost all candidates read the meters correctly. Common incorrect responses included 0.94 A.

(b) Most candidates calculated the value correctly. 1.67, 1.6, 1.75 and 1 were common responses.

(c) Many candidates estimated the value correctly. Common incorrect responses included 4.4, 5.6, 1.6 or 1.7.

(d) Candidates found this very challenging. Most thought that proportionality meant that as resistance increases so length increases. Proportionality means that as length doubles so resistance doubles or that the ratio between R/l is constant.

(e) Candidates found this difficult. Most described reading or parallax errors.

(f) Many candidates added a component in resistance but this was often a thermistor or a bulb and some connected it in the resistance wire.

CO-ORDINATED SCIENCES

Paper 0654/63
Alternative to Practical

Key messages

Candidates were generally well prepared for this examination and were familiar with several experimental techniques.

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

General comments

Candidates generally demonstrated good understanding of basic practical knowledge and techniques. The standard of graph drawing was generally high although candidates need to remember that axes need to be labelled with quantity and unit and a line of best fit needs to be a single line.

Undertaking as much practical work as possible would help the candidates to interpret and evaluate experimental methods effectively. This would also allow them to describe better the experimental methods required by the planning question.

Comments on specific questions

Question 1

(a) (i) More successful candidates knew the colours of the testing solutions. Common errors included blue, yellow-orange and red instead of purple; brown, yellow or purple instead of blue and blue, red, orange, yellow, purple, purple-black instead of blue-black. A significant number omitted some or all of the table.

(ii) Many candidates knew the nutrient being tested. Common incorrect responses included lipid instead of protein and carbohydrate instead of starch. A significant number omitted the question.

(b) (i) Many candidates knew that heat was needed but some just mixed the reagents or used a water bath without specifying a hot water bath. Quite a few only said ‘until the colour changes’ rather than specifying a positive colour change. A significant number omitted the question.

(ii) Many candidates appreciated that sugar was being tested but many of these did correctly say it is a reducing sugar. Carbohydrate and protein were also common incorrect responses. A significant number omitted the question.

(iii) Candidates found this difficult with common responses including carrots do not contain sugar, it gives a negative result, and carrot is a solid. A significant number omitted the question.

(c) Candidates found this question challenging. Common incorrect responses included measuring cylinder, test-tube and ruler. Beaker was also a common response but this is never used to measure volumes. Pipette was seen but this needed to be more specific by stating a graduated pipette.

Question 2

(a) Most candidates drew a large clear detailed diagram of the cell. Some outlines were not as clear as they could be with multiple feathery lines and gaps. Very few were too small or too large. Almost all showed the required detail although a small number had no linkage between the lobes of the nucleus.

(b) (i) Most candidates measured the width correctly. A small number had issues with the unit and so gave 2.6 or 260.

(ii) Many candidates drew a line and measured it correctly. The most common error was to omit the line, so the measurement could not gain credit.

(iii) Most candidates calculated the magnification correctly. A small number inverted the division, incorrectly rounded their answer or did not give their answer to two significant figures..

(c) Many candidates gave one difference and one similarity. Incorrect responses included, they are white and red blood cells, both blood cells and both in blood.

(d) Most candidates showed awareness of the prevention of disease or the contamination of the blood sample. The most common non-creditworthy response was to stop transmission of germs. Incomplete answers included, to stop contamination or not to get blood on the hands.

Question 3

(a) (i) Many candidates recorded the two burette readings correctly. Many read the scale in the opposite direction so 35.8 and 2.65 were common, as was missing the final 0 so 34.2.

(ii) Most candidates subtracted the values correctly.

(iii) Better performing candidates appreciated that the experiment needed to be repeated and data averaged. Common incorrect responses included, same volume in the burette, start the burette from 0, use clean flasks and repeat at other concentrations.

(iv) Candidates needed to be specific for this experiment, so contamination was insufficient. Other incorrect responses included accuracy and affects the results.

(v) Most candidates gave a correct colour. Incorrect responses included orange, yellow and brown.

(b) (i) The standard of graph drawing was generally quite good. Some candidates reversed the axes and a significant number omitted the label and/or the unit on the axes. Whilst many scales were linear, some were written right to left and some of these had the points plotted incorrectly from left to right. Some of the scales chosen were inappropriate and these usually had points which were plotted inaccurately. Plotting of points on linear axes was generally good.

(ii) Better performing candidates drew a straight line, many of which went through the origin. Many incorrectly drew two lines or used a ruler to draw dot-to-dot lines.

(iii) Candidates found this challenging. Where the line was straight and passed through the origin then the relationship was proportional because it went through the origin. Most stated that, as the concentration increased so the volume of acid increased but did not explain how this was shown by the graph. A small number said the relationship was linear but did not explain that this was shown by a straight line which did not pass through the origin. A substantial number omitted the question.

(c) Many candidates had the correct value but did not demonstrate on the graph how they arrived at their answer. Two lines are the clearest way of showing this. Common incorrect responses included 13 and 42. A sizeable number omitted the question.

Question 4

(a) (i) The gas tests were well known by many of the candidates.

(ii) More successful candidates appreciated that the litmus test did not change colour in P, Q and R but changed to blue in S. Common incorrect responses included burns, pops, bleaches and blue, yellow; and colourless, bleaches, stays the same or changes colour for S.

Question 5

(a) (i) The majority of candidates measured the length correctly. Common incorrect responses included 2, 2.8 and 3.

(ii) The majority of candidates measured the length correctly. Common incorrect responses included 13.1, 13.5 and 13.2.

(iii) Almost all candidates subtracted the values correctly.

(b) (i) Candidates found this a challenge. Incorrect responses included keeping the spring flat, measuring directly, measuring parallel and stretching the spring.

(ii) Candidates found the safety precautions difficult. Most stated using goggles but could not explain why they were needed. Many said gloves to stop the hand getting caught in the springs but this was not correct.

(c) The majority of candidates calculated the value correctly. A small number used 300 or inverted the fraction.

(d) Most candidates read the stop-watch correctly. A small number did not follow the pattern of the other results and gave the value as 14.20.

(e) (i) Most candidates calculated the average correctly.

(ii) Candidates found this very difficult with most giving just accuracy or precision. Which were not sufficient.

(f) Many candidates calculated the average correctly. Incorrect responses included 1.4 and 14.2.

(g) Many candidates calculated the value correctly.

(h) (i) Many candidates subtracted the values correctly.

(ii) Many candidates could compare the two values and state whether they were within experimental error, the best answers calculated 10 per cent and showed that the answers were within 10 per cent.

Question 6

Candidates were generally quite well prepared for this style of question and many addressed the bullet points and gave a logical description of the investigation. A few omitted the question and almost all candidates who attempted the question gained some credit. The full range of marks was seen and some candidates gave detailed answers gaining full or almost full credit.

A diagram was not required but candidates who included one then often gave a logically sequenced plan.

Many did not name the apparatus they used to measure the distance often just saying meter.

Many candidates dropped the ball with no added push from a height and measured the bounce. Many used a camera to record the bounce height, so that they could be as accurate as possible. Often at least five heights were used.

Quite a few candidates were confused by the method and chose different sized balls or chose varied materials and compared them one with another. It was clear that some had done a similar experiment in class but had kept the height constant and varied the material of the ball and so did that here, despite the question specifically asking for the relationship between drop height and bounce height.

Whilst control variables were well known, some candidates contradicted themselves by controlling the height of the ball when that was what was being changed.

A number threw the ball rather than allowing it to fall.

The table tended to have either one or two heights being measured but few included the unit.

Candidates continue to find processing results and drawing conclusions challenging. Where a graph is to be drawn then five values of the variable need to be taken, the quantities for each axis need to be specified and then the possible results need to be explained, for example, a straight line through the origin means the variables are proportional.

Citing a conclusion from prior knowledge or simply looking for a pattern in the results is insufficient.