CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Question 29** and **37**. **Question 22**, **25**, **30**, **31**, **35** and **40** proved the most difficult for candidates.

Comments on specific questions

Question 1

Some candidates were confused about respiration. Some thought that it was the release of energy for body activities and some thought it was breathing to supply oxygen to cells. Candidates should ensure they can distinguish between gas exchange and respiration.

Question 6

Many candidates understood that the question described assimilation. However, some confused it with absorption and ingestion.

Question 8

The range of answers for the percentage of oxygen in expired air suggested that candidates, while generally believing it was less than inspired air, were unsure of how much less. Many candidates believed there was no oxygen in expired air.

Question 10

The majority of candidates correctly selected the oviduct as the site of fertilisation. A few candidates selected the ovary or the uterus.

Question 15

Candidates are expected to know that impurities reduce the melting point of a substance and, by extension, understand that the greater the amount of impurities, the greater the reduction in melting point.

Question 20

Many candidates incorrectly chose option **C,** rather than the correct option, **B**. Candidates are required to know that ammonia is a base, and that bases react with acids.

Question 21

Many candidates incorrectly chose option **C,** rather than the correct option, **B**. Candidates should know that lithium, a Group I metal, has a low density and so it floats on water. Although candidates may have seen magnesium reacting with water, they should understand that it only appears to float because the bubbles of gas that form, cause it to rise to the surface of the water.

Question 22

Candidates chose the incorrect options **B** and **C** more often than the correct option, **D**. Candidates are expected to understand that because carbon is a non-metal, it forms acidic oxides, not basic oxides.

Question 24

Candidates chose the incorrect option **B** more often than the correct option, **D**. The three essential elements required for plant growth are nitrogen, potassium and phosphorus. Only option D contained just one of these elements.

Question 25

Candidates chose the incorrect options **A** and **D** more often than the correct option, **C**. Candidates are expected to know that lime, calcium oxide, is made by the thermal decomposition of limestone, calcium carbonate. They should also understand that when basic oxides dissolve in water they form alkaline hydroxides, such as calcium hydroxide. They are expected to know that calcium sulfate is the product of the neutralisation of sulfuric acid by calcium oxide.

Question 27

There was evidence that a large number of candidates were uncertain about this question. Many candidates chose the incorrect option **D** rather than the correct option, **C**. Candidates should be able to describe the formation of poly(ethene) from ethene monomer units.

Question 30

In this question, candidates needed to know the conditions for equilibrium. Many candidates selected option **A** (a resultant force and a resultant turning effect acting) rather than the correct option, **D** (no resultant force and no resultant turning effect).

Question 31

Many candidates incorrectly believed that there is an increase in chemical energy, rather than kinetic energy, as a man falls and accelerates through the air.

Question 35

Many candidates knew that distance should be divided by the speed, fewer remembered to subtract the direct distance (P to Q) from the indirect distance (P to R to Q) to find the difference in distance; as a result, they incorrectly selected option **B** rather than option **A**.

Question 37

Calculation of the combined resistance of two resistors in series caused few problems.

Question 38

A common mistake made by some candidates was to believe that a high current rating of the fuse could cause the fuse to blow.

Question 39

Most candidates recognised the shape of the magnetic field pattern around a straight wire, but fewer knew the correct direction of the field lines, leading them to option **D**.

Question 40

There appeared to be much uncertainty between options **A**, **B** and **C** in this question on nuclear change caused by β-decay. Candidates were quite unsure about the effect of this emission.

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

General comments

Candidates performed very well on **Question 29** and **37**. **Question 31**, **33**, **35**, **38**, **39** and **40** proved the most difficult for candidates.

Comments on specific questions

Question 1

Some candidates were confused about respiration. Some thought that it was the release of energy for body activities and some thought it was breathing to supply oxygen to cells. Candidates should ensure they can distinguish between gas exchange and respiration.

Question 7

In this question on transpiration, most candidates correctly identified that water vapour is lost through the stomata, however, they were then unsure whether evaporation occurred from the epidermis or from the mesophyll cells. The presence of the cuticle limits evaporation from the epidermis.

Question 8

The range of answers for the percentage of oxygen in expired air suggested that candidates, while generally believing it was less than inspired air, were unsure of how much less. Many candidates believed there was no oxygen in expired air.

Question 15

Candidates should understand that graphite, a form of carbon, exists as a macromolecule which is insoluble in water, and that this enables separation from aqueous substances by filtration.

Question 19

Candidates frequently selected the incorrect options **B** and **C** rather than the correct option, **A**. Candidates are expected to know that potassium produces a lilac colour in a flame test and that nitrates, when heated with aluminium powder and aqueous sodium hydroxide, produce ammonia, which turns damp red litmus paper blue.

Question 20

Many candidates incorrectly chose option **C,** rather than the correct option, **B**. Candidates are required to know that ammonia is a base, and that bases react with acids.

Question 21

Candidates are expected to know the trends in the properties of the elements descending Group I, i.e. that the melting points decrease and that their reactivity increases.

Question 24

Candidates chose the incorrect option **B** more often than the correct option, **D**. The three essential elements required for plant growth are nitrogen, potassium and phosphorus and only option D contained just one of these elements.

Question 27

There was evidence that a number of candidates were uncertain about this question. Some candidates chose the incorrect option **C** rather than the correct option, **D**. Candidates should be able to describe the formation of poly(ethene) from ethene monomer units.

Question 29

A significant proportion of candidates appeared to confuse acceleration with speed, leading them to think that a falling object has increasing acceleration, option **C**.

Question 31

Many candidates incorrectly believed that there is an increase in gravitational potential energy, rather than kinetic energy, as a man falls and accelerates through the air.

Question 32

Many candidates thought that only conduction is prevented by the use of a vacuum, rather than conduction and convection.

Question 33

There was a misconception that the position of the image formed by a plane mirror is on its surface, leading to the choice of option **B**.

Question 35

Many candidates knew that distance should be divided by the speed, fewer remembered to subtract the direct distance (P to Q) from the indirect distance (P to R to Q) to find the difference in distance; as a result, they incorrectly selected option **B** rather than option **A**.

Question 37

Many candidates realised that a variable resistor could be used to vary the brightness of a lamp. A few candidates incorrectly selected options **B** (a fixed resistor) and **C** (a fuse).

Question 38

A common mistake made by some candidates was to believe that a high current rating of the fuse could cause the fuse to blow.

Question 39

The most popular choice here was option **C**, these candidates believing that reversing the current direction would cause the wire to move sideways, rather than simply being the reverse of the original direction, option **B**.

Question 40

There appeared to be much uncertainty between options **A**, **B** and **C** in this question on nuclear change caused by β-decay. Candidates were quite unsure about the effect of this emission.

CO-ORDINATED SCIENCES

Paper 0654/13
Multiple Choice (Core)

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

General comments

Candidates performed very well on **Question 29** and **37**. **Question 31**, **33**, **35**, **38**, **39** and **40** proved the most difficult for candidates.

Comments on specific questions

Question 1

Some candidates were confused about respiration. Some thought that it was the release of energy for body activities and some thought it was breathing to supply oxygen to cells. Candidates should ensure they can distinguish between gas exchange and respiration.

Question 7

In this question on transpiration, most candidates correctly identified that water vapour is lost through the stomata, however, they were then unsure whether evaporation occurred from the epidermis or from the mesophyll cells. The presence of the cuticle limits evaporation from the epidermis.

Question 8

The range of answers for the percentage of oxygen in expired air suggested that candidates, while generally believing it was less than inspired air, were unsure of how much less. Many candidates believed there was no oxygen in expired air.

Question 15

Candidates should understand that graphite, a form of carbon, exists as a macromolecule which is insoluble in water, and that this enables separation from aqueous substances by filtration.

Question 19

Candidates frequently selected the incorrect options **B** and **C** rather than the correct option, **A**. Candidates are expected to know that potassium produces a lilac colour in a flame test and that nitrates, when heated with aluminium powder and aqueous sodium hydroxide, produce ammonia, which turns damp red litmus paper blue.

Question 20

Many candidates incorrectly chose option **C,** rather than the correct option, **B**. Candidates are required to know that ammonia is a base, and that bases react with acids.

Question 21

Candidates are expected to know the trends in the properties of the elements descending Group I, i.e. that the melting points decrease and that their reactivity increases.

Question 24

Candidates chose the incorrect option **B** more often than the correct option, **D**. The three essential elements required for plant growth are nitrogen, potassium and phosphorus and only option D contained just one of these elements.

Question 27

There was evidence that a number of candidates were uncertain about this question. Some candidates chose the incorrect option **C** rather than the correct option, **D**. Candidates should be able to describe the formation of poly(ethene) from ethene monomer units.

Question 29

A significant proportion of candidates appeared to confuse acceleration with speed, leading them to think that a falling object has increasing acceleration, option **C**.

Question 31

Many candidates incorrectly believed that there is an increase in gravitational potential energy, rather than kinetic energy, as a man falls and accelerates through the air.

Question 32

Many candidates thought that only conduction is prevented by the use of a vacuum, rather than conduction and convection.

Question 33

There was a misconception that the position of the image formed by a plane mirror is on its surface, leading to the choice of option **B**.

Question 35

Many candidates knew that distance should be divided by the speed, fewer remembered to subtract the direct distance (P to Q) from the indirect distance (P to R to Q) to find the difference in distance; as a result, they incorrectly selected option **B** rather than option **A**.

Question 37

Many candidates realised that a variable resistor could be used to vary the brightness of a lamp. A few candidates incorrectly selected options **B** (a fixed resistor) and **C** (a fuse).

Question 38

A common mistake made by some candidates was to believe that a high current rating of the fuse could cause the fuse to blow.

Question 39

The most popular choice here was option **C**, these candidates believing that reversing the current direction would cause the wire to move sideways, rather than simply being the reverse of the original direction, option **B**.

Question 40

There appeared to be much uncertainty between options **A**, **B** and **C** in this question on nuclear change caused by β-decay. Candidates were quite unsure about the effect of this emission.

CO-ORDINATED SCIENCES

Paper 0654/21
Multiple Choice (Extended)

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

General comments

Candidates performed very well on **Question 5**, **12**, **13**, **14**, **16**, **28** and **34**. **Question 11** and **35** proved the most difficult for candidates.

Comments on specific questions

Question 8

The range of answers for the percentage of oxygen in expired air suggested that candidates, while generally believing it was less than in inspired air, were unsure of how much less. Many candidates believed there was no oxygen in expired air.

Question 11

Candidates were unclear about the concept of dominant and recessive alleles. Candidates should understand that a homozygous recessive individual can only pass on a recessive allele, and therefore all of its offspring must contain at least one recessive allele. Likewise, both parents must contain at least one recessive allele if they are to produce a homozygous recessive offspring.

Question 14

Candidates understood very well how to interpret diagrammatic representations of covalent molecules. They were able to use these diagrams to deduce the number of different elements in a compound, as well as the total number of atoms in the compound.

Question 15

Candidates are expected to know that impurities reduce the melting point of a substance and, by extension, understand that the greater the amount of impurities, the greater the reduction in melting point.

Question 16

Candidates understood very well that covalent compounds have lower melting points than ionic compounds because the attractive forces between molecules are weaker than the attraction between oppositely charged ions.

Question 23

There was evidence that candidates were unsure of the answer to this question. At the high temperatures produced by the combustion of fuel in a car engine, oxygen and nitrogen from the air combine to form oxides of nitrogen.

Question 25

Candidates chose the incorrect options **A** and **D** more often than the correct option, **C**. Candidates are expected to know that lime, calcium oxide, is made by the thermal decomposition of limestone, calcium carbonate. They should also understand that when basic oxides dissolve in water they form alkaline hydroxides, such as calcium hydroxide. They are expected to know that calcium sulfate is the product of the neutralisation of sulfuric acid by calcium oxide.

Question 29

Candidates needed to recall the equation $F = ma$. Many candidates incorrectly believed that the quantities required to calculate acceleration were mass and speed or resultant force and speed.

Question 30

In this question, candidates needed to know the conditions for equilibrium. Many candidates selected option **A** (a resultant force and a resultant turning effect acting) rather than the correct option, **D** (no resultant force and no resultant turning effect).

Question 31

Many candidates incorrectly believed that there is an increase in gravitational potential energy, rather than kinetic energy, as a man falls and accelerates through the air.

Question 32

Although a majority knew that nuclear energy powers the Sun, many believed that the process was fission rather than fusion. Some candidates thought geothermal energy to be the source.

Question 34

Almost all candidates were familiar with the effect of colour on absorption of radiation from the Sun and this question was particularly well answered.

Question 35

Candidates were required to identify that the right-hand diagram showed light on the verge of being totally internally reflected, and then to subtract 55° from 90° to determine the critical angle. Most chose the correct diagram, but a majority of these gave 55° as the answer.

Question 36

Many candidates knew that X becomes a N pole, but a number of these believed that it would remain so, despite the bar being soft iron and it being moved a large distance away from the magnet.

Question 37

The most common error was to confuse series and parallel combinations of resistors, and select option **D**, rather than the correct option, **A**.

Question 38

A common mistake made by some candidates was to believe that a high current rating of the fuse could cause the fuse to blow.

Question 39

Most candidates recognised the shape of the magnetic field pattern around a straight wire, but fewer knew the correct direction of the field lines, leading them to option **D**.

Question 40

The most common error was to confuse proton number with nucleon number; these candidates therefore selected option **A**. Also, a significant number of candidates confused β-decay with α-decay and chose option **C**.

CO-ORDINATED SCIENCES

Paper 0654/22
Multiple Choice (Extended)

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

General comments

Candidates performed very well on **Question 5**, **9**, **12**, **14** and **28**. **Question 13**, **35**, **37** and **40** proved the most difficult for candidates.

Comments on specific questions

Question 13

This question on eutrophication proved challenging. Most candidates correctly knew that nitrates increase the growth of producers, however, they were divided on whether oxygen or carbon dioxide decreases as a result. Candidates should be aware that producers and decomposers are not the same, and their increases occur sequentially. Therefore, while an increase in producers might decrease carbon dioxide, this occurs before the increase in decomposers, which will decrease oxygen.

Question 14

Candidates understood very well how to interpret diagrammatic representations of covalent molecules. They were able to use these diagrams to deduce the number of different elements in a compound, as well as the total number of atoms in the compound.

Question 20

Many candidates incorrectly chose option **C,** rather than the correct option, **B**. Candidates are required to know that ammonia is a base, and that bases react with acids.

Question 25

Many candidates chose the incorrect option **C**, rather than the correct option, **A**. During the Contact process, sulfur trioxide rapidly reacts with water in a very exothermic reaction that causes unreacted sulfur trioxide to decompose to sulfur dioxide and oxygen, and that sulfur dioxide combines with water to form an acidic mist. Candidates should also know that sulfur trioxide combines with concentrated sulfuric acid to form oleum, $H_2S_2O_7$, and that this is reacted with water to form more concentrated sulfuric acid.

Question 27

There was evidence that candidates were uncertain about the answer to this question. Ethene reacts with steam to form ethanol, which is not a hydrocarbon. Ethene reacts with hydrogen to form ethane, a saturated hydrocarbon. Ethene undergoes addition polymerisation to form poly(ethene). They are expected to know the structure of poly(ethene) and recognise that, since this contains carbon-carbon single bonds and no carbon-carbon double bonds, this is also a saturated hydrocarbon.

Question 31

Many candidates incorrectly believed that there is an increase in gravitational potential energy, rather than kinetic energy, as a man falls and accelerates through the air.

Question 32

Although a majority knew that nuclear energy powers the Sun, many believed that the process was fission rather than fusion. Some candidates thought geothermal energy to be the source.

Question 34

Very few candidates believed that either of the cans with lids would cool the fastest, but a significant number thought that the can with a shiny surface would be quicker than the can with a dull surface.

Question 35

Candidates were required to identify that the right-hand diagram showed light on the verge of being totally internally reflected, and then to subtract 55° from 90° to determine the critical angle. Most chose the correct diagram, but a majority of these gave 55° as the answer.

Question 38

A common mistake made by some candidates was to believe that a high current rating of the fuse could cause the fuse to blow.

Question 40

The most common error was to confuse proton number with nucleon number; these candidates therefore selected option **A**. Also, a significant number of candidates confused β-decay with α-decay and chose option **C**.

CO-ORDINATED SCIENCES

Paper 0654/23
Multiple Choice (Extended)

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

General comments

Candidates performed very well on **Question 14** and **Question 21**. **Question 22**, **Question 23** and **Question 27** proved the most difficult for candidates.

Comments on specific questions

Question 5

Candidates found this question, where they had to correctly identify the chemical composition of glucose in the balanced equation for photosynthesis, straightforward.

Question 6

Although almost all candidates appreciated that chemical digestion occurs when saliva is mixed with a starch suspension, many confused osmosis and diffusion. Candidates need to be reminded that only water moves by osmosis, and therefore the appearance of glucose in the water must be due to diffusion.

Question 11

This question on cell division proved challenging. Although many candidates correctly identified mitosis as producing two diploid cells from diploid cells, quite a few candidates, while correctly identifying that meiosis produces four cells, confused the terms diploid and haploid.

Question 12

Candidates found this question on food chains straightforward.

Question 14

Candidates understood very well how to interpret diagrammatic representations of covalent molecules. They were able to use these diagrams to deduce the number of different elements in a compound, as well as the total number of atoms in the compound.

Question 18

Some of the more able candidates chose the incorrect option **D** rather than the correct option, **C**. Candidates are expected to know the products of the electrolysis of aqueous copper(II) sulfate using inert carbon electrodes and that these are different when using copper electrodes during the refining of copper.

Question 19

There was evidence that candidates were unsure at the answer to this question. They should be able to identify oxidation and reduction, in terms of electron transfer, and also to identify oxidising and reducing agents.

Question 20

Some of the more able candidates chose the incorrect option **D** rather than the correct option, **B**. Candidates are required to know that ammonia is a base, and that bases react with acids.

Question 21

Candidates understood very well that bromine, being in the same group of the Periodic Table as chlorine, has similar chemical properties to chlorine.

Question 22

Candidates chose the incorrect option **B** more often than the correct option, **A**. Candidates are expected to recognise that a more reactive metal displaces a less reactive metal from its salt. Many candidates did deduce the most and least reactive of the four metals correctly, but determined the order of the second and third metals incorrectly.

Question 23

There was evidence that candidates were unsure at the answer to this question. Candidates are expected to know that at the high temperatures produced by the combustion of fuel in a car engine, oxygen and nitrogen from the air combine to form oxides of nitrogen.

Question 25

Candidates chose the incorrect option **D** more often than the correct option, **C**. Candidates are expected to know the essential conditions of the Contact process.

Question 27

There was evidence that candidates were unsure at the answer to this question. Candidates are required to describe the formation of smaller alkanes, alkenes and hydrogen by the cracking of larger alkane molecules.

Question 29

In this question on Hooke's law, more candidates chose option **C** than the correct option **B**, not taking into account the fact that the spring constant of spring Q was double that of spring P. A common mistake by a few candidates was to believe that doubling the spring constant would double the extension for each newton applied, leading them to choose option **D**.

Question 30

Many candidates incorrectly believed that there is an increase in gravitational potential energy, rather than kinetic energy, as a man falls and accelerates through the air.

Question 31

Although a majority knew that nuclear energy powers the Sun, many believed that the process was fission rather than fusion. Some candidates thought geothermal energy to be the source.

Question 32

Although a very large majority of candidates knew that molecular vibration is involved, many of these did not appreciate that moving electrons also played a part in the process, leading them to choose the incorrect option **B**.

Question 34

A common mistake was to choose option **B**, ignoring the fact that when the boy moves closer to the mirror, his image also moves a similar distance closer.

Question 35

Candidates were required to identify that the right-hand diagram showed light on the verge of being totally internally reflected, and then to subtract 55° from 90° to determine the critical angle. Most chose the correct diagram, but a majority of these gave 55° as the answer.

Question 37

Although many candidates chose the correct option **C**, other candidates chose either option **A** or option **B**.

Question 38

A common mistake made by some candidates was to believe that a high current rating of the fuse could cause the fuse to blow.

Question 40

The most common error was to confuse proton number with nucleon number; these candidates therefore selected option **A**. Also, a significant number of candidates confused β-decay with α-decay and chose option **C**.

CO-ORDINATED SCIENCES

Paper 0654/31
Theory (Core)

Key messages

Candidates should be reminded to read the stimulus material and each question carefully. To be awarded full marks, candidates should ensure that they complete all the instructions contained within the question.

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

When asked for a comparison, candidates should use comparative phrases such as greater than or higher than rather than simply describing the information.

General comments

Calculations were frequently done well with all working shown.

Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided. Similarly, formulae consisting of a mixture of words, symbols and units should also be avoided.

Comments on specific questions

Question 1

(a) (i) A common error was to suggest that part **A** was an intercostal muscle rather than the rib.

(ii) Many correct responses were given. The most popular responses were nose, trachea and bronchus. Alveoli, lungs and oesophagus were not accepted.

(iii) Many candidates correctly ticked the pulmonary artery. A common error was to select the vena cava.

(b) (i) Many candidates correctly suggested differences between the composition of expired and inspired air. Some candidates described the difference in carbon dioxide levels, but this was given in the question and could therefore not be credited. Some candidates suggested that expired air would be warmer. This is a correct statement but did not answer the question.

(ii) The test for carbon dioxide with limewater was well known.

(c) (i) Almost all candidates were able to use the graph to determine the breathing rate of the student while walking.

(ii) Most candidates gained one mark for describing the decrease in breathing rate. Very few candidates described a decrease in the depth of breathing. There was also some confusion between breathing rate and heart rate.

Question 2

(a) (i) Many candidates gained at least one mark. The formula for a bromine molecule (Br_2) was very well known.

(ii) Many candidates correctly described the Group VII elements as halogens.

(b) Most candidates were able to write the correct word equation for the reaction. The only common error was confusing bromine with bromide. Some candidates attempted a balanced symbol equation rather than a word equation. Such equations were accepted as long as they were correctly balanced.

(c) Some candidates knew the colour change from orange to colourless. Few candidates were able to explain that the colour change is caused by an unsaturated compound or by a carbon-carbon double bond.

(d) The test for bromide ions was not well known.

(e) Many candidates knew that lead and bromine were produced during the electrolysis of molten lead(II) bromide but some candidates were unable to place them at the correct electrodes.

Question 3

(a) (i) Most candidates were awarded at least one mark. There were some common errors:–

- the line not being at 5 m / s after 20 s
- the line not being at a constant speed for 90 s
- completing the journey after 120 s rather than 115 s.

(ii) Many candidates correctly determined the distance as 450 m. A few attempted to calculate the area under the graph.

(b) (i) Radiation was not well known as the method of energy transfer between the Sun and the Earth. Thermal energy was often suggested.

(ii) Infrared was not well known as the part of the electromagnetic spectrum that is responsible for heating the saddle. Gamma radiation and visible light were often suggested.

(iii) Some candidates gained full marks. A common misconception was to suggest that molecules expand.

(c) Many candidates were able to explain that spanner **B** was longer, but very few were able to explain that this meant there was a greater moment or turning force.

(d) Upright and same size were the two characteristics most commonly suggested. Some candidates correctly suggested laterally inverted. Some candidates who could not remember the term lateral inversion attempted to describe lateral inversion.

Question 4

(a) (i) Most candidates drew a correct food chain, but many drew the arrows the wrong way round. Arrows should be drawn to show the flow of energy through the food chain.

(ii) Grass as the producer and jackal as the secondary consumer were frequently given. Goats were sometimes suggested as the producer or the secondary consumer.

(b) Plants were often incorrectly suggested as the principal source of energy for all food chains. The Sun is the principal source of energy for all food chains.

(c) (i) Many correct differences were suggested, the most common being that humans have canine teeth and goats do not. A few candidates described similarities rather than differences. This highlights the importance of reading the question carefully.

(ii) Most candidates gained one mark. Usually this was for suggesting that goats only eat plants.

(iii) Dentine and enamel were well known as the top two layers in a human tooth.

Question 5

(a) (i) Copper and iron were often identified as the two metals that were transition elements. A common incorrect answer was lithium and sodium.

(ii) Hydrogen was not well known as the gas produced when an alkali metal reacts with water. Carbon dioxide was often suggested.

(iii) Some candidates worked out the order of reactivity correctly. A few named metals that were not mentioned in the question.

(b) (i) Most candidates balanced the equation successfully.

(ii) Copper oxide was not well known as the substance reduced. The idea that reduction means the loss of oxygen was better known.

(c) (i) Oxygen and nitrogen were well known as the two gases found in large quantities in clean air.

(ii) Carbon monoxide and hydrogen were often incorrectly suggested as greenhouse gases.

(iii) Candidates need to be careful to name the fossil fuels as accurately as possible. For example, crude oil or petroleum rather than oil. Many candidates incorrectly suggested gasoline or diesel.

Question 6

(a) (i) Few candidates knew the correct electrical symbol for a battery. A number of cells connected together was accepted.

(ii) Many candidates were able to complete the calculation correctly.

(iii) Many candidates gave vague answers such as ‘so they can be the same brightness’ or ‘so that they have the same voltage’. Candidates should be encouraged to give detailed explanations, so their ideas are fully expressed.

(b) (i)(ii) Many candidates were confused about conduction and convection.

(c) The role of friction was understood by some candidates. Few candidates were able to explain the transfer of electrons.

(d) Some candidates were able to explain that steel is magnetic and that plastic filler is not.

Question 7

(a) Red blood cells linked to oxygen transport and white blood cells linked to phagocytosis or antibody production were the most popular correct answers.

(b) Many candidates did not read the question carefully enough and attempted to join all the boxes together. The question only required one sentence to be completed.

(c) Many candidates were able to name two other characteristics of living organisms. A few attempted to use the characteristics given in the question.

Question 8

(a) Water, H_2O, was not well known as the substance that reacts with ethene to make ethanol.

(b) Many candidates had some understanding of the terms but missed marks by describing one atom rather than one type of atom for the description of an element and referring to compounds as mixtures rather than elements bonded together.

(c) This question proved demanding. Few candidates were able to suggest both carbon dioxide and water.

(d) The description of an exothermic reaction was well known.

(e) (i) Some candidates were able to state that there are six electrons in an atom of carbon and one electron in an atom of hydrogen. A common error was state that a carbon atom contains twelve electrons.

(ii) Few candidates stated that the atom of hydrogen contained no neutrons. One neutron was the commonest answer.

(f) Many candidates correctly showed at least one shared pair of electrons. Few candidates were able to show four shared pairs and no extra electrons.

Question 9

(a) (i) Few candidates were able to describe the frequency of a wave.

(ii) Many candidates correctly identified the piano as the instrument producing a sound with the lowest pitch. Guitar was often incorrectly suggested.

(iii) Many candidates correctly identified the piano as the instrument producing sounds with the widest range of frequencies. Flute was often incorrectly suggested.

(iv) Some candidates correctly stated the normal audible frequency range for a healthy human ear as 20 Hz to 20 000 Hz. Many other frequencies were suggested.

(b) (i) Many candidates correctly completed the calculation to determine the density of the alloy. Few candidates were able to state the correct units for density. Common incorrect suggestions were cm^3 or cm^3 / g.

(ii) Few calculations for the weight of the flute were correct. The calculation involved a unit conversion from grams to kilograms.

Question 10

(a) Phloem and xylem were well known as the parts of a plant that are adapted for transport. Capillaries and vena cava were the commonest incorrect responses.

(b) (i) Root hair cells were well known, although a number of candidates suggested plant cells.

(ii) Many candidates correctly identified part **X** as the cell wall, although a few thought it was the cell membrane. Almost all candidates correctly identified part **Y** as the nucleus.

(c) Experiment **C** was correctly identified by many candidates as the experiment where seeds would germinate.

(d) Some candidates correctly suggested that the seeds would not germinate. Fewer were able to explain why in terms of enzymes being denatured. Many candidates suggested that germination and growth would be improved due to the higher temperature.

Question 11

(a) (i) Oxygen and water were well known as the two substances present when iron rusts.

(ii) Many suitable methods to prevent the rusting of iron were suggested. Some candidates were also able to explain that the method suggested provided a barrier to the water and oxygen.

(b) Cutlery was frequently suggested as a use for stainless steel. Candidates should avoid vague suggestions such as for cars. Car bodies would have been a clearer response.

(c) This question was asking for a difference in the properties of a solid compared to a liquid. Many candidates described differences in particle separation and arrangement. Suitable answers described a solid as having a fixed shape or that a liquid takes up the shape of its container.

(d) Many candidates gained full marks and were confident about the changes of state**.**

Question 12

(a) This question proved demanding. Few candidates referred to the penetrative properties of alpha, beta and gamma radiations. Even fewer suggested that gamma penetrates lead but alpha and beta do not.

(b) (i) The idea of the nucleus splitting during nuclear fission was not well known.

(ii) The most popular and correct answer was 0.05 g.

(iii) The term isotope was not explained by most candidates. There was confusion between atoms and elements.

(c) Many candidates correctly identified at least one factor that can be changed to increase the turning effect in a d.c. motor.

CO-ORDINATED SCIENCES

Paper 0654/32
Theory (Core)

Key messages

Candidates should be reminded to read the stimulus material and each question carefully. To be awarded full marks, candidates should ensure that they complete all the instructions contained within the question.

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

When asked for a comparison, candidates should use comparative phrases such as greater than or higher than rather than simply describing the information.

General comments

Calculations were frequently done well with all working shown.

Any formula quoted should be in a standard form and use recognisable symbols. Formulae consisting of units should be avoided. Similarly, formulae consisting of a mixture of words, symbols and units should also be avoided.

Comments on specific questions

Question 1

(a) (i) A common error was to suggest that fertilisation occurs in the uterus rather than the oviducts.

(ii) The uterus was well known as part **B**.

(b) Many candidates determined that the two incorrect words in the description of fertilisation in humans were separation and ovary.

(c) (i) Some candidates correctly ticked the boxes for days 1 – 4. Additional ticks for days 0 and 5 were allowed.

(ii) Some candidates correctly crossed the boxes for days 24 – 26. Additional crosses for days 19 – 23 and 27 – 0 were allowed.

(d) Many candidates focused on sexual reproduction and so did not supply the general definition of reproduction.

Question 2

(a) (i) Some candidates suggested Group III elements rather than the noble gas in Period 3. This highlights the importance of reading the question carefully.

(ii) Many candidates described the change in reactivity across the period or stated that the change was from metals to gases.

(b) (i) Some candidates attempted a balanced symbol equation rather than a word equation. Such equations were accepted as long as they were correctly balanced.

(ii) The description of an exothermic reaction was well known.

(c) This question proved demanding. Few candidates suggested both protons and neutrons. Magnesium, nucleons and electrons were frequently seen. The numbers of particles suggested was usually either 12 or 24.

(d) (i) Filtration was well known as a suitable separation technique.

(ii) Crystallisation was not well known. Filtration was a common incorrect answer. Evaporation was allowed.

(iii) Many candidates correctly balanced the equation with a 2 in front of HC*l*.

(iv) Few candidates knew the test for chloride ions. The test for chlorine gas was sometimes seen.

(e) (i) Many correct answers were seen and candidates were comfortable in calculating the mass of magnesium in the alloy.

(ii) Most candidates could state that alloys used in aircraft were likely to be stronger and less dense than pure magnesium.

Question 3

(a) (i) Some candidates drew a series circuit but omitted to show four cells in their circuit diagram. A battery symbol was allowed.

(ii) Candidates showed good data handling skills when calculating the current in the lamp.

(iii) Calculating the combined resistance of the two resistors was well done by many candidates. A few attempted to calculate the combined resistance in parallel.

(b) This part was well answered with many candidates gaining two or three marks. The first form of energy (chemical) was the least well known. Here, gravitational was often suggested.

(c) A number of candidates suggested solar which could not be credited because it was given in the question. Water was too vague to be accepted, instead, it needed to be wave or hydroelectricity.

(d) (i) The normal was not well known. Many reflection lines were mentioned.

(ii) Reflection was well known but some candidates suggested ‘reflact’ or ‘refrect’ which were not allowed.

Question 4

(a) (i) The structure of the heart was well understood by many candidates.

(ii) The fact that valves ensure a one-way flow of blood was quite well known. A number of candidates suggested controlling blood flow but a more specific answer was required.

(iii) There was some confusion over the role of arteries. Arteries carry blood away from the heart, but not all arteries carry oxygenated blood.

(b) Many candidates named substances carried in the blood, such as oxygen and haemoglobin, rather than the four components of blood; red blood cells, white blood cells, platelets and plasma.

(c) (i) This part was well answered and many candidates successfully calculated the difference in heart rate.

(ii) Some candidates found this part difficult. The question stated that the fitness class started at 10.00 so candidates needed to look at the graph and determine when the heart rate slowed down.

(iii) Many candidates suggested that the heart rate increased but fewer candidates mentioned the role of adrenaline despite the prompt in the question.

Question 5

(a) Few candidates were able to explain that the purpose of the oil was to prevent potassium reacting with oxygen or water.

(b) Many candidates completed very clear diagrams showing an electronic structure of 2.8.8.1. A common incorrect structure was 2.4.8.5.

(c) (i) Many candidates were able to describe the differences in separation but fewer could describe the differences in arrangement.

(ii) Some candidates were able to suggest that a potassium atom loses one electron but other candidates suggested that it gains one electron.

(iii) Many candidates had the right idea but missed marks by describing one atom rather than one type of atom for the description of an element and referring to compounds as mixtures rather than elements bonded together.

(d)(i) Many candidates stated that the solubility increased but did not link this to rising temperature. Candidates need to mention both variables when describing trends.

(ii) Many candidates correctly used the graph to determine the mass of potassium chloride that dissolved.

Question 6

(a) (i) This part was well answered. A common error was to identify the two stations as B and C.

(ii) Most candidates correctly identified a part of the journey when the train was accelerating. The only incorrect answers seen were points between **B** and **C**.

(iii) Some candidates correctly determined the area under the graph. A few candidates correctly determined the area using the formula for the area of a trapezium. A common error was to multiply the total time (200 s) by the maximum speed (20 m / s).

(b) (i) This part was very well answered and the majority identified force **R** as the weight of the train.

(ii) A common misconception was that **Q** must be greater than **S** if the train is moving at a constant speed.

Question 7

(a) (i) Many candidates correctly described the changes seen. However, some candidates attempted to explain the changes seen, rather than describe the changes seen.

(ii) Most candidates realised that cell **B** was in a solution of the same concentration as the plant cell because its appearance had not changed.

(b) A number of candidates gained one mark but few gained two marks. Root cortex and mesophyll cell were the required terms.

(c) The phloem was well known as the tissue that transports sugars through the stem.

(d) Chlorophyll and light were often correctly suggested. Some candidates suggested carbon dioxide and water, which were given in the question. Other popular incorrect responses were oxygen and glucose.

(e) This part was well answered with many candidates gaining full marks.

Question 8

(a) (i) The cathode was not well known as the electrode where lead is made.

(ii) Few candidates were able to identify bromine vapour as the orange gas. Many candidates suggested that it was lead bromide or lead.

(b) Some candidates answered this correctly although some reversed the substances stating that lead oxide was oxidised and carbon was reduced.

(c) A number of candidates incorrectly suggested that magnetism would be a suitable test because metals are magnetic. Testing for electrical conductivity was an appropriate test.

(d) Some candidates gained full marks and many others gained one mark. Common correct answers included increasing the concentration of the sulfuric acid and increasing the temperature.

Question 9

(a) (i) Many candidates were confused by the context and described boiling rather than evaporation.

(ii) Many candidates correctly stated the boiling point of water but there were a wide range of incorrect boiling points also seen.

(iii) Condensation was well known as the term used to describe a gas changing into a liquid.

(iv) Conduction was well known as the method of thermal energy transfer through metals.

(b) (i) Many candidates misunderstood the question and gave definitions of amplitude and frequency.

(ii) Twenty was better known as the lowest audible frequency but hertz (Hz) was less well known.

(iii) Many candidates correctly determined the time. The commonest error was to divide the speed by the distance.

Question 10

(a) (i) Many candidates gained at least two marks. A common error was to confuse the large intestine with the small intestine.

(ii) Ingestion and egestion were often confused. The mouth was usually correctly identified as the part of the alimentary canal where mechanical digestion occurs.

(b) Few candidates were able to describe chemical digestion at a molecular level. The strongest answers described the role of enzymes and acidity in chemical digestion.

(c) Many candidates did not read the question carefully enough and attempted to join all the boxes together. The question only required one sentence to be completed.

Question 11

(a) A number of candidates correctly identified **B**, **C** and **D** as hydrocarbon molecules. A number of candidates only identified one or two and therefore were not awarded the mark.

(b) Some candidates answered this correctly although many incorrectly suggested **B** (methane) and **C** (ethane) as the two products of the complete combustion of a hydrocarbon.

(c) Many candidates were able to identify carbon dioxide or methane as a greenhouse gas.

(d) Some candidates gained full marks for drawing a clear dot-and-cross diagram for water. Many candidates gained at least one mark for showing one shared pair of electrons between the oxygen and each hydrogen atom. A common error was to show three lone pairs of electrons on the oxygen atom.

(e) (i) Some candidates were able to explain that unsaturated compounds contain a carbon – carbon double bond.

(ii) Cracking was not well known as the process that produces smaller unsaturated hydrocarbon molecules from large saturated hydrocarbon molecules. Fractional distillation was frequently suggested.

(iii) Using aqueous bromine to test for an unsaturated hydrocarbon was not well known.

Question 12

(a) The idea of the nucleus splitting during nuclear fission was not well known.

(b) (i) The term isotope was not explained by most candidates. There was confusion between atoms and elements.

(ii) Storing a beta radiation source in a lead-lined container was not well known.

(iii) A few candidates correctly determined the mass remaining after two half-lives as 200 g. Many candidates gave an answer of 400 g and others suggested 1600 g.

(iv) This question proved demanding. Few candidates gave specific reference to penetrating properties, ionising potential or charge. Incorrect answers attempted to relate the relative 'strengths' of the two forms of radiation.

(v) Most candidates correctly placed gamma radiation in the left-hand box.

CO-ORDINATED SCIENCES

Paper 0654/33
Theory (Core)

Key messages

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When asked for a comparison, candidates should use comparative phrases such as greater than or higher than rather than simply describing the information.

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(iv) This question proved demanding. Few candidates gave specific reference to penetrating properties, ionising potential or charge. Incorrect answers attempted to relate the relative 'strengths' of the two forms of radiation.

(v) Most candidates correctly placed gamma radiation in the left-hand box.

CO-ORDINATED SCIENCES

Paper 0654/41
Theory (Extended)

Key messages

Candidates should ensure that they use all the information provided in the question in their answers and data should be transcribed with care.

Candidates should ensure that units used in the question are included in their written answer and when converting them they should be compatible with the numerical answer.

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

General comments

In general, the use of scientific terminology was very good. Answers were often precise and constructed with thought.

Numerical calculations often arrived at the correct value and arithmetic operations were generally error free. Candidates should be aware that such questions are marked in stages and credit can be given for a correct operation leading to an incorrect answer if evidence for that process is clearly shown.

Comments on specific questions

Question 1

(a) Most candidates knew some of the features of each type of respiration, and there were many correctly completed tables.

(b) Bread making or alcohol production was usually given as a use of anaerobic respiration in yeast.

(c) Few candidates gave the release of less energy per glucose molecule as a disadvantage of anaerobic respiration. Some were given credit for discussing the efficiency of energy release, rather than simply stating that less energy is released.

Question 2

(a) (i) Most candidates knew that pencil is used on the chromatography paper due to it being insoluble.

(ii) Those who knew the formula for R_f usually calculated the correct value. Some subtracted the distances and a minority inverted the formula.

(b) (i) The mixture with the insoluble food colouring was usually correctly identified.

(ii) The mixture with the greatest number of soluble food colourings was usually correctly identified. Only the best answers explained why **X** had not been chosen or that **Z** had the greatest number of spots above the line.

(c) Successful responses explained that impurities cause a change in melting point or the melting to occur over a range of temperatures. Answers that simply restated the temperatures could not be awarded credit.

Question 3

(a) Some candidates correctly suggested that a fixed resistor would limit current through the wire. Others described the effect of a variable resistance instead.

(b) (i) The calculation of the resistance was almost always correct.

(ii) The formula for electrical energy was well known. Candidates were not as confident in choosing the appropriate unit.

(iii) The energy transfer was correctly stated by some, while others did not show knowledge of the forms of energy involved when a current flows through an ohmic conductor.

(c) Some candidates knew that resistance is indirectly proportional to cross-sectional area while many others doubled the value they obtained in **(b)(i)**.

(d) Those who knew that the student needs to measure the diameter of the wire to calculate cross-sectional area could often suggest an appropriate instrument. Others suggested that the length was required. Many showed they were unaware of the need for precision when measuring small distances by suggesting the use of a ruler.

(e) (i) Some candidates could apply a learned rule to indicate the correct direction of the force on the wire. Some curved arrows were drawn.

(ii) Increasing the current and the strength of the magnetic field were often correctly stated as ways to increase the force on the wire. Candidates often suggested two ways of increasing the strength of the magnetic field rather than describing two different ways. There was some confusion with electric motors with references to coils and a turning effect.

Question 4

(a) (i) The calculation of the mass of tofu needed was usually done well.

(ii) Most candidates were aware that plant-based products have less vitamin D than animal products. Fewer used the information to explain that vegans need to eat more to get their RDA or did not compare the vitamin D content per 100g.

(b) It was usually realised that pregnant women need to take in extra vitamin D for their developing baby. Fewer answers explained that vitamin D is needed for the growth of bones.

(c) Some candidates could name a disease caused by protein deficiency, other incorrect suggestions included anaemia, rickets and scurvy.

(d) There were some good descriptions of the chemical digestion of protein with many candidates being awarded full marks.

(e) Some candidates described chemical digestion as requiring the use of an enzyme. In questions of this type, candidates should be careful to describe the differences as required by the question.

Question 5

(a) (i) The numbers of particles in an atom of chlorine were often all correct.

(ii) Most candidates knew that atoms of Group VII elements have 7 electrons in their outer shell.

(iii) The meaning of the term isotopes was usually explained correctly. A few compared the numbers of protons and neutrons.

(b) Most candidates were challenged by the need to explain the normal states of chlorine and sodium chloride. The strongest responses made it clear that the forces between molecules of chlorine are weak, and the forces between oppositely charged sodium ions and chloride ions are strong. Marks could not be awarded for referring to the covalent bonds between atoms or molecules, or just

referring to the ionic bonds in sodium chloride. Few answers went on to compare the energy required to overcome the intermolecular and electrostatic forces.

(c) The equation for the reaction between chlorine and sodium bromide was sometimes correct, most errors occurring when formulae had been copied incorrectly from the question.

Question 6

(a) (i) The β-particle was sometimes identified as an electron. Many candidates were confused by the word nature, which is used in the syllabus, and described the properties of a β-particle. This would have been acceptable had they described the charge and mass of an electron.

(ii) The decay equation was usually completed correctly.

(b) Correct answers to the question based on a paper mill control system, described the decreasing count rate caused by fewer β-particles penetrating the thicker paper. Others stated that the count rate stopped and no particles penetrated. Many candidates did not answer the full question, just describing the feedback control system.

(c) (i) The half-life was usually determined correctly.

(ii) A number of candidates suggested correctly that the source is suitable for this use as the half-life is long enough to prevent the need for frequent replacement. Others were imprecise in their answers and simply stated that it takes a long time to decay.

Question 7

(a) (i) Many candidates knew the function of the optic nerve, but the functions of the other parts of the eye were not well known.

(ii) Using the appropriate words to describe the changes in the eye proved difficult for many candidates. Recommended terminology would be that the lens thickens, the suspensory ligaments slacken and the ciliary muscles contract.

(b) (i) Some candidates could name the retina as the receptor in the pupil reflex.

(ii) Few suggested that the circular and radial muscles are effectors, some just suggesting the iris. Generally, candidates seemed not to be aware that the effectors involved in a response are muscles or glands.

(c) The involuntary actions were identified by almost all candidates.

(d) The brain and spinal cord were usually named as the two parts of the central nervous system, whereas some incorrectly suggested the spine.

Question 8

(a) Many candidates could label the diagram of the electrolysis experiment.

(b) (i) Some knew that the electrolysis of copper(II) sulfate produces oxygen gas at the positive electrode. Other suggestions included hydrogen and various oxides of sulfur.

(ii) The ionic half-equation for the formation of copper was quite well known.

(c) (i) Those who stated that the discharge of bromide ions is oxidation usually explained that electrons are lost.

(ii) There were some good answers to the calculation of the volume of bromine gas, with candidates showing their working clearly. The most common error was to use 80 rather than 160 for the relative molecular mass.

Question 9

(a) Most candidates used the graph to deduce that the sprinter was stationary during the first 0.5 s, while others described the motion of the sprinter over the whole race.

(b) Many candidates realised that the value of the acceleration could be shown to be 2.0 m / s^2 by taking data from the graph and clearly showing the calculation.

(c) This calculation of the mass of the sprinter was generally done well.

(d) (i)(ii) When the correct forces diagram was selected, constant speed was usually identified. Complete answers went on to explain that the motion is caused by a resultant force of zero.

(e) (i) Many candidates described how sweat cools the skin by referring to the most energetic particles leaving the surface when water evaporates. Fewer completed their answer by explaining the temperature drop in terms of the fall in average energy of the remaining particles. Responses which involved a description of vasodilation and homeostasis did not answer the question.

(ii) The differences between evaporation and boiling were quite well known. The misconception that the term boiling means heating water to boiling point was apparent in some answers.

Question 10

(a) The eutrophication flow chart was often completed correctly. The most common error was the nature of the ions involved, with nitrogen ions suggested rather than nitrate ions.

(b) There were a few good suggestions for why deforestation causes eutrophication, these were based on the erosion of soil containing nitrate ions. Others suggested that the lack of absorption of water and mineral ions by trees leads to polluted run-off into water courses or that decayed matter and increased use of fertiliser is responsible. Some confused the terms eutrophication with extinction.

(c) This question on the effect of deforestation on animals was well answered.

(d) Organisms that make their own nutrients were usually described correctly as producers.

(e) Candidates often named at least two substances needed to make nutrients. Glucose and oxygen were incorrectly suggested by many. It was common for sunlight to be included in the list even though ‘substances’ was highlighted in the question.

Question 11

(a) Common features of members of a homologous series were often correctly identified. Being hydrocarbons and having similar properties were too vague to be awarded marks.

(b) (i) The conditions for cracking were well known. Just heat or pressure were insufficient.

(ii) Where the alkane was correctly named, the structural formula was usually drawn well. A common error was to include one or more double bonds.

(c) Many candidates worked out the formula of the product correctly. Often errors occurred in copying the formulae of reactants or in the balancing stage.

(d) The correct structure of poly(propene) was sometimes drawn. Other candidates included a double bond.

(e) The correct representation of the formula for the dicarboxylic acid used to make nylon was rarely seen.

Question 12

(a) There were some good answers to the calculation of the speed of sound, with candidates showing their working clearly. The most common error was in converting the units of time from ms to s.

Rather than dividing by 1000, some divided by 60 or did not notice that the data was not compatible with an answer quoted in m / s.

(b) The strongest explanations for the difference between the speeds of sound in wood and in air included the observation that particles in solid wood are close together. Some went on to describe the difference in the speed of transfer of vibrations, rather than sound waves.

(c) Successful candidates recalled a learned definition of a longitudinal wave.

(d) There were many good diagrams of the diffracted waves showing spreading round the aperture and curved wavefronts. Some wavefronts were incorrectly drawn with discontinuous lines.

CO-ORDINATED SCIENCES

Paper 0654/42
Theory (Extended)

Key messages

An important skill that candidates should practise is the conversion of units when completing calculation questions. This was particularly evident in **Questions 5(b)(iii)** and **6(c)(i)**.

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. These were important skills in **Questions 3(b)**, **6(c)(ii)** and **12(a)(ii)**.

Candidates should be encouraged to take particular care is spelling keywords. Words such as fission and fusion, exothermic and endothermic, glycogen and glucagon have very different meanings, although have similar spellings. **Questions 8(e)**, **9(a)** and **10(b)(iii)** are examples of questions where these skills were beneficial.

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

General comments

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

There were examples of vague responses which prevented some candidates from accessing the available marks. Candidates should be encouraged to be specific in their responses. Clear and concise scientific language should be used to express ideas in sufficient depth.

It is important that candidates read all the stimulus material carefully and complete all the instructions contained within the question. There were occasions where candidates could not access the full marks available due to not reading the question thoroughly.

Some areas of the syllabus were better known than others. Candidates should be reminded to revise all the material detailed in the syllabus. A useful tool is to use the syllabus as a revision guide and encourage candidates to go through the syllabus ensuring that they have covered each learning objective in their revision.

Comments on specific questions

Question 1

(a) Candidates were generally able to identify some of the correct words or phrases to explain the plasmolysis of the cells seen in the figure. Some candidates incorrectly identified the solution outside the cells as having a greater water potential than the cells. The concept of turgor pressure was less well known amongst candidates.

(b) (i) This question asked candidates to identify the cell structure shown in the figure. Most candidates could correctly identify this as a chloroplast with incorrect responses of chlorophyll, nucleus and vacuole also seen.

(ii) Some good explanations were seen linking the lack of chloroplasts to root hair cell function and their lack of access to light for photosynthesis.

(iii) The majority of candidates could state two correct cell structures, with a minority including chloroplasts or cell membrane.

(c) (i) The vast majority of candidates could identify red blood cells with a few vaguely referring to blood cells.

(ii) Several correct adaptations were seen, the most frequent being reference to their biconcave shape or the lack of a nucleus. Candidates should take care to use the correct terminology when describing the shape of red blood cells. Responses such as donut shape or concave were not credited.

Question 2

(a) Almost all candidates could identify the states of matter from their particle arrangements. Very occasionally air was given for gas.

(b) Almost all candidates were able to identify the correct change of state as melting.

(c) Some candidates were not able to express their ideas fully to access all the marks available. The most able candidates gave the speed of the particle movement and the arrangement before and after the water was cooled. Some candidates incorrectly referred to water particles moving closer together upon freezing.

(d) The bonding pairs of electrons were often correctly drawn, with some candidates continuing to draw either too few or too many electrons on the oxygen atom.

Question 3

(a) (i) Almost all candidates could calculate the correct distance. A few candidates used an incorrect arrangement of the formula. Candidates should be encouraged to state the formula they are using and to clearly set out their working.

(ii) Almost all candidates were able to suggest an appropriate measuring instrument to record time.

(iii) Most candidates understood that the time would be too small to be measured.

(b) It should be noted that candidates should read questions carefully and complete all the instructions contained therein. To access full credit for this question, candidates were required to state the formula, calculate their answer and express this answer to 2 significant figures. Occasionally candidates omitted the formula or did not express the value correctly.

(c) (i) This question proved challenging for some candidates, with many suggesting that an optical fibre was a hollow tube or trying unsuccessfully to explain this in terms of refractive index.

(ii) The correct term was frequently stated. Occasionally incorrect references to refraction were seen as well as incomplete references to reflection.

(iii) The use of optical fibres in the medical field and communications were commonly seen. Some candidates confused optical fibres with fabric or material and suggested garment construction.

Question 4

(a) (i) Some excellent descriptions of the data were seen with many including comparative data with the correct units and the best responses showing evidence of correct data manipulation. Candidates should be encouraged to use the axes labels and units as a guide to indicate the information that is contained in the graph and use these to aid their descriptions.

(ii) The correct response of alcohol / ethanol was frequently seen. A few incorrect responses of water and carbon dioxide were sometimes given.

(iii) The equation proved challenging for some candidates with many including carbon dioxide and water. Equations should be stated as given in the syllabus and any references to the inclusion of energy were ignored.

(b) There were some detailed and accurate explanations of the effect of extremes of temperature on enzyme activity. The best responses referred to change in shape of the enzymes active site so that it was no longer complementary to the substrate. Correct reference to denaturation were frequently seen.

Question 5

(a) The conditions necessary for the Haber process were well known. Few candidates could state the sources of nitrogen and hydrogen. Descriptions of the subsequent use of ammonia were less successful, the most common of which being fertiliser. There were many vague references to ammonia being used in industry or for chemicals.

(b) (i) Most candidates could calculate the mass correctly. Occasional issues occurred with calculation of the molecular masses.

(ii) Most candidates described the test for hydrogen accurately. It was evident that a minority of candidates confused this with the test for oxygen gas by making reference to a glowing splint rather than a lit splint.

(iii) The most common omission was the lack of conversion to grams. In addition, a few candidates gave the molecular mass of a diatomic molecule of nitrogen as 14 rather than 28. However, most candidates demonstrated the ability to calculate moles and the volume correctly.

Question 6

(a) A number of candidates misinterpreted the question and gave general properties of metals. A good number of responses could identify particle vibration and transfer by electrons as the mechanisms of energy transfer. Correct references to delocalised electrons were also credited.

(b) (i) The correct value of 20 °C was most frequently seen. Some candidates gave the starting temperature of 80 °C.

(ii) This question proved challenging for all but the most able candidates. A common misconception was that line **Q** represented the black painted can because the colour black is a better absorber of heat energy. Candidates that did recognise that line **P** represented the black painted can generally identified that the loss in temperature was more rapid. Difficulties in using the correct comparative terminology were evident with fewer candidates referring to the black painted can as emitting radiation more quickly than the white painted can and simply describing the colour black as being a good emitter.

(c) (i) Practicing the conversion of units would benefit candidates in answering questions of this type, this was the most common omission and gave an answer of 180 J. A small number of candidates rearranged the formula incorrectly, dividing rather than multiplying.

(ii) A number of candidates did not recognise that the work done would be equivalent to the amount of energy calculated in the previous question. Some tried various methods to calculate this, often unsuccessfully, with a number of incorrect values of 1500 W seen.

(d) Many correct responses were seen with candidates most commonly referring to increasing the temperature or surface area.

Question 7

(a) The vast majority of candidates correctly stated the nucleus.

(b) Many candidates tried to state the number of chromosomes rather than identifying the sex chromosomes as XX in females and XY in males. Very occasionally candidates only stated one of the chromosomes, or got the male and female chromosomes the wrong way round.

(c) The correct number of 46 was frequently seen with occasional incorrect numbers of 23 or 48 given.

(d) (i) The vast majority of candidates were able to use the table to correctly identify the number of chromosomes in a body cell of a goldfish.

(ii) Fewer candidates were able to deduce the number of chromosomes in a gamete of a fruit fly with the number 8 commonly seen.

(e) A number of candidates needed to be more specific in their responses. References to radiation were not detailed enough to be creditworthy and candidates should have made reference to ionising radiation or alternatively a named type of ionising radiation or carcinogen.

(f) There was some evidence of misconceptions about the roles of mitosis. There were some references to cell repair rather than tissue repair and cells growing. A minority of candidates confused mitosis with meiosis and suggested gamete production. Few candidates referred to asexual reproduction.

(g) The number of marks can be used as a good indication of the number of responses required. Candidates were required to identify two correct statements with a number incorrectly identifying three or more statements or not recognising that meiosis is a form of cell division.

Question 8

(a) The majority of candidates identified the correct time of 50 s, with a few giving 140 s.

(b) The majority of candidates were able to draw a line underneath the original line to predict the results with an increase in temperature.

(c) Lack of detail hampered some candidates with some simply describing an increase in the number of collisions rather than an increase in the collision frequency and/or describing an increase in the number of particles rather than an increase in the number of particles in the same volume. There were also many references to the kinetic energy of particles which was not relevant for this question.

(d) Many candidates were able to correctly balance the equation.

(e) The correct answer of endothermic was frequently seen with the most common response being exothermic. References to conduction were also seen.

(f) Some candidates struggled to express their ideas in terms of proton transfer with a number referring to pH values.

Question 9

(a) A number of candidates stated the correct process of nuclear fission. However, a variety of incorrect processes were also given by candidates including fusion, exothermic, radiation, nuclear decay and combustion.

(b) Candidates demonstrated good knowledge of nuclide notation. Occasionally a few candidates tried to state the use of a beta particle rather than an alpha particle.

(c) Candidates should be reminded of the importance of stating the correct units. Occasionally, candidates calculated the correct half-life but omitted the unit of days. Occasionally inaccuracies occurred calculating half-life and incorrect values such as 100 were seen.

(d) (i) This proved challenging for the majority of candidates with many making reference to the positively and negatively charged plates. Some candidates were confused and described forces experiencing a charge rather than the reverse.

(ii) Many candidates drew a correct path for the gamma ray. The most common error was to reverse the paths of alpha particles and beta particles.

Question 10

(a) (i) The correct term of phototropism was frequently seen.

(ii) There were some excellent descriptions seen with some candidates giving detailed explanations on how auxin causes the growth response seen in the figure. Some candidates were not clear on the action of auxin, incorrectly stating that auxin was attracted to the light. Occasionally candidates tried to explain why plants needed access to light with no reference to auxin. The best responses referred to auxin stimulating cell elongation in the shaded area of the plant stem.

(b) (i) Several suitable organs were suggested with liver commonly seen. Pancreas was a suitable alternative.

(ii) Several correct effects of the release of adrenaline were given. Most commonly seen were increase in pulse rate and dilation of pupils. Weaker candidates vaguely referred to flight or fight response without any detail of the effects on the body.

(iii) A large number of candidates gave the incorrect hormone of insulin. Spelling of certain biological terms is very important. In this instance, glucagon must not be confused with glycogen.

(c) This question specifically asked for differences in the transmission of information between hormonal and nervous control so responses referring to the duration of the effect were ignored. Candidates generally referred to hormones travelling via the blood and taking a longer time to be transmitted.

Question 11

(a) This question was well answered by the majority of candidates. Inaccuracies were sometimes seen with the relative mass of neutrons given as less than 1 and the charges reversed for protons and electrons.

(b) (i) Nearly all candidates gave the correct atom as C.

(ii) Nearly all candidates gave the correct atom as C.

(iii) The majority of candidates gave atoms D and E. Occasionally atoms A and B were given.

Question 12

(a) (i) Most candidates were able to add an accurate line to the graph to show the speed. Occasionally, there were some inaccuracies seen when reading the scale with some lines drawn at 11 m / s rather than 12 m / s. Some candidates continued their lines after the 15 s period of constant speed.

(ii) The majority of candidates were able to calculate the acceleration correctly. A common error was to give the incorrect units of m / s rather than m/s^2.

(iii) Most candidates were able to describe the use of area under the graph to calculate the distance travelled.

(b) Most candidates were able to identify a similarity and a difference between speed and velocity. Some answers were too vague to gain credit, simply referring to them both as having speed.

(c) (i) The correct answer of 460 N was frequently seen. A common misconception was that the value should be less than 460 N.

(ii) Most candidates stated air resistance or friction but there were some that tried to explain why force **R** would be equal in magnitude in terms of resultant forces.

Question 13

(a) The correct ions of Na^+, Cl^-, and H^+ were frequently seen. The ion OH^- was less frequently seen with candidates often giving O^{2-} in its place. Occasionally, candidates misinterpreted the question and tried to provide the ionic half-equations for each of the ions.

(b) There was some confusion of the cathode and anode evident with some candidates reversing the gases. Occasionally, other incorrect gases such as oxygen or sodium were seen, in addition to a small number stating chloride gas.

(c) Many candidates were able to state sodium hydroxide as the solution remaining after electrolysis. Fewer candidates were able to provide an explanation in terms of hydroxide ions. Often candidates tried unsuccessfully to explain this in terms of alkalinity.

(d) Some candidates confused the gaining of electrons with oxidation. However, the majority of candidates recognised that the lead ions gained electrons and was therefore reduced.

(e) Some candidates struggled to write an ionic half-equation. The main issues were balancing the number of electrons, including the incorrect charges on the aluminium ion and stating that aluminium was a diatomic molecule.

CO-ORDINATED SCIENCES

Paper 0654/43
Theory (Extended)

Key messages

Candidates should ensure that units used in the question are included in their written answer and when converting them they should be compatible with the numerical answer.

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

There was evidence that some questions had not been read carefully, which led to misinterpretation of what was required. Candidates should pay special attention to any words written in bold font.

General comments

Calculations were often carried out accurately with few arithmetic mistakes. Candidates should record every stage of their calculation in a logical fashion to gain credit for every process. 'Formula triangles' are not given credit. Care should be taken when extracting data and units from a question. When writing numbers, candidates should ensure that they are clear.

There were examples of vague responses which prevented some candidates from accessing the available marks. Candidates should be encouraged to be specific in their responses. Clear and concise scientific language should be used to express ideas in sufficient depth.

It is important that candidates read all the stimulus material carefully and complete all the instructions contained within the question. There were occasions where candidates could not access the full marks available due to not reading the question thoroughly.

Comments on specific questions

Question 1

(a) (i) The parts of the flower were usually identified correctly.

(ii) Many candidates appreciated that insect-pollinated flowers have the stigma and anther inside the flower. Others regarded the figure as showing them outside. Some features that were not visible in the figure were described but could not be credited.

(iii) Many responses described ways in which pollen from insect-pollinated and wind-pollinated flowers differ. Some described differences in the seeds rather than pollen.

(b) The difference between the numbers of chromosomes was usually correct.

(c) The place where fertilisation takes place in a plant was often named correctly as the ovary or ovule. There were several references to the mammalian reproductive system.

(d) All three of the disadvantages of asexual reproduction were usually identified.

Question 2

(a) (i) The majority of candidates wrote the correct equation for the decomposition of hydrogen peroxide. A few included reactants not mentioned in the question.

(ii) Most wrote that a catalyst increases the rate of reaction. Fewer observed that a catalyst remains unchanged or is not used up.

(b) (i) The majority of candidates determined the loss in mass from the graph.

(ii) Most successfully stated that the rate of reaction decreases. A few described the increasing loss in mass.

(c) This question, involving the explanation of factors affecting rate of reaction, was answered quite well. Those who did not gain full marks usually omitted reference to more frequent collisions of particles. The mention of more collisions was not acceptable.

Question 3

(a) (i) Most candidates used the terms conductor and insulator to explain why the kettle is made of plastic. A few were concerned with electrical conductivity, so did not answer the question.

(ii) Very few responses explained that the white outer surface of the kettle is a poor emitter of thermal radiation. Most candidates appeared to be under the misapprehension that a kettle transfers thermal energy by absorption of radiation from the water, according to the colour of the kettle, suggesting that heat is reflected inwards.

(b) (i) Marks were often gained by candidates describing the flow of hot water due to its reduced density. Some answers did not show how cold water is displaced by the hot water. A mark was often missed when convection was not mentioned. There were some references to heat rising, which was not credited.

(ii) The calculation of current using I=P/V was done well.

(iii) Ohm's law was usually used correctly to verify the value for the resistance of the element.

(iv) There were some good calculations of the combined resistance, when candidates showed their working clearly. The most common error was to treat the resistances as being connected in series and adding them together.

Question 4

(a) (i) Most described trends in the forest areas and supported their inferences using the data supplied. Marks were missed when units of km^2 were used rather than of thousands of km^2.

(ii) This question on the effect of deforestation on animals was well answered.

(iii) Many described the results of deforestation as less carbon dioxide being removed and more carbon dioxide being produced. Successful candidates linked the results to the processes of photosynthesis and combustion. Credit was not given for secondary processes such as increased burning of fossil fuels and increased human population.

(b) Phototropism was sometimes described correctly. The most difficult parts of the process proved to be the site of auxin production and the elongation, rather than growth, of cells.

Question 5

(a) The reactivity of metals was often linked correctly with their method of extraction.

(b) (i) Hematite was often correctly chosen as an iron ore, with bauxite being a popular incorrect choice.

(ii) Forms of carbon were correctly suggested by some as being a raw material for the blast furnace, other choices including biproducts of the process and materials from the list in part **(i)**.

(iii) The equation for the blast furnace reaction was generally written well. Some candidates had difficulty with balancing.

(iv) Most candidates recognised that electron gain is associated with reduction.

(v) There were a few correct determinations of the formula of iron(III) sulfate. There was little written evidence of the use of a logical procedure.

(c) There were some good answers to the calculation of the mass of carbon dioxide, with a few candidates showing their working clearly. A mark was often missed by not writing the relative molecular masses of calcium carbonate and carbon dioxide.

Question 6

(a) (i) The speed of the sprinter was almost always correct.

(ii) Many candidates who knew the formula for kinetic energy had difficulty with the mathematical operations.

(b) (i) The resultant force was almost always calculated correctly.

(ii) Few candidates used the fact that there is a resultant force forward to predict that the sprinter accelerates. Most responses read the question as requiring a description of the effect of changing each of the forces independently, and seldom gained marks.

Question 7

(a) Most candidates could identify some of the parts of the skin.

(b) (i) There were a few good descriptions of vasodilation, including the widening of the arterioles to enable more blood to flow to the capillaries. Some candidates appeared to be under the misapprehension that capillaries widen or move closer to the surface.

(ii) Some candidates correctly stated a response by the body to a decrease in internal body temperature. Others read the question as: state one response by the body to decrease internal body temperature, responding with sweating.

(iii) The mechanism was often named correctly as negative feedback or homeostasis.

(c) Many candidates knew that adrenaline increases blood flow. Fewer stated the effect on blood glucose concentration.

Question 8

(a) The structure of ethane was usually drawn correctly. Drawings of the electronic structure were accepted.

(b) There were few good energy level diagrams. Those who did draw the correct profile for an exothermic reaction needed to label the activation energy and energy change correctly.

(c) Some candidates correctly suggested that cracking is useful because it produces more petrol. There were few references to the general uses of alkane and alkene products.

(d) The equation for the cracking reaction was often correct, most errors occurring when formulae had been copied incorrectly from the question.

(e) Monomer was often correctly selected as the name of the small molecules used in polymerisation.

(f) Most candidates linked the term unsaturated with having a double bond, while some offered a general definition of the word.

(g) Many candidates drew the structure of chloroethene, while poly(propene) proved to be more of a challenge.

Question 9

(a) (i) The magnetic field was sometimes correctly drawn as concentric circles with an arrow pointing anticlockwise. Other representations were drawn above or below the paper and it was not always clear whether they were concentric. Lines of force were not always drawn as complete circles.

(ii) The mark was sometimes awarded for stating that reversing the current would reverse the magnetic field, rather than just changing the direction.

(b) (i) Some candidates could apply a learned rule to indicate the correct direction of the force on the wire. Some curved arrows were drawn.

(ii) Increasing the current and the strength of the magnetic field were often correctly stated as ways to increase the force on the wire. Candidates often missed a mark by suggesting two ways of increasing the strength of the magnetic field. There was some confusion with electric motors with references to coils and a turning effect.

(c) (i) The processes occurring in the electric motor were often placed in the correct order.

(ii) The majority of candidates could label the split-ring commutator.

(iii) A few described how the commutator keeps the coil turning. Others mentioned prevention of wires twisting which did not answer the question.

(d) (i)(ii) The time taken for one rotation and the smaller voltage were usually added to the diagram correctly. A mark was missed where the time arrow was drawn inaccurately.

Question 10

(a) (i) The difference in percentages of oxygen was usually calculated correctly. Some candidates were prompted by the % sign to incorrectly express this difference as a percentage of the inspired air.

(ii) The best explanations for the difference in oxygen content referred to respiration. Others missed a mark for stating anaerobic respiration or just stating that more oxygen is needed when exercising. The few correct references to energy described its release rather than production.

(b) Another effect of exercising on breathing was sometimes correctly described as increased depth of breathing rather than vague phrases such as heavy breathing.

(c) Carbon dioxide was usually correctly given as the gas that increases breathing rate.

(d) Many candidates named two structures that air must pass through before the alveoli. Lungs and oesophagus were popular incorrect choices.

Question 11

(a) Most candidates could link at least one of the elements to its descriptor.

(b) Many knew that argon is used in incandescent lamps due to its low reactivity. Apparently, a few were aware that it is used in discharge lamps but did not make the context clear.

(c) The majority of candidates knew the charge on a proton.

(d) The electron transfer that occurs in the formation of an ionic bond was generally described well. Candidates did not always go on to mention the attraction between positive and negative ions.

(e) Candidates who were aware of the double bond between carbon and oxygen usually managed to draw the dot-and-cross diagram for carbon dioxide.

Question 12

(a) The structure and properties of a solid were well known.

(b) Most candidates read this question as requiring an explanation of the increase in pressure when the piston is moved into the syringe, rather than a description of what causes the pressure of a gas. Nevertheless, some were still given credit where they showed knowledge of the collision of molecules with the walls leading to the production of a force.

(c) (i) The volume of gas was always read correctly from the graph.

(ii) When the formula for density was known, its value was usually calculated correctly.

(d) Explanations of the effect of temperature on pressure were generally good, highlighting the increased speed or energy of molecules and sometimes their more frequent collisions with the walls of the container.

CO-ORDINATED SCIENCES

Paper 0654/51
Practical Test

Key messages

When drawing graphs, candidates should:

- label the axes with a quantity and a unit
- draw a line of best fit as a single, smooth line
- plot points to cover at least half of the grid.

Candidates should be consistent with regard to the use of significant figures.

General comments

Candidates demonstrated a good understanding of practical skills and techniques.

Candidates need to include enough detail in their experimental observations.

Candidates must read the questions carefully so that they answer exactly what is being asked in the question. The number of marks available is an indication of the number of points that have to be made if full credit is to be awarded.

Comments on specific questions

Question 1

(a) (i) The standard of drawing was generally high. A number of candidates drew outlines which were feathery, had gaps or had smooth edges rather than crinkly. Some drew the whole length of the celery stem or attempted three dimensional diagrams. Almost all diagrams were sufficiently large.

(ii) The majority of candidates identified one of the circles they had drawn. Common errors included placing a cross inside the drawing with no label line and the label line not reaching the circle.

(iii) The majority of candidates stated a correct conclusion. The most common incorrect responses identified liquids instead of water or discussed the transport of nutrients.

(b) (i) The standard of graph drawing was generally good. Some candidates reversed the axes and a significant number did not include units on the axes or did not label the axes at all. Whilst most scales were linear, some candidates had a different scale between 0 and 1 hour to that for the rest of the graph. Plotting of points was very good although some candidates used awkward scales and subsequently found the points difficult to plot. A small number used a scale where the points did not cover at least half of the grid.

(ii) Lines were generally well drawn but some were drawn feathery or point to point rather than best fit. Some candidates did not include 0,0 in their line.

(iii) The majority of candidates read the value from their graph correctly, those with more difficult scales often misread the value. A significant number did not show how they determined their answer on the graph. A vertical line at 1.5 hours and a horizontal line to the *y*-axis is the clearest way to show this.

(iv) The relationship was well described by most candidates. Some gave a snapshot of one point rather than a relationship.

Question 2

(a) (i) Many candidates obtained the correct final colours for each of the three reagents. Some gave green for the colour of iodine.

(ii) Many candidates gave three correct conclusions. Some gave sugar instead of reducing sugar or gave positive and negative with no mention of the nutrient being tested. Reducing sugar and protein were sometimes reversed.

(b) (i) The fat test was quite well known. Some candidates only named ethanol or gave ethanol and fat.

(ii) Many candidates appreciated that something must be flammable but far fewer identified the ethanol. Fat was a common incorrect response.

Question 3

(a) Candidates found the recording of observations challenging. Methyl orange was often recorded as orange. Most candidates recorded bubbling when dilute acid was added. Far fewer could test and identify the carbon dioxide, the most common response being hydrogen. Few candidates gave the correct observation for aqueous sodium carbonate with magnesium chloride; white, milky and cloudy were common responses that were too vague to be credited.

(b) Some candidates used the results in the table to identify the reagent which could be used to distinguish between the two solutions and the most able gave the expected observation for each.

Question 4

(a) Many candidates recorded three times that became smaller as the surface area increased. A significant number had times that increased. Some recorded times that were greater than three minutes suggesting that these candidates did not replace the stopper quickly enough, hence, most of the gas was lost to the atmosphere before timing began.

(b) Some candidates described the relationship between surface area and rate correctly, although some discussed time instead of rate. Candidates needed to use their results for the relationship and not prior knowledge, hence, some reversed the relationship that their results showed.

(c) Candidates found this challenging. More able candidates described the use of a syringe but far fewer recognised the need to measure time. Some did not change the method but swapped the test-tube for a measuring cylinder. In chemistry experiments, counting bubbles is rarely appropriate as the reactions proceed too quickly for this to be possible and, in this instance, it also does not include collecting the gas.

Question 5

Candidates were generally quite well prepared for the style of answer required of a planning question. Stronger responses addressed the bullet points in the question, which are included as a guide to help candidates structure their plan. There were five points which needed to be included in the plan. Candidates needed to address at least one point from each aspect and then any two others in order to gain full credit.

Whilst a diagram and sample results table were not required, more able candidates included both to illustrate their answers, and these often included several of the points on the mark scheme.

Some candidates measured the time for the water to boil instead of the temperature of boiling. A significant number put their solutions into a heated water bath meaning that the temperature could not rise above 100°C. Few candidates included a balance to measure the mass of salt added and those who measured temperature often did not mention the use of a thermometer.

Most candidates added salt to water and boiled it, some heated to bubbling failing to appreciate that this does not necessarily indicate boiling and some just measured the temperature each time salt was added without boiling. Few boiled water on its own to determine the boiling temperature without the addition of salt.

Some repeated each amount of salt added so that calculation of an average was possible. Few appreciated the need for five different masses of salt to be added in order to draw a graph of the results. Few candidates explained a safety precaution in the detail required such as gloves to protect the skin from the hot apparatus or boiling water.

Controlling the volume of water was well known, however, many candidates also incorrectly controlled the mass of salt added to the water.

Some candidates found it difficult to process the results and to draw a conclusion, many gave a conclusion from prior knowledge rather than explaining how the results can be used to find a pattern. Comparing results is not sufficient for a conclusion. If a graph is to be drawn, the quantities on each axis need to be given.

Question 6

(a) (i) Most candidates recorded the values appropriately.

(ii) Most candidates recorded values of the correct magnitude and pattern. A small number gave current or potential difference readings higher than the expected range or current to only one decimal place.

(b) (i) Most candidates calculated the power correctly. Some gave their values to an inconsistent number of significant figures.

(ii) The unit of power was not well known. Common incorrect responses included P, J and Ω.

(iii) Many candidates did not include an observation. The most common responses described the current or potential difference decreasing rather than the observation that the lamp becomes dimmer.

(c) Candidates found this challenging. The most common incorrect response agreed with the statement explaining that as length increased the voltage decreased. Some quoted data with no explanations linking the numbers.

Question 7

(a) (i) Most candidates accurately measured the length to the nearest millimetre.

(ii) The appropriate length to be measured was well known.

(b) (i) Most candidates measured the length appropriately.

(ii) Almost all candidates calculated the extension correctly.

(c) (i) Most candidates measured the length appropriately and calculated the extension correctly.

(ii) Almost all candidates calculated the mass of the stone correctly, a small number rounded their value incorrectly.

(d) Most candidates measured the length appropriately and calculated the extension correctly.

(e) Most candidates calculated the density of the stone correctly. Some reversed e_A and e_W.

(f) (i) Many candidates appreciated that the scale should be read at eye level. Incorrect responses included laying the spring flat or only reading when the spring is not oscillating.

(ii) Some candidates appreciated that the experiment should be repeated and the results averaged. Responses that could not be credited described the use of the same spring, use of the same ruler, more accurate equipment or allowing more than one student to measure the length.

CO-ORDINATED SCIENCES

Paper 0654/52
Practical Test

Key messages

When drawing graphs, candidates should:
- label the axes with a quantity and a unit
- draw a line of best fit as a single, smooth line
- plot points to cover at least half of the grid.

Candidates should be consistent with regard to the use of significant figures.

General comments

Candidates demonstrated a good understanding of practical skills and techniques.

Candidates need to include enough detail in their experimental observations.

Candidates must read the questions carefully so that they answer exactly what is being asked in the question. The number of marks available is an indication of the number of points that have to be made if full credit is to be awarded.

Comments on specific questions

Question 1

(a) Many candidates recorded the three colours correctly. Some reversed either Benedict's and biuret or biuret and iodine. A small number had clearly muddled the test-tubes with the results in a random order.

(b) The majority of candidates recorded the three colours correctly.

(c) The majority of candidates recorded the three colours correctly.

(d) The nutrients present were well known. Sugar instead of reducing sugar was the most common incorrect response.

(e) Many candidates named a safety precaution, but few explained in sufficient detail to gain credit. The answer should be in three parts; the precaution, what is being protected and what it is being protected from.

(f) Many candidates named one control variable and some named two. Many candidates gave volume or concentration without specifying the substance. The use of amount should be avoided and candidates should use the name of the specific quantity being controlled.

Question 2

Candidates were generally quite well prepared for the style of answer required of a planning question. Stronger responses addressed the bullet points in the question, which are included as a guide to help candidates structure their plan. There were five points which needed to be included in the plan. Candidates needed to address at least one point from each aspect and then any two others in order to gain full credit.

Whilst a diagram and sample results table were not required, more able candidates included both to illustrate their answers, and these often included several of the points on the mark scheme.

Some candidates put the maggots into a container or onto paper, of those that measured distance fewer mentioned the need for a ruler. Some candidates put the maggots into soil which meant the maggots would not be able to detect the coloured lights.

Few candidates explained a safety precaution in the detail required. For example, gloves to prevent the bacteria on the maggots from getting on the skin.

More able candidates repeated each colour and averaged the results or used a large number of maggots initially. Some candidates only used one maggot.

Some candidates found it difficult to process the results and to draw a conclusion, many gave a conclusion from prior knowledge rather than explaining how the results can be used to find a pattern. Comparing results is not sufficient for a conclusion. If a graph is to be drawn, the quantities on each axis need to be given.

Question 3

(a) (i) Many candidates recorded all four temperatures correctly. Some did not record to the nearest 0.5°C or did not use a fresh volume of dilute hydrochloric acid for the second length of magnesium ribbon.

(ii) Many candidates calculated the values correctly.

(b) (i) Many candidates calculated the values correctly, far fewer gave the answers to two significant figures. A small number did not multiply by 63.

(ii) More able candidates calculated either double or half the appropriate value or divided them. Most calculated 10% and then commented on whether these values were within 10% of each other. Many responses were vague and described results as being close, or far apart but didn't qualify the statement.

(iii) Many candidates appreciated that a change to the apparatus had been requested in the question, therefore stating more accurate apparatus could not gain credit. Other responses that did not gain credit suggested a change to the conditions such as the same starting temperature or repeating the experiment. Some chose a pipette or burette for measuring the volume of dilute acid but there was no indication in the method as to which apparatus had been used initially.

(iv) Candidates found this very difficult. Incorrect responses suggested that it was the maximum temperature, temperature or mass was measured incorrectly, heat was lost or an incorrect concentration of acid had been used.

Question 4

(a) Few candidates recorded the precipitate as cream, most gave white precipitate. Other responses included cloudy, milky and a small number of blue precipitates.

(b) Many candidates recorded the correct flame colour. Common incorrect responses included yellow, orange and red.

(c) Many candidates gave the name of at least one of the ions, often as an error carried forward from their results in **(a)** and **(b)**.

Question 5

(a) The best drawings were two dimensional and were done with a pencil and ruler using single lines. Erasing must be done thoroughly. Some candidates drew a filter funnel with no paper or a filter paper with no filter funnel. Many drew a filter paper as either a dotted line or with a hole at the tip of the cone, both of which are incorrect. Some omitted a receiving vessel. Filter is not a sufficient label for the filter funnel. Many labelled the substances as filtrate and residue rather than sand and salt solution.

(b) Most candidates drew a clear and fully labelled distillation diagram. Some drew the filtration apparatus or an evaporating basin over a Bunsen burner. Of those that drew a distillation diagram, the means of heating was often omitted, there was no stopper in the flask or a boiling tube was used to contain the salt solution. Some omitted the condenser. Few labelled the condenser correctly, labelled the substances separated or had sand in the flask. A small number added extra apparatus such as a pipette.

Question 6

(a) (i) Many candidates measured the height correctly. Some did not quote their value to the nearest millimetre.

(ii) Many candidates measured *R* correctly.

(iii) Many candidates calculated *V* correctly. A small number reversed *R* in **(ii)** and *V* in **(iii)**.

(b) (i) The majority of candidates recorded the values correctly.

(ii) Most candidates calculated the values correctly, with some continuing to reverse *R* and *V*.

(c) (i) The standard of graph drawing was generally very good. Some candidates reversed the axes and a significant number did not include units on the axes or did not label the axes at all. Plotting of points was very good although some candidates gave awkward scales and subsequently found the points difficult to plot. A small number used a scale where the points did not cover at least half of the grid or plotted *R* against *h*.

(ii) Lines were generally well drawn but some were drawn feathery or point to point rather than best fit.

(d) The majority of candidates omitted to indicate on their graph the values chosen for the calculation of the gradient or used less than half of their line. The best way to indicate on the graph is by drawing horizontal and vertical lines for the part of the line used for the calculation. Common errors included inverting the division or quoting the answer as a fraction.

(e) The majority of candidates calculated *d* correctly. A significant number rounded their value incorrectly.

(f) (i) Candidates found this very challenging with few discussing parallax or line-of-sight errors.

(ii) Candidates found this very challenging. Common responses suggested that the thickness of the test-tube had not been considered and that measurements had been rounded.

Question 7

(a) (i) The majority of candidates recorded a value for I and *V*.

(ii) The majority of candidates recorded values to complete the table. A significant number did not record the values to a consistent number of significant figures.

(b) (i) Most candidates calculated the resistance correctly. A small number recorded the values to an inconsistent number of significant figures or rounded incorrectly.

(ii) Most candidates calculated the values correctly. A small number recorded the values to an inconsistent number of significant figures or rounded incorrectly.

(c) Candidates found this very challenging. Responses that could not be credited were either qualitative (as length increases so resistance increases) or simply quoted data with no explanation to link the numbers.

(d) Candidates found this difficult. Common incorrect responses included to prevent electrocution, to reset the meters, for accuracy and to stop the current flow.

CO-ORDINATED SCIENCES

Paper 0654/53
Practical Test

Key messages

When drawing graphs, candidates should:
- label the axes with a quantity and a unit
- draw a line of best fit as a single, smooth line
- plot points to cover at least half of the grid.

Candidates should be consistent with regard to the use of significant figures.

General comments

Candidates demonstrated a good understanding of practical skills and techniques.

Candidates need to include enough detail in their experimental observations.

Candidates must read the questions carefully so that they answer exactly what is being asked in the question. The number of marks available is an indication of the number of points that have to be made if full credit is to be awarded.

Comments on specific questions

Question 1

(a) The standard of drawing was generally high. A number of candidates drew three-dimensional diagrams or outlines which were feathery or had gaps. A small number used less than half of the box or did not show any lobes.

(b) (i) Most candidates measured the line to the nearest millimetre.

(ii) Many candidates drew the line and measured it correctly. Some did not draw the diameter on their drawing and so did not gain credit for the measurement.

(iii) Most calculated the magnification correctly. A small number inverted the calculation or rounded their value incorrectly.

(c) (i) Food test colours were generally recorded accurately. Blue for iodine was a common incorrect response.

(ii) More able candidates gave full conclusions citing the nutrient present and the nutrient absent. Many candidates only stated which nutrient was present.

(iii) Candidates found this challenging. Common incorrect responses noted that it was a solid or that it isn't a solution.

Question 2

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

(ii) Almost all candidates interpreted the data and gave the concentrations correctly.

(b) (i) Many candidates selected the correct water sample and gave a suitable explanation. A significant number gave high carbon dioxide concentration as their explanation which was insufficient.

(ii) Many candidates selected the correct water sample and gave a suitable explanation. A significant number gave an explanation that was too vague.

(iii) Candidates found this challenging, not appreciating the balance between plants and animals.

Question 3

(a) (i) Almost all candidates recorded correct results for all four experiments showing the increase in number of drops needed as the concentration increased.

(ii) Most candidates drew a table with lines and with headers for the columns with the best tables having the values in ascending order. Many omitted the unit for concentration.

(iii) Candidates found this challenging with repeating being the most common correct response. Common responses that were not credited described using a different measuring cylinder, washing apparatus, using new indicator, using a different concentration of sodium hydroxide and using even increments of concentration of sodium hydroxide.

(b) (i) The standard of graph drawing was generally good. A significant number gave a non-linear *x*-axis with 0.1, 0.2, 0.4 and 0.6 on adjacent grid lines. Some candidates reversed the axes and a significant number did not include the unit on the *x*-axis. Plotting of points was generally good.

(ii) Most candidates drew a good line of best fit**.** A small number were feathery or point to point rather than best fit.

(iii) Most candidates described the relationship correctly, a small number gave a snapshot of one point rather than a relationship.

(iv) Most candidates read the value from their graph correctly and gave the value as a whole number. A significant number did not show the reading on their graph, a vertical line at 0.5 M and a horizontal line to the *y*-axis is the clearest way to show this.

(v) Candidates found this very challenging. Stronger candidates drew a line which was lower across all points and at approximately half of the original values. Many lines were above the original points.

(c) (i) Few candidates correctly named the burette. Common incorrect responses included measuring cylinder, pipette, dropper and titrating cylinder.

(ii) Candidates found the drawing challenging**.** The gauze and the labels were often missing and a significant number drew filtration apparatus.

Question 4

(a) (i) Appropriate units were well known. Temperature was sometimes given as C°.

(ii) Almost all candidates completed the time column correctly.

(iii) Candidates found this very difficult with most responses suggesting that it would be more accurate or that it would allow the temperature to cool.

(iv) Candidates found this quite difficult. Responses often described accuracy or that it would become even, or the same, without mentioning temperature or heat.

(b) The majority of candidates recorded the temperatures accurately, both beakers showing a decrease in temperature with the largest decrease in beaker Y.

(c) Candidates found this challenging with many simply rewording the stem of the question.

(d) Almost all candidates calculated both values correctly.

(e) Candidates found this challenging. Some used the processed data instead of the results.

(f) Many candidates identified temperature as a control variable without specifying initial temperature or room temperature.

Question 5

Candidates were generally quite well prepared for the style of answer required of a planning question. Stronger responses addressed the bullet points in the question, which are included as a guide to help candidates structure their plan. There were five points which needed to be included in the plan. Candidates needed to address at least one point from each aspect and then any two others in order to gain full credit.

Whilst a diagram and sample results table were not required, more able candidates included both to illustrate their answers, and these often included several of the points on the mark scheme.

The majority of candidates measured the time for the ball to stop but many timed from the top of the ramp rather than from the point at which the ball meets the bench.

Few appreciated the need for five different masses of ball to be used in order to draw a graph of the results. Some candidates omitted to repeat the time for each mass of ball in order to take an average or ignore anomalies. Few candidates included a balance to measure the mass of the balls.

Controlling the height or angle of the ramp and the release height of the ball were well known.

Some candidates found it difficult to process the results and to draw a conclusion, many gave a conclusion from prior knowledge rather than explaining how the results can be used to find a pattern. Comparing results is not sufficient for a conclusion. If a graph is to be drawn, the quantities on each axis need to be given.

CO-ORDINATED SCIENCES

Paper 0654/61
Alternative to Practical

Key messages

When drawing graphs, candidates should:

- label the axes with a quantity and a unit
- draw a line of best fit as a single, smooth line
- plot points to cover at least half of the grid.

Candidates should be consistent with regard to the use of significant figures.

General comments

Candidates demonstrated a good understanding of practical skills and techniques.

Candidates need to include enough detail in their experimental observations.

Candidates must read the questions carefully so that they answer exactly what is being asked in the question. The number of marks available is an indication of the number of points that have to be made if full credit is to be awarded.

Comments on specific questions

Question 1

(a) (i) The standard of drawing was generally high. A number of candidates drew outlines which were feathery, had gaps or had smooth edges rather than crinkly. Some drew the whole length of the celery stem or attempted three dimensional diagrams. Almost all diagrams were sufficiently large.

(ii) The majority of candidates identified one of the circles they had drawn. Common errors included placing a cross inside the drawing with no label line and the label line not reaching the circle.

(iii) The majority of candidates stated a correct conclusion. The most common incorrect responses identified liquids instead of water or discussed the transport of nutrients.

(b) (i) The standard of graph drawing was generally good. Some candidates reversed the axes and a significant number did not include units on the axes or did not label the axes at all. Whilst most scales were linear, some candidates had a different scale between 0 and 1 hour to that for the rest of the graph. Plotting of points was very good although some candidates used awkward scales and subsequently found the points difficult to plot. A small number used a scale where the points did not cover at least half of the grid.

(ii) Lines were generally well drawn but some were drawn feathery or point to point rather than best fit. Some candidates did not include 0,0 in their line.

(iii) The majority of candidates read the value from their graph correctly, those with more difficult scales often misread the value. A significant number did not show how they determined their answer on the graph. A vertical line at 1.5 hours and a horizontal line to the *y*-axis is the clearest way to show this.

(iv) The relationship was well described by most candidates. Some gave a snapshot of one point rather than a relationship.

Question 2

(a) (i) Many candidates gave three correct conclusions. Some candidates gave sugar instead of reducing sugar or gave positive and negative with no mention of the nutrient being tested. Reducing sugar and protein were sometimes reversed.

(ii) Many candidates knew which test requires heat. The most common incorrect response was biuret.

(iii) The appropriate apparatus was well known. Beaker and dropper were common incorrect responses.

(b) (i) The fat test was well known. Some candidates only named ethanol or gave ethanol and fat.

(ii) The result should be precise and be white emulsion. Some candidates described solutions or precipitates.

(iii) Many candidates appreciated that something must be flammable but far fewer identified the ethanol.

Question 3

(a) More able candidates interpreted the table, chose the correct reagent and described the observations for both compounds. For these candidates, the most common error was to only give the negative result. Many candidates either suggested a test not in the table or described the hydrogen carbonate releasing hydrogen and then describing the test for hydrogen.

(b) The limewater test was generally well known with good descriptions of bubbling the gas through the limewater. Incorrect responses included a white emulsion for the observation, the extinguishing of a lighted splint, the hydrogen test and the oxygen test.

(c) Candidates found this very difficult. Many described holding the solid, often a piece of metal, in tweezers or heating the substance in a beaker. Very few appreciated that the Bunsen burner flame needed to be blue or roaring. A significant number described a test using a lighted splint.

Question 4

(a) (i) Candidates found it very difficult to communicate their answers clearly. More able candidates circled the mistakes in the diagram and numbered them so that it was clear which explanation belonged to which mistake. Some referred to both tubes as test-tubes and so it was unclear which should have the stopper and some stoppered both tubes. Other incorrect responses included missing clamps, missing reagents, missing Bunsen burner and an inverted test-tube.

(ii) Most candidates recorded the values in the correct cells in the table, but fewer followed the example in the table and gave the values to one decimal place.

(b) (i) Many candidates correctly described the relationship between surface area and rate, although some discussed time instead of rate. A significant number reversed the relationship.

(ii) Candidates found this challenging. More able candidates described the use of a syringe but far fewer recognised the need to measure time. Some did not change the method but swapped the test-tube for a measuring cylinder. In chemistry experiments, counting bubbles is rarely appropriate as the reactions proceed too quickly for this to be possible and, in this instance, it also does not include collecting the gas.

Question 5

Candidates were generally quite well prepared for the style of answer required of a planning question. Stronger responses addressed the bullet points in the question, which are included as a guide to help candidates structure their plan. There were five points which needed to be included in the plan. Candidates needed to address at least one point from each aspect and then any two others in order to gain full credit.

Whilst a diagram and sample results table were not required, more able candidates included both to illustrate their answers, and these often included several of the points on the mark scheme.

Some candidates measured the time for the water to boil instead of the temperature of boiling. A significant number put their solutions into a heated water bath meaning that the temperature could not rise above 100°C. Few candidates included a balance to measure the mass of salt added and those who measured temperature often did not mention the use of a thermometer.

Most candidates added salt to water and boiled it, some heated to bubbling failing to appreciate that this does not necessarily indicate boiling and some just measured the temperature each time salt was added without boiling. Few boiled water on its own to determine the boiling temperature without the addition of salt. Some repeated each amount of salt added so that calculation of an average was possible. Few appreciated the need for five different masses of salt to be added in order to draw a graph of the results. Few candidates explained a safety precaution in the detail required such as gloves to protect the skin from the hot apparatus or boiling water.

Controlling the volume of water was well known, however, many candidates also incorrectly controlled the mass of salt added to the water.

Some candidates found it difficult to process the results and to draw a conclusion, many gave a conclusion from prior knowledge rather than explaining how the results can be used to find a pattern. Comparing results is not sufficient for a conclusion. If a graph is to be drawn, the quantities on each axis need to be given.

Question 6

(a) (i) Most candidates read the meters correctly. A small number of 0.22 A were seen.

(ii) Candidates found this difficult. Common incorrect responses included to prevent electrocution, to reset the meters, for accuracy and to stop the current flow.

(b) (i) Most candidates calculated the power correctly. A small number did not take the example from the table and give the value to two decimal places.

(ii) The unit of power was not well known. Common incorrect responses included P, J, N, Ω and V.

(iii) Most candidates discussed at least one of the variables decreasing in value. Some quoted data with no explanations linking the numbers.

(c) Candidates found this challenging. The most common incorrect response agreed with the statement explaining that as length increased the voltage decreased. Some quoted data with no explanations linking the numbers.

(d) Candidates found this very challenging. Many knew the symbol for a voltmeter but either connected it in series or drew a line though the meter. Few knew the symbol for a variable resistor, most drawing a thermistor.

Question 7

(a) (i) Almost all candidates measured the length correctly.

(ii) Almost all candidates calculated the extension correctly.

(b) (i) Almost all candidates calculated the extension correctly.

(ii) Almost all candidates calculated the mass of the stone correctly, a significant number gave the value to more than three significant figures.

(c) Almost all candidates calculated the extension correctly.

(d) Almost all candidates calculated the density of the stone correctly.

(e) (i) Many candidates appreciated that the scale should be read at eye level. Incorrect responses included laying the spring flat or only reading when the spring is not oscillating.

(ii) Some candidates appreciated that the experiment should be repeated and the results averaged. Responses that could not be credited described the use of the same spring, use of the same ruler, more accurate equipment or allowing more than one student to measure the length.

(f) Many candidates missed the fact that the question asked for a single piece of equipment and so the suggested piece of equipment must be calibrated. A measuring cylinder would be ideal.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

Key messages

When drawing graphs, candidates should:
- label the axes with a quantity and a unit
- draw a line of best fit as a single, smooth line
- plot points to cover at least half of the grid.

Candidates should be consistent with regard to the use of significant figures.

General comments

Candidates demonstrated a good understanding of practical skills and techniques.

Candidates need to include enough detail in their experimental observations.

Candidates must read the questions carefully so that they answer exactly what is being asked in the question. The number of marks available is an indication of the number of points that have to be made if full credit is to be awarded.

Comments on specific questions

Question 1

(a) The Benedict's test was quite well known, although some candidates incorrectly suggested biuret and iodine.

(b) (i) Many candidates gave the three positive test colours correctly, some reversed either Benedict's and biuret or biuret and iodine. Candidates found recording the colours of negative tests quite challenging with some giving no change or no reaction, rather than stating a colour.

(ii) The nutrients present were well known. Sugar instead of reducing sugar was the most common incorrect response.

(c) The fat test was quite well known. Some candidates only named ethanol or gave ethanol and fat. The observation for a positive result should be precise, a white emulsion being the ideal answer.

(d) (i) Candidates found this very difficult. Most candidates appreciated that different colours would be obtained but few linked red/orange to high concentration and yellow/green to low concentration. Many candidates simply listed the possible colours with no indication of which was for high or low concentration.

(ii) Many candidates named one control variable and some named two. Many candidates gave volume or concentration without specifying the substance. The use of amount should be avoided and candidates should use the name of the specific quantity being controlled.

Question 2

Candidates were generally quite well prepared for the style of answer required of a planning question. Stronger responses addressed the bullet points in the question, which are included as a guide to help

candidates structure their plan. There were five points which needed to be included in the plan. Candidates needed to address at least one point from each aspect and then any two others in order to gain full credit.

Whilst a diagram and sample results table were not required, more able candidates included both to illustrate their answers, and these often included several of the points on the mark scheme.

Some candidates put the maggots into a container or onto paper, of those that measured distance fewer mentioned the need for a ruler. Some candidates put the maggots into soil which meant the maggots would not be able to detect the coloured lights.

Few candidates explained a safety precaution in the detail required. For example, gloves to prevent the bacteria on the maggots from getting on the skin.

More able candidates repeated each colour and averaged the results or used a large number of maggots initially. Some candidates only used one maggot.

Some candidates found it difficult to process the results and to draw a conclusion, many gave a conclusion from prior knowledge rather than explaining how the results can be used to find a pattern. Comparing results is not sufficient for a conclusion. If a graph is to be drawn, the quantities on each axis need to be given.

Question 3

(a) (i) Candidates found this challenging. Incorrect responses included speeding up the reaction, dissolving the magnesium and making it react.

(ii) Many candidates gave both values to the nearest 0.5°C. Most common incorrect response was 27°C.

(iii) Many candidates calculated the values correctly.

(b) (i) Many candidates calculated the values correctly, far fewer gave the answers to two significant figures. A small number did not multiply by 63.

(ii) More able candidates calculated either double or half the appropriate value or divided them. Most calculated 10% and then commented on whether these values were within 10% of each other. Many responses were vague and described results as being close, or far apart but didn't qualify the statement.

(iii) Many candidates appreciated that a change to the apparatus had been requested in the question, therefore stating more accurate apparatus could not gain credit. Other responses that did not gain credit suggested a change to the conditions such as the same starting temperature or repeating the experiment. Some chose a pipette or burette for measuring the volume of dilute acid but there was no indication in the method as to which apparatus had been used initially.

(iv) Candidates found this very difficult. Incorrect responses suggested that it was the maximum temperature, temperature or mass was measured incorrectly, heat was lost or an incorrect concentration of acid had been used.

Question 4

(a) The test for hydrogen was quite well known. Common errors included the use of a glowing splint or the squeaky pop test with no lighted splint.

(b) More able candidates recognised the tests for ammonia and chlorine. Ammonium and chloride were quite common incorrect responses.

Question 5

(a) The best drawings were two dimensional and were done with a pencil and ruler using single lines. Erasing must be done thoroughly. Some candidates drew a filter funnel with no paper or a filter paper with no filter funnel. Many drew a filter paper as either a dotted line or with a hole at the tip of the cone, both of which are incorrect. Some omitted a receiving vessel. Filter is not a sufficient

label for the filter funnel. Many labelled the substances as filtrate and residue rather than sand and salt solution.

(b) Most candidates drew a clear and fully labelled distillation diagram. Some drew the filtration apparatus or an evaporating basin over a Bunsen burner. Of those that drew a distillation diagram, the means of heating was often omitted, there was no stopper in the flask or a boiling tube was used to contain the salt solution. Some omitted the condenser. Few labelled the condenser correctly, labelled the substances separated or had sand in the flask. A small number added extra apparatus such as a pipette.

Question 6

(a) Many candidates measured the height correctly. Some did not quote their value to the nearest millimetre.

(b) (i) Almost all candidates measured *R* correctly.

(ii) Almost all candidates calculated *V* correctly.

(c) (i) The standard of graph drawing was generally very good. Some candidates reversed the axes and a significant number did not include units on the axes or did not label the axes at all. Plotting of points was very good although some candidates gave awkward scales and subsequently found the points difficult to plot. A small number used a scale where the points did not cover at least half of the grid or plotted *R* against *h*.

(ii) Lines were generally well drawn but some were drawn feathery or point to point rather than best fit.

(d) The majority of candidates omitted to indicate on their graph the values chosen for the calculation of the gradient or used less than half of their line. The best way to indicate on the graph is by drawing horizontal and vertical lines for the part of the line used for the calculation. Common errors included inverting the division or quoting the answer as a fraction.

(e) The majority of candidates calculated *d* correctly. A significant number rounded their value incorrectly.

(f) (i) Candidates found this very challenging with few discussing parallax or line-of-sight errors.

(ii) Candidates found this very challenging. Common responses suggested that the thickness of the test-tube had not been considered and that measurements had been rounded.

Question 7

(a) The majority of candidates read the meters correctly.

(b) (i) Most candidates calculated the resistance correctly. A small number recorded the values to an inconsistent number of significant figures or rounded incorrectly.

(ii) The unit of resistance was well known. Common incorrect responses included W and J.

(iii) Most candidates calculated the ratio correctly. A small number did not use the examples in the table and gave the value to an inconsistent number of significant figures.

(c) Candidates found this very challenging. Responses that could not be credited were either qualitative (as length increases so resistance increases) or simply quoted data with no explanation to link the numbers.

(d) Candidates found this quite difficult with few correctly suggesting that the experiment should be repeated using more values of l.

(e) Candidates found this difficult. Common incorrect responses included to prevent electrocution, to reset the meters, for accuracy and to stop the current flow.

CO-ORDINATED SCIENCES

Paper 0654/63
Alternative to Practical

Key messages

When drawing graphs, candidates should:
- label the axes with a quantity and a unit
- draw a line of best fit as a single, smooth line
- plot points to cover at least half of the grid.

Candidates should be consistent with regard to the use of significant figures.

General comments

Candidates demonstrated a good understanding of practical skills and techniques.

Candidates need to include enough detail in their experimental observations.

Candidates must read the questions carefully so that they answer exactly what is being asked in the question. The number of marks available is an indication of the number of points that have to be made if full credit is to be awarded.

Comments on specific questions

Question 1

(a) The standard of drawing was generally high. A number of candidates drew three-dimensional diagrams or outlines which were feathery or had gaps. A small number used less than half of the box or did not show any lobes.

(b) (i) Most candidates measured and recorded the line correctly.

(ii) Many candidates drew the line and measured it correctly. Some did not draw the diameter on their drawing and so did not gain credit for the measurement.

(iii) Most calculated the magnification correctly. A small number inverted the calculation or rounded their value incorrectly.

(c) (i) Food test colours were generally well known. A small number recorded red for iodine in egg white, blue for iodine in potato puree and brown for biuret in potato puree.

(ii) Candidates found this a little challenging with a significant number saying that the red of the pepper masks the red of the biuret solution.

(d) (i) The fat test was well known. Some candidates only named ethanol or gave ethanol and fat.

(ii) Many candidates appreciated that something must be flammable but far fewer identified the ethanol.

Question 2

(a) (i) Almost all candidates interpreted the data and gave the concentrations correctly.

(ii) Almost all candidates identified a correct piece of apparatus. A few gave beaker which could not be credited.

(b) (i) Many candidates selected the correct water sample and gave a suitable explanation. A significant number gave an insufficient explanation.

(ii) Many candidates selected the correct water sample and gave a suitable explanation. A significant number gave an explanation that was too vague.

(iii) Candidates found this challenging, not appreciating the balance between plants and animals.

(c) The test reagent for carbon dioxide was well known. Limestone was a common incorrect response.

Question 3

(a) (i) Most candidates drew a table with lines and with headers for the columns. Many omitted the unit for concentration.

(ii) Most completed the table correctly with the best tables having the values in ascending order. A very small number miscounted the tally.

(iii) Candidates found this challenging with repeat being the most common correct response. Measuring at eye-level, having someone else count, keeping the volume of sodium hydroxide the same and adding more indicator were common incorrect responses.

(b) (i) The standard of graph drawing was generally very good. Some candidates reversed the axes and a significant number did not include units on the axes or did not label the axes at all. Plotting of points was very good. A small number used a scale where the points did not cover at least half of the grid.

(ii) Most candidates drew a good line of best fit**.** A small number were feathery or point to point rather than best fit.

(iii) Most candidates described the relationship qualitatively, as concentration increases so the number of drops increases. Stronger responses described the relationship quantitatively or stated that the variables were proportional.

(iv) Most candidates read the value from their graph correctly and gave the value as a whole number. A significant number did not show the reading on their graph, a vertical line at 1.8 M and a horizontal line to the *y*-axis is the clearest way to show this.

(v) Candidates found this very challenging. Stronger candidates drew a line which was lower across all points and at approximately half of the original values. Many lines were above the original points.

(c) (i) The syringe was very well known but few candidates could name the burette. Common incorrect responses included measuring cylinder, pipette, dropper, titration tube and distillation tube.

(ii) Candidates found the drawing challenging**.** The gauze and the labels were often missing and a significant number drew filtration apparatus.

Question 4

(a) (i) Appropriate units were well known. Temperature was sometimes given as C°.

(ii) Almost all candidates completed the time column correctly.

(iii) Candidates found this very difficult with most responses suggesting that it would be more accurate or that it would allow the temperature to cool.

(iv) Candidates found this quite difficult. Responses often described accuracy or that it would become even, or the same, without mentioning temperature or heat.

(b) The majority of candidates read the thermometers correctly.

(c) (i) Most candidates calculated the decreases correctly.

(ii) Almost all candidates calculated the value correctly. A very small number did not evaluate the expression or gave a value 10 times too large.

(iii) Almost all candidates calculated the value correctly.

(d) Candidates found this challenging with many simply rewording the stem of the question.

(e) Candidates found this challenging. Many used the processed data instead of the results.

(f) Many candidates identified temperature as a control variable without specifying initial temperature or room temperature.

Question 5

Candidates were generally quite well prepared for the style of answer required of a planning question. Stronger responses addressed the bullet points in the question, which are included as a guide to help candidates structure their plan. There were five points which needed to be included in the plan. Candidates needed to address at least one point from each aspect and then any two others in order to gain full credit.

Whilst a diagram and sample results table were not required, more able candidates included both to illustrate their answers, and these often included several of the points on the mark scheme.

The majority of candidates measured the time for the ball to stop but many timed from the top of the ramp rather than from the point at which the ball meets the bench.

Few appreciated the need for five different masses of ball to be used in order to draw a graph of the results. Some candidates omitted to repeat the time for each mass of ball in order to take an average or ignore anomalies. Few candidates included a balance to measure the mass of the balls.

Controlling the height or angle of the ramp and the release height of the ball were well known.

Some candidates found it difficult to process the results and to draw a conclusion, many gave a conclusion from prior knowledge rather than explaining how the results can be used to find a pattern. Comparing results is not sufficient for a conclusion. If a graph is to be drawn, the quantities on each axis need to be given.