CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice (Core)

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

General comments

The majority of candidates successfully selected the correct responses.

Candidates performed very well on **Question 18**. **Question 20** proved most challenging for the candidates.

The physics questions that were found particularly challenging were **Questions 28**, **30**, **38** and **40**.

Comments on specific questions

Question 4

This question about food tests and enzymes had answers almost equally distributed over three distractors, most candidates choosing an incorrect answer. The question requires careful reading, to gain credit candidates needed to understand the concepts of enzyme action at different temperatures, and remember the iodine starch test. The answer most often given suggests that candidates were not reading the question carefully, rather than a lack of understanding.

Question 7

Although more candidates chose the correct answer than any other, a substantial number got confused between temperature and humidity, incorrectly suggesting that high humidity increases transpiration.

Question 8

The majority of candidates answered this question about energy usage incorrectly. There seems to be a common misconception that respiration uses energy, rather than releasing it. In some cases, this may be a confusion between respiration and breathing.

Question 11

Only about half the candidates correctly answered this question. Candidates need to be clear about the definitions of the terms gene and allele, and also the meanings of a number of similar names as displayed here (genotype / phenotype, homozygous / heterozygous), which candidates can easily mix up.

Question 13

Many candidates found this question challenging, with slightly less than half the candidates getting it right. They needed to look carefully at the labelling on the diagram.

Question 16

Candidates are expected to be able to describe the differences in volatility, solubility and electrical conductivity between ionic and covalent compounds, and hence to know the characteristic properties of covalent compounds. They chose the incorrect **A** more often than the correct answer, **D**. Some of the stronger candidates chose the incorrect **B** and incorrect **C**.

Question 17

Candidates are expected to be able to describe electroplating with copper, which includes the changes to the electrodes during this process. They chose the incorrect **C** more often than the correct answer, **B**. Some of the stronger candidates chose the incorrect **A**.

Question 18

Candidates understood very well the meaning of exothermic in terms of heat energy transfer.

Question 20

Candidates are required to know the tests and positive results for carbon dioxide, chloride ions and copper(II) ions, as well as being able to describe the reaction between carbonate ions and dilute hydrochloric acid. There is evidence that candidates guessed at the answer to this question.

Question 23

The reaction of magnesium with dilute hydrochloric acid and the properties of magnesium as a metallic element are required knowledge. Some of the stronger candidates chose the incorrect **A** rather than the correct answer, **B**.

Question 24

Candidates chose the incorrect **B** more often than the correct answer, **C**. They should know that whilst carbon dioxide is weakly acidic, carbon monoxide is not.

Question 28

Candidates had to calculate a speed that was very low. They needed to convert the time from hours to seconds. Many either did not convert the time from hours at all (option **C**), or converted it into minutes (option **B**).

Question 29

Although many candidates chose the correct value for the weight, a number did not check the unit and therefore opted for **C**.

Question 30

There appeared to be widespread guessing in this question on electricity generation, with all four options being popular.

Question 32

A very large number of candidates knew that the image is the same size as the object, but a significant number thought it to be inverted top to bottom.

Question 34

To calculate speed, almost half the candidates correctly divided distance by time, but most of the others multiplied instead.

Question 38

In this question candidates were required to identify a mystery component as a fuse, and then recognise its symbol. Considerably more chose option **C** (a variable resistor) than the correct option **A**.

Question 39

Two thirds of candidates were unfamiliar with the magnetic field pattern around a solenoid, with option **C** being slightly more popular than the correct option **D**.

Question 40

This question on ionisation was not well answered, with many candidates believing that either infrared rays or γ-rays were the most highly ionising.

CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice (Core)

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

General comments

The majority of candidates successfully selected the correct responses.

Question 23 proved most challenging for the candidates.

The physics questions that were found particularly challenging were **Questions 34** and **35**.

Comments on specific questions

Question 6

This was a straightforward question about the release of pancreatic enzymes. Almost all candidates knew it released into the intestine, however, they needed to be clear that it was into the small intestine rather than the large. Some incorrectly believed it was connected to the anus.

Question 7

Although more candidates chose the correct answer than any other, a substantial number got confused between temperature and humidity, incorrectly suggesting that low temperature and high humidity increase transpiration.

Question 9

This question about plants growing towards light was well answered.

Question 11

This question involved a graph. It is important to stress to candidates that continuous distribution gives a smooth graph, as shown here, while discontinuous does not, and would therefore be shown as a bar chart.

Question 13

Many candidates found this question challenging, with slightly more than half of them answering correctly. They need to look very carefully at the labelling on the diagram.

Question 14

Candidates are expected to be able to demonstrate understanding of the terms atom, molecule and ion, as well as understanding what is meant by elements, mixtures and compounds. They chose the incorrect **C** more often than the correct answer, **A**. Some of the stronger candidates chose the incorrect **B**.

Question 15

Candidates are expected to be able to describe and explain methods of separation, including those used to produce pure crystals. Although most chose the correct answer, **C**, a significant number of the stronger candidates chose the incorrect **A**.

Question 17

Candidates are expected to be able to describe electroplating with copper, which includes the changes to the electrodes during this process. They chose the incorrect **C** more often than the correct answer, **B.**

Question 18

Some of the stronger candidates chose the incorrect **D** rather than the correct answer, **B**. They clearly understood that combustion is an exothermic process, but not that evaporation is endothermic.

Question 20

Candidates are expected to be able to describe the preparation of salts, which requires them to know that magnesium sulfate is a salt. There was evidence that candidates guessed at the answer to this question.

Question 21

Candidates are required to know the trends in the properties of Group I metals from lithium to potassium. Many of the stronger candidates chose the incorrect **D** rather than the correct answer, **B.**

Question 23

Candidates should be able to describe the chemical test for water using cobalt(II) chloride. They chose the incorrect **A** more often than the correct answer, **D**. Some of the stronger candidates chose the incorrect **C**.

Question 25

Candidates are expected to understand that limestone, a base, neutralises acidic substances. Some of the stronger candidates chose the incorrect **C** rather than the correct answer, **A.**

Question 30

Almost two thirds of candidates could not identify power stations that do not use steam.

Question 31

More candidates thought conduction, rather than convection, to be the main method of heat transfer in water.

Question 32

Nearly one in three candidates confused the wavelength of a wave with its amplitude.

Question 34

In this question on the speed of sound, slightly more than half of candidates did not double the distance and therefore opted for **A**.

Question 35

Candidates need to know the unit of e.m.f.. Many guessed, with the ohm being the most popular incorrect choice.

Question 37

This question was reasonably well answered. However, a significant proportion of candidates believed that fitting the 3 A fuse would cause the water to reach its boiling point more slowly due to a decrease in the current (option **D**).

Question 38

More than half the candidates were unfamiliar with the magnetic field pattern around a solenoid, with option **C** being as popular as the correct option **D**.

Question 39

Candidates found this question on ionisation challenging, with many candidates believing that γ-rays are the most highly ionising.

Question 40

The topic here was half-life, and roughly half the responses were correct. However, many chose 5.0 years, this being half of the total time represented by the graph.

CO-ORDINATED SCIENCES

Paper 0654/13
Multiple Choice (Core)

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

CO-ORDINATED SCIENCES

Paper 0654/21
Multiple Choice (Extended)

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

General comments

The majority of candidates successfully selected the correct responses, and the paper was generally well answered.

Candidates performed very well on **Question 14** and **Question 27**. **Question 18** proved the most challenging for the candidates.

The physics questions that were found particularly challenging were **Questions 32**, **34**, **35** and, particularly, **Question 33**.

Comments on specific questions

Question 4

This question about food tests and enzymes requires careful reading, students needed to understand the concepts of enzyme action at different temperatures, and to remember the iodine starch test. The question had answers almost equally distributed over two distractors, slightly more candidates choosing the correct answer. The incorrect answer most often given suggests that candidates were not reading the question carefully, rather than a lack of understanding.

Question 9

This question about accommodation in the eye showed a spread of responses across all four distractors, suggesting widespread guessing.

Question 12

The majority of candidates answered this question about consumers in a food web correctly, but a substantial number did not look at the diagram carefully enough with regard to the arrows rather than the positioning of the organisms.

Question 13

The majority of candidates answered this question about eutrophication correctly, but some did not look further than the first distractor, which although it might reduce oxygen taken out of context, is not the main factor in eutrophication.

Question 14

Candidates understood very well how a soluble salt and insoluble chalk can be separated from water.

Question 15

Candidates are expected to be able to describe the differences in volatility, solubility and electrical conductivity in ionic and in covalent compounds, and hence to know the characteristic properties of covalent compounds. They chose the incorrect **A** more often than the correct answer, **D**. Stronger candidates chose the incorrect **C**.

Question 16

Candidates are expected to be able to calculate stoichiometric reacting masses from balanced equations. It appears that many of them may not have doubled the M_r of oxygen. They chose the incorrect **C** more often than the correct answer, **D**

Question 17

There was evidence that candidates guessed at the answer to this question. They are required to interpret energy level diagrams of exothermic and endothermic reactions, so they should be able to identify the relative amount of energy possessed by the reactants and by the products.

Question 18

Candidates are expected to understand the relationship between temperature and activation energy, and between temperature and the number of effective collisions between reacting particles and hence rate of reaction. They chose the incorrect **A** more often than the correct answer, **D**.

Question 20

Candidates are required to know the tests and positive results for carbon dioxide, chloride ions and copper(II) ions, as well as being able to describe the reaction between carbonate ions and dilute hydrochloric acid. They chose the incorrect **A** more often than the correct answer, **B**

Question 27

Candidates knew very well that ethene is a monomer in the formation of poly(ethene).

Question 30

A relatively popular incorrect choice in the question on moments was option **D**. In this arrangement the force on the right-hand side was furthest from the pivot and this probably attracted candidates who found the calculations challenging.

Question 31

Slightly more candidates thought that nuclear power stations do not use steam than chose the correct answer **C**, hydroelectric.

Question 32

Sensitivity of a thermometer was not well understood, with more than half believing that this meant how quickly a thermometer shows a change in temperature.

Question 33

This was the physics question that was the most challenging. There was a considerable amount of information to process and candidates needed to consider it carefully. Options **C** and **D** were both considerably more common choices than the correct option **A**.

Question 34

There was much confusion about the nature of the wave shown, with many thinking it to be longitudinal and then correctly giving sound as an example.

Question 35

The question stated that the angle of incidence was greater than the critical angle. Candidates needed to be clear about the phenomenon of total internal reflection. Most candidates chose option **B**, the refracted ray.

Question 38

In this question candidates were required to identify a mystery component as a fuse, and then recognise its symbol. More chose option **C** (a variable resistor) than the correct option **A**.

Question 40

Although this question on ionisation was reasonably well answered, almost one in three candidates believed that γ-rays were the most highly ionising.

CO-ORDINATED SCIENCES

Paper 0654/22
Multiple Choice (Extended)

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

General comments

The majority of candidates successfully selected the correct responses, and the paper was generally well answered.

Candidates performed very well on **Question 14**, **Question 15**, **Question 18**, **Question 22** and **Question 27.**

Comments on specific questions

Question 1

This question proved challenging. The majority of candidates selected an incorrect response here.

Question 2

This question was extremely well answered.

Question 4

This question about food tests and enzymes had most answers over two distractors, more candidates choosing the correct answer, but a substantial number choosing incorrectly. The question requires careful reading. Students need to have understood the concepts of enzyme action at different temperatures, and to remember the iodine starch test. The incorrect answer most often given suggests that candidates were not reading the question carefully, rather than a lack of understanding.

Question 14

Candidates understood very well how to obtain pure crystals of a soluble salt from an impure salt solution.

Question 15

Candidates easily recognised the dot-and-cross diagram of ammonia.

Question 18

Candidates had no difficulty in interpreting the graph showing the volume of gas over time, and thereby relating the rates of reaction to the stated concentrations of the dilute hydrochloric acid.

Question 20

Candidates are expected to be able to describe the preparation of salts, which requires them to know that magnesium sulfate is a salt. There was evidence that they guessed at the answer to this question.

Question 22

Candidates had no difficulty in interpreting the tabulated results of the displacement reactions, and thereby they were able to deduce the order of reactivity of the metals.

Question 26

Candidates knew that ethanol is made by fermentation using yeast as a catalyst, but fewer knew that phosphoric acid is used to catalyse the addition of steam to ethene to make ethanol. Some of the stronger candidates chose the incorrect **B** rather than the correct answer, **D**.

Question 27

Candidates knew very well that ethene is a monomer in the formation of poly(ethene).

Question 31

Although almost half the candidates correctly identified hydroelectric power stations as not using steam, a significant number chose nuclear.

Question 33

Four out of ten candidates incorrectly thought that the wave shown was longitudinal, although most of these could identify sound as an example of this.

Question 34

Candidates must read the question carefully, they need to recognise the significance of the angle of incidence being greater than the critical angle. Many candidates correctly chose the totally internally reflected wave (**D**). However, a slightly greater number opted for **B**, this being a refracted ray.

Question 35

A large majority of candidates knew that the resistance of a thermistor is affected by temperature, but more than a third did not recall the inverse relationship between them for an NTC type.

Question 36

Two thirds of candidates did not select the correct p.d. across the resistor, with most of these thinking it would be 12 V, as if the resistors were in series.

Question 40

Although this question on ionisation was well answered, the most common error was choosing γ-rays, option **D,** as the most highly ionising radiation.

CO-ORDINATED SCIENCES

Paper 0654/23
Multiple Choice (Extended)

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

General comments

The majority of candidates successfully selected the correct responses, and the paper was generally well answered.

Candidates performed very well on **Question 14**, **Question 18**, **Question 21** and **Question 27**. **Question 17** proved most challenging for the candidates.

In this paper, **Question 29** was very well answered.

Comments on specific questions

Question 1

Candidates answered this question extremely well.

Question 4

This question about food tests and enzymes had most answers over two distractors, more candidates choosing the correct answer, but a substantial number choosing incorrectly. The question requires careful reading, students need to understand the concepts of enzyme action at different temperatures, and to remember the iodine starch test. The incorrect answer most often given suggests that candidates were not reading the question carefully, rather than a lack of understanding.

Question 12

Candidates answered this question extremely well.

Question 14

Candidates understood very well how to obtain pure crystals of soluble sodium chloride salt from an impure solution containing insoluble sulfur.

Question 17

Candidates are expected to understand that the combustion of hydrogen is an exothermic change, and that energy is required for boiling, cracking and decomposing limestone. They chose the incorrect **A** more often than the correct answer, **D**. Some of the stronger candidates chose the incorrect **C**.

Question 18

Candidates understood very well how an increase in temperature increases the rate of a reaction.

Question 21

Candidates demonstrated a very clear understanding of periodic trends, both across periods and within groups.

Question 22

Although most candidates chose the correct answer, **D**, there was evidence that some of the stronger candidates chose the incorrect **A**. They are expected to be able to use tabulated experimental results to deduce the order of reactivity of metals.

Question 24

Candidates are required to know the essential conditions for the manufacture of ammonia by the Haber process. Some of the stronger candidates chose the incorrect **D** rather than the correct answer, **B**.

Question 27

Candidates knew very well that ethene is a monomer in the formation of (poly)ethene.

Question 28

More than half the candidates correctly answered this question on the equation for pressure, with most of the rest choosing to multiply weight by area of contact.

Question 29

A very large majority of candidates were able to carry out the necessary moments calculations involved here.

Question 33

Although quite a good proportion of candidates could identify the type of wave shown and give an example of it, one in four thought it was longitudinal.

Question 34

Candidates need to read the question carefully and to recognise the significance of the angle of incidence being greater than the critical angle. Approximately one third of candidates correctly chose the totally internally reflected wave (**D**). However, a much greater number opted for **B**, this being a refracted ray.

Question 37

In this question on electricity candidates needed to note that the time was in minutes and to convert it; one in three failed to convert the time to seconds, leading them to choose the incorrect option **C**.

Question 40

Although this question on ionisation was quite well answered, the most common error was choosing option **D** (γ-rays) as the most highly ionising radiation.

CO-ORDINATED SCIENCES

Paper 0654/31
Theory (Core)

Key message

Candidates seemed to have a good understanding of what the questions were asking.

A good standard of scientific knowledge was displayed by many candidates. Some candidates should be congratulated for their clear and accurate responses.

Calculations were frequently done well with working shown.

General comments

Most candidates attempted all the questions. Many candidates answered most of the questions well. There was a good range of marks on every question. Candidates generally scored on all questions. Few gained no credit on any question but very few gained full credit on any question. Performance depended not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

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

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.

A number of candidates seemed to doubt their original answers and ended up crossing out a correct answer and replacing it with an incorrect answer.

Comments on specific questions

Question 1

(a) (i) Most candidates gained at least half the available credit for identifying two of the parts of the alimentary canal and associated organs.

(ii) Organ **J** was frequently identified as the liver.

(iii) Organ **E** was frequently identified as the pancreas.

(b) In the incorrect definition for digestion, many candidates were able to identify the two errors.

(c) In the table of food molecules and the smaller molecules they are made from, most candidates gained most of the available credit.

Question 2

(a) (i) Exothermic was well known.

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

(b) A number of different correct physical properties of magnesium were seen. Most candidates gained at least some credit.

(c) (i) This was not well answered. The question asked for differences and similarities in the observations made. Few candidates correctly identified a difference or a similarity in the observations made.

(ii) Magnesium chloride was not well known as a product of both of the reactions.

(d) (i) This was not well answered. Candidates needed to be clearer in their references to reactivity, i.e., the position of copper in the reactivity series, or the relative reactivities of copper and hydrogen.

(ii) Few candidates made the connection between transition metals and coloured compounds.

(e) (i) Water was often identified as the other substance that needed to be present for iron to rust.

(ii) Many barrier methods were suggested for rust prevention.

(iii) Many candidates continued to suggest barrier methods in this part rather than making alloys.

Question 3

(a) (i) Many candidates placed an **X** somewhere along the line where the speed was a maximum rather than where the bus was not moving.

(ii) Few candidates determined the distance correctly as 600 m. Most calculated the distance as 1200 m, because they did not determine the area under the graph but did a simple distance = speed × time calculation.

(b) (i) Most candidates were able to calculate the weight of the bus as 50 000 N.

(ii) The only response accepted was the Earth.

(c) (i) Many candidates were able to suggest that the bus would go faster.

(ii) Some candidates correctly determined the resultant force as 400 000 N, although many others suggested 600 000 N

(d) The calculation was often well done. Some candidates forgot to convert 45 cm into metres.

Question 4

(a) (i) 72 bpm was the only value accepted.

(ii) Many candidates found it challenging to determine values from the graph, usually making multiple errors.

(iii) This simple calculation was generally well done.

(iv) The question asked for changes to the pattern of breathing. Many candidates gave answers in terms of pulse rate. Answers needed to focus on breathing rate and breathing depth.

(b) (i) The only clear piece of evidence from the diagram that showed that the blood vessel was an artery was the thick wall.

(ii) The component of the blood visible on the diagram was a red blood cell. A number of candidates suggested plasma.

(c) (i) The structure that separates the right and left sides of the heart was correctly identified by many candidates as the septum. Artery, vein and aorta were common incorrect responses.

(ii) The type of tissue that the walls of the heart are made from is muscle or muscular tissue.

Question 5

(a) (i) The chemical names for limestone and lime need to be better known by many candidates.

(ii) This idea that the limestone and carbon inside the lime kiln were in small pieces so that the reaction would be speeded up needed to be better known by many candidates.

(iii) Many candidates correctly suggested treating acidic soils or reducing or neutralising the acidity of the soil. A few candidates incorrectly suggested that it was to lower the pH of the soil. Reference to fertility of the soil without further detail did not gain credit.

(b) (i) Candidates needed to use all the information in the question to produce a word equation. Many gained partial credit.

(ii) A common error here was to suggest that the sodium hydrogencarbonate loses hydrogen gas when it decomposes into sodium carbonate.

(c) (i) Some candidates gained partial credit here. To gain full credit, responses needed to give greater detail.

(ii) The colour change from orange to colourless needs to be better known.

Question 6

(a) (i) Kinetic energy was well known.

(ii) Many candidates gave the answer fuel. They needed to read the question very carefully and think about what is being asked.

(iii) Chemical potential energy was well known.

(iv) There were a number of different correct answers seen.

(b) Almost all the candidates correctly identified the Sun for the first answer but a number of candidates incorrectly suggested either kinetic, chemical, thermal or solar rather than electrical for the second answer.

(c) Most candidates were able to state one way to increase the turning effect.

(d) (i) Many candidates omitted the switch from their diagram.

(ii) Many candidates were able to explain one advantage of connecting the lamps in parallel.

Question 7

(a) (i) Most candidates gained at least partial credit. It was usually the medium or high sugar concentration that they correctly identified.

(ii) Most candidates correctly identified plant cell **A**.

(b) Many candidates gained full credit for an answer that described the movement of water across a partially permeable membrane.

(c) (i) Light and chlorophyll were both well known as requirements needed for photosynthesis.

Oxygen was sometimes suggested incorrectly.

(ii) This was well answered by many candidates.

(d) Producer is the term used to describe organisms that use photosynthesis to make their own nutrients.

Question 8

(a) Bauxite was not well known as the ore of aluminium. Aluminium ore or iron ore were frequently given as answers.

(b) Most candidates were able to insert one word correctly into the sentences about electrolysis.

(c) (i) Hydrochloric acid was the most popular answer.

(ii) Few candidates were able to explain that the liquid was not an electrolyte.

(iii) Few candidates suggested sulfuric acid.

(d) (i) A number of candidates referred to neutrons.

(ii) Neutrons were also referred to in the responses of some candidates.

Question 9

(a) (i) Many candidates were able to identify the three states of matter shown on the diagram.

(ii) Very few candidates were able to explain that the liquid expands when heated.

(iii) Candidates found this part challenging. The clearest answers referred to placing the thermometer in melting ice and in boiling water and marking 0 °C and 100 °C on the scale.

(b) Few candidates located the correct position for infrared. Many placed infrared in the position of either ultraviolet or visible light.

(c) Many candidates referred to the penetrative properties of alpha particles. Some did not choose paper as the correct material to use.

(d) Few candidates got both of the numbers correct. 40 was a common suggestion for both the number of neutrons and the number of protons.

Question 10

(a) Most candidates scored at least some credit but very few gained full credit.

(b) Relay neurone was a common incorrect response.

(c) (i) Many candidates referred to gravitropism. This was often accompanied by a very weak explanation of what happens to the root and shoot.

(ii) Many candidates suggested light as the correct answer here.

Question 11

(a) (i) Diamond and graphite were the commonest answers but many candidates placed them the wrong way round.

(ii) Some candidates knew that it was covalent bonding. Other candidates knew that it was a giant structure. Few candidates knew both.

(b) (i) Few candidates identified methane as gas **Q**. Hydrogen, oxygen or nitrogen were frequently suggested.

(ii) Few candidates realised that it was the test for ammonia gas that was needed.

Question 12

(a) (i) The term normal needs to be better known. Mirror line was the most common answer.

(ii) Most candidates correctly drew the reflected ray. A few candidates stopped the reflected ray halfway to the boy rather than continue it on to reach the boy.

(iii) The angle of incidence was well known. A few candidates confused it with the angle of reflection.

(iv) Same size and laterally inverted were frequently given as the descriptions of the image in the mirror.

(b) (i) Candidates found this challenging. Few candidates drew clear and accurate ray diagrams.

(ii) Few candidates located the focal length of the lens.

(c) This part was well answered with many candidates gaining full credit.

CO-ORDINATED SCIENCES

Paper 0654/32
Theory (Core)

Key messages

Candidates seemed to have a good understanding of what the questions were asking.

A good standard of scientific knowledge was displayed by many candidates. Some candidates should be congratulated for their clear and accurate responses.

Calculations were usually done well with working shown.

General comments

Most candidates attempted all the questions. Many candidates answered most of the questions well. There was a good range of marks on every question. Candidates generally scored on all questions. Few gained no credit on any question but very few gained full credit on any question. Performance depended not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

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

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.

A number of candidates seemed to doubt their original answers and ended up crossing out a correct answer and replacing it with an incorrect answer.

Comments on specific questions

Question 1

(a) (i) This was usually answered correctly. A number of candidates omitted the arrows. Some candidates produced a food chain containing organisms not shown on the food web.

(ii) This was well answered.

(iii) Many candidates gave sensible consequences of the changes in the limpet population.

(b) Many different undesirable effects of deforestation were given by candidates.

Question 2

(a) (i) Few candidates gained more than partial credit here. Candidates needed to use the melting point and boiling point data to determine the physical states of the three halogens and then link the physical state to the correct halogen.

(ii) Few candidates described one other trend in properties of the halogens. Many chose to describe a property which did not change for the halogens. For example, all the halogens have 7 electrons in their outer shell.

(b) Many candidates were awarded part of the available credit for identifying two correct sentences. There were three correct sentences.

(c) (i) About half the candidates suggested ionic and the other half suggested covalent.

(ii) Few candidates explained that the ions had opposite electrical charges or that opposite electrical charges attracted each other.

(d) Very few candidates suggested a flame test.

Question 3

(a) Few candidates determined the distance correctly as 250 m. Most calculated the distance as 500 m, because they did not determine the area under the graph but did a simple distance = speed × time calculation.

(b) Friction, drag and air resistance were all given as answers.

(c) (i) Many candidates were able to use the information given on the graph and work out that as the skydiver was falling at a constant speed, the upward force would be equal to the skydiver's weight.

(ii) The value of *g* was well known but not the units.

(d) Many candidates gained full credit. A common error was to use an incorrect equation to determine the mass.

Question 4

(a) Most candidates gained most or all of the available credit.

(b) (i) Many candidates referred to a balanced diet. This did not quite answer the question. Candidates also needed to imply that menu **A** contained more fat and more sugar, rather than just that menu **A** contained fat and sugar.

(ii) The use of water as a solvent was not well known.

(c) (i) Some candidates knew that ingestion occurred in the mouth. Many others suggested the stomach or small intestine.

(ii) Similarities and differences between absorption and assimilation were not well known.

(d) All the characteristics of life were mentioned by the candidates.

Question 5

(a) (i) Malleability was well known as the physical property of aluminium which allows it to be made into thin sheets.

(ii) Many candidates were able to give a property of aluminium which related to it being safe to use for food containers.

(b) (i) Calculating the mass of aluminium was well done.

(ii) Many candidates incorrectly suggested other transition elements.

(iii) Most candidates suggested stronger.

(c) (i) The cathode was well known.

(ii) Candidates found it challenging to explain why the positive electrode becomes smaller. Few candidates appreciated that the reaction of the carbon electrode with oxygen produces a gaseous product, carbon dioxide.

(iii) Bauxite was not well known as the ore of aluminium. Aluminium ore or iron ore were frequently given as answers.

(iv) Recycling was well known.

Question 6

(a) (i) Some candidates were unable to use the correct symbols in their circuit diagram.

(ii) Kinetic energy was often given as one of the forms of energy.

(iii) This calculation was almost invariably correct.

(b) (i) The ammeter was well known. Ampmeter was not accepted.

(ii) Electrons were well known as the particles that flow when there is a current in a wire.

(c) Calculation of the combined resistance of the two resistors in series was almost invariably correct.

Question 7

(a) (i) Most candidates gained much of the available credit for identifying two of the parts of the human gas exchange system.

(ii) Few candidates identified both of the correct statements that described diffusion.

(b) (i) Differences involving oxygen or nitrogen content were not accepted in the question.

(ii) Many candidates were able to explain that respiration releases energy for protein synthesis.

(iii) Glucose was well known as the substance that reacts with oxygen in aerobic respiration.

Question 8

(a) Very few candidates knew either of the two suitable tests to show that a liquid is water.

(b) (i) Candidates needed to state where there were differences in the number of oxygens. There were many vague answers referring to two oxygens or only one oxygen.

(ii) Many candidates were able to balance the equation but some tried to involve H_2O_2.

(c) Some candidates only used one hydrogen atom in their dot-and-cross diagram.

(d) (i) Most candidates found this part of the question very challenging. They needed to understand that water would boil but potassium chloride would not. The idea that water is covalent but potassium chloride is ionic was rarely mentioned.

(ii) Most candidates were unable to do this calculation.

(iii) The silver nitrate test for chloride ions was not well known.

Question 9

(a) (i) Most candidates correctly described the motion of molecules in a solid as the temperature rises.

(ii) Few candidates could describe evaporation. The escape of the more energetic molecules from the surface of a liquid was not known.

(b) Convection was the most popular and correct answer.

(c) Infrared was correctly placed in the electromagnetic spectrum by many candidates.

(d) (i) Many candidates were able to locate the amplitude of the sound wave.

(ii) Many candidates gave a correct value for either the lowest frequency or the highest frequency. Few candidates gave both frequencies.

(e) Advantages and disadvantages of generating electricity using solar cells were well known.

Question 10

(a) (i) Person A was correctly identified as the person under the most stress because of the concentration of adrenaline in the blood.

(ii) 03.00 was usually identified as the time when all three people had the lowest release of adrenaline.

(iii) Many sensible effects of adrenaline on the body were given.

(iv) Plasma was not well known as the part of the blood that transports hormones such as adrenaline.

(b) (i) Most candidates were able to complete the calculation.

(ii) Methods of transmission of HIV were well known.

(iii) AIDS was mentioned by a number of candidates but some candidates attempted to write out the full name and were unable to remember “acquired”

Question 11

(a) (i) Many candidates knew the answer but found it challenging to explain why. They needed to be able to distinguish clearly between alkanes and alkenes and between saturated and unsaturated.

(ii) Few candidates were able to explain why bottle **E** (heptane) was the hydrocarbon.

(b) (i) The purpose of the catalyst was well known.

(ii) Bromine was frequently identified as the orange solution.

(iii) The idea of unsaturation was not well known.

(c) (i) Oxygen was frequently added to the word equation as the other reactant. Many candidates were unable to identify the two products as carbon dioxide and water.

(ii) Many sensible ideas were suggested as to why the balance reading changed while the ethanol was burning.

Question 12

(a) (i) Few candidates correctly identified the angle of incidence and the angle of refraction.

(ii) There was multiple credit here. For partial credit, the candidates needed to continue the refracted ray until it refracted for the second time when it left the glass block. For full credit they also needed to draw a line showing the emergent ray parallel to the incident ray.

(b) (i) The focal length was quite well known.

(ii) Enlarged and inverted were frequently given as the descriptions of the image on the screen.

(c) (i) Very few candidates mentioned that the radiation was ionising or explained the consequences of the ionising radiation on a human being.

(ii) Few candidates calculated the half life as 2 years. Even fewer showed any working on the graph or elsewhere.

(d) Most candidates were able to state at least one way to increase the turning effect.

CO-ORDINATED SCIENCES

Paper 0654/33
Theory (Core)

Key message

Candidates seemed to have a good understanding of what the questions were asking.

A good standard of scientific knowledge was displayed by many candidates. Some candidates should be congratulated for their clear and accurate responses.

Calculations were frequently done well with working shown.

General comments

Most candidates attempted all the questions. Many candidates answered most of the questions well. There was a good range of marks on every question. Candidates generally scored on all questions. Few gained no credit on any question but very few gained full credit on any question. Performance depended not only on scientific knowledge but on the ability of the candidates to understand the question and express themselves clearly.

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

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.

A number of candidates seemed to doubt their original answers and ended up crossing out a correct answer and replacing it with an incorrect answer.

Comments on specific questions

Question 1

(a) (i) Most candidates gained at least half the available credit for identifying two of the parts of the alimentary canal and associated organs.

(ii) Organ **J** was frequently identified as the liver.

(iii) Organ **E** was frequently identified as the pancreas.

(b) In the incorrect definition for digestion, many candidates were able to identify the two errors.

(c) In the table of food molecules and the smaller molecules they are made from, most candidates gained most of the available credit.

Question 2

(a) (i) Exothermic was well known.

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

(b) A number of different correct physical properties of magnesium were seen. Most candidates gained at least some credit.

(c) (i) This was not well answered. The question asked for differences and similarities in the observations made. Few candidates correctly identified a difference or a similarity in the observations made.

(ii) Magnesium chloride was not well known as a product of both of the reactions.

(d) (i) This was not well answered. Candidates needed to be clearer in their references to reactivity, i.e., the position of copper in the reactivity series, or the relative reactivities of copper and hydrogen.

(ii) Few candidates made the connection between transition metals and coloured compounds.

(e) (i) Water was often identified as the other substance that needed to be present for iron to rust.

(ii) Many barrier methods were suggested for rust prevention.

(iii) Many candidates continued to suggest barrier methods in this part rather than making alloys.

Question 3

(a) (i) Many candidates placed an **X** somewhere along the line where the speed was a maximum rather than where the bus was not moving.

(ii) Few candidates determined the distance correctly as 600 m. Most calculated the distance as 1200 m, because they did not determine the area under the graph but did a simple distance = speed × time calculation.

(b) (i) Most candidates were able to calculate the weight of the bus as 50 000 N.

(ii) The only response accepted was the Earth.

(c) (i) Many candidates were able to suggest that the bus would go faster.

(ii) Some candidates correctly determined the resultant force as 400 000 N, although many others suggested 600 000 N

(d) The calculation was often well done. Some candidates forgot to convert 45 cm into metres.

Question 4

(a) (i) 72 bpm was the only value accepted.

(ii) Many candidates found it challenging to determine values from the graph, usually making multiple errors.

(iii) This simple calculation was generally well done.

(iv) The question asked for changes to the pattern of breathing. Many candidates gave answers in terms of pulse rate. Answers needed to focus on breathing rate and breathing depth.

(b) (i) The only clear piece of evidence from the diagram that showed that the blood vessel was an artery was the thick wall.

(ii) The component of the blood visible on the diagram was a red blood cell. A number of candidates suggested plasma.

(c) (i) The structure that separates the right and left sides of the heart was correctly identified by many candidates as the septum. Artery, vein and aorta were common incorrect responses.

(ii) The type of tissue that the walls of the heart are made from is muscle or muscular tissue.

Question 5

(a) (i) The chemical names for limestone and lime need to be better known by many candidates.

(ii) This idea that the limestone and carbon inside the lime kiln were in small pieces so that the reaction would be speeded up needed to be better known by many candidates.

(iii) Many candidates correctly suggested treating acidic soils or reducing or neutralising the acidity of the soil. A few candidates incorrectly suggested that it was to lower the pH of the soil. Reference to fertility of the soil without further detail did not gain credit.

(b) (i) Candidates needed to use all the information in the question to produce a word equation. Many gained partial credit.

(ii) A common error here was to suggest that the sodium hydrogencarbonate loses hydrogen gas when it decomposes into sodium carbonate.

(c) (i) Some candidates gained partial credit here. To gain full credit, responses needed to give greater detail.

(ii) The colour change from orange to colourless needs to be better known.

Question 6

(a) (i) Kinetic energy was well known.

(ii) Many candidates gave the answer fuel. They needed to read the question very carefully and think about what is being asked.

(iii) Chemical potential energy was well known.

(iv) There were a number of different correct answers seen.

(b) Almost all the candidates correctly identified the Sun for the first answer but a number of candidates incorrectly suggested either kinetic, chemical, thermal or solar rather than electrical for the second answer.

(c) Most candidates were able to state one way to increase the turning effect.

(d) (i) Many candidates omitted the switch from their diagram.

(ii) Many candidates were able to explain one advantage of connecting the lamps in parallel.

Question 7

(a) (i) Most candidates gained at least partial credit. It was usually the medium or high sugar concentration that they correctly identified.

(ii) Most candidates correctly identified plant cell **A**.

(b) Many candidates gained full credit for an answer that described the movement of water across a partially permeable membrane.

(c) (i) Light and chlorophyll were both well known as requirements needed for photosynthesis.

Oxygen was sometimes suggested incorrectly.

(ii) This was well answered by many candidates.

(d) Producer is the term used to describe organisms that use photosynthesis to make their own nutrients.

Question 8

(a) Bauxite was not well known as the ore of aluminium. Aluminium ore or iron ore were frequently given as answers.

(b) Most candidates were able to insert one word correctly into the sentences about electrolysis.

(c) (i) Hydrochloric acid was the most popular answer.

(ii) Few candidates were able to explain that the liquid was not an electrolyte.

(iii) Few candidates suggested sulfuric acid.

(d) (i) A number of candidates referred to neutrons.

(ii) Neutrons were also referred to in the responses of some candidates.

Question 9

(a) (i) Many candidates were able to identify the three states of matter shown on the diagram.

(ii) Very few candidates were able to explain that the liquid expands when heated.

(iii) Candidates found this part challenging. The clearest answers referred to placing the thermometer in melting ice and in boiling water and marking 0 °C and 100 °C on the scale.

(b) Few candidates located the correct position for infrared. Many placed infrared in the position of either ultraviolet or visible light.

(c) Many candidates referred to the penetrative properties of alpha particles. Some did not choose paper as the correct material to use.

(d) Few candidates got both of the numbers correct. 40 was a common suggestion for both the number of neutrons and the number of protons.

Question 10

(a) Most candidates scored at least some credit but very few gained full credit.

(b) Relay neurone was a common incorrect response.

(c) (i) Many candidates referred to gravitropism. This was often accompanied by a very weak explanation of what happens to the root and shoot.

(ii) Many candidates suggested light as the correct answer here.

Question 11

(a) (i) Diamond and graphite were the commonest answers but many candidates placed them the wrong way round.

(ii) Some candidates knew that it was covalent bonding. Other candidates knew that it was a giant structure. Few candidates knew both.

(b) (i) Few candidates identified methane as gas **Q**. Hydrogen, oxygen or nitrogen were frequently suggested.

(ii) Few candidates realised that it was the test for ammonia gas that was needed.

Question 12

(a) (i) The term normal needs to be better known. Mirror line was the most common answer.

(ii) Most candidates correctly drew the reflected ray. A few candidates stopped the reflected ray halfway to the boy rather than continue it on to reach the boy.

(iii) The angle of incidence was well known. A few candidates confused it with the angle of reflection.

(iv) Same size and laterally inverted were frequently given as the descriptions of the image in the mirror.

(b) (i) Candidates found this challenging. Few candidates drew clear and accurate ray diagrams.

(ii) Few candidates located the focal length of the lens.

(c) This part was well answered with many candidates gaining full credit.

CO-ORDINATED SCIENCES

Paper 0654/41
Theory (Extended)

Key messages

Successful candidates gained marks by:
- reading questions carefully
- recalling syllabus definitions
- showing working in calculations
- checking units.

General comments

The presentation of responses by candidates was generally of a high standard. Written answers were legible, with good use of English, enabling efficient communication of ideas. This was evident in the strongest answers to **4(a)** explaining osmosis, and in **7(a)(iv)** suggesting reasons for the small population of the desert fox. Full credit was obtained when candidates were aware of all the data supplied and the requirements of each question, as in **8(a)(i)** where the names of the reactants and products, and the formula of methanol facilitated the writing of the balanced equation. Where definitions and meanings were required, full credit was more likely when the syllabus wording was recalled. This was useful to candidates finding the concept of e.m.f. challenging in **3(c)** and in completing the definition of adaptation in **7(b)(i)**.

Where numerical answers were required, showing formulae, substitution and manipulation for each stage of the calculation often gained credit even when there was an error in the result on the answer line. Those making a mathematical error in **6(b)**, the acceleration calculation, often gained some credit for showing the correct formula. Candidates should be aware that the system of units are based on the metre, kilogram and second and that they gain credit for making conversions from the data supplied, as in the energy calculation in **12(b)**. They should also check whether the question or answer line specifies the unit to be used in the reported answer as done by successful candidates in calculating the moment in **12(c)**.

Comments on specific questions

Question 1

(a) (i) Several candidates noticed that the circulatory systems of fish and mammals differ in the number of atria and ventricles. Some mentioned that blood flows through the heart once, being careful to refer to one circuit of the body.

(ii) Good explanations of the advantages of a double circulatory system mentioned higher blood pressure or greater blood flow and the idea of more efficient delivery of oxygen, rather than just more blood.

(b) (i) Most calculations of the difference in thickness of the blood vessels were correct.

(ii) Correct explanations for the difference in thickness of the aorta and vena cava involved the prevention of bursting due to higher pressure, rather than suggesting the effect of higher blood flow or oxygen content. Some candidates were under the misapprehensions that the aorta exerts pressure on the blood or pumps the blood.

(c) (i) The adaptations of red blood cells were well known.

(ii) Statements of the components of blood were usually correct.

Question 2

(a) Most candidates realised that pencil is used to draw the chromatography start line because it is insoluble.

(b) Those who knew that chromatography shows that the fruit drink contains more than one substance could explain why it is a mixture.

(c) Correct explanations of whether the drink contains **X** depended on the ability to compare the chromatograms of **D** and **X**.

(d) Those who knew the formula for R_f were generally able to calculate its value. Many just measured the distance travelled by the substance.

(e) Successful candidates identified the task as converting a mass in grams to a mass in moles. Others tried to use the formula for calculating concentration: mass ÷ volume.

Question 3

(a) Many knew that the difference between speed and velocity is that velocity has direction. Some confused velocity with acceleration.

(b) Some responses did state that stronger wind increases the rate of evaporation. The strongest candidates explained that this is due to more air molecules escaping into the moving air, rather than suggesting that the wind provides molecules in the surface with the energy required to escape. Many candidates needed to describe the effect of increasing wind strength rather than focussing on a comparison between evaporation with and without wind.

(c) The meaning of electromotive force as the energy supplied by a source per unit charge was recalled by just a few candidates.

(d) (i) A minority of candidates realised that the current through the fuse is shared between the two lamps.

(ii) Those who knew that if one lamp fails in a parallel circuit, the other lamp will stay lit, seldom explained this in terms of the maintenance of a complete circuit.

(e) (i) Explanations why the light stays inside the fibre usually cited total internal reflection or an accurate diagram. The importance of critical angle was less commonly mentioned.

(ii) The clearest diagrams showed accurate representations of transverse and longitudinal waves, correctly labelled. They indicated the correct relationships between direction of oscillation and direction of wave travel.

Question 4

(a) There were some good explanations for the increased mass of the grape in terms of the movement of water by osmosis down a water potential gradient. The use of the concept of water concentration was not accepted.

(b) The best explanations for there being no change in mass of the grape placed in grape juice identified zero potential gradient. It was rarely stated that movement occurs in both directions causing there to be no net movement of water.

(c) The descriptions of the immersed cells were often chosen correctly.

(d) The structural differences between plant cells and animal cells were well known.

Question 5

(a) (i) Most candidates used the graph to find the correct mass of carbon dioxide.

(ii) Many responses included the correct explanation that the same amounts of reactants would produce the same amounts of carbon dioxide. Others attempted to explain that temperature does not affect yield while omitting the observation that reactant quantities were kept constant.

(iii) The relative molecular mass of carbon dioxide was usually correct and good use of the molar gas volume was made. Those who did not obtain the correct volume had often used an incorrect formula for calculating the number of moles.

(b) Explanations of the dependence of reaction rate on temperature usually referred correctly to the kinetic energy of particles and the rate of collision. Full credit was obtained by recognising the important fact that, at higher temperature, more colliding particles possess the minimum energy or activation energy to react, rather than making vague reference to the number of successful collisions.

(c) Respiration, or a process involving respiration, was often correctly suggested as a process producing carbon dioxide. Where combustion was suggested, reference had to be made to a carbon containing substance or a named example.

Question 6

(a) (i) The gravitational force was usually correctly identified.

(ii) Many candidates gave the correct value of the force resisting motion, knowing that it equalled the driving force. Others were under the misconception that a resultant force is required to maintain constant speed.

(b) Those who realised that the mass of the tractor had to be found before application of the formula $a = F / m$ usually calculated the correct acceleration.

(c) It was usually recognised that the area of contact between the tyres and the ground is increased by using wider tyres. The strongest candidates were able to express the fact that the weight is spread over a larger area rather than repeating the reduced pressure information in the question.

(d) Most candidates correctly calculated the work done in lifting the bucket.

Question 7

(a) (i)(ii) The correct food chain and the number of trophic levels were usually obtained from the information in the food web.

(iii) The best explanations for desert foxes feeding at two trophic levels named their possible prey and identified their trophic levels, rather than restating the question.

(iv) The best reasons for the lower population of desert foxes identified how energy is lost between trophic levels so that the energy available is only sufficient to support a small population of predator. Comparison between foxes and rats based on predation and litter size were less successful suggestions. Most candidates found this question challenging.

(b) (i) Most definitions of adaptation included the fact that populations become more suited to their *environment*. A few correctly specified the time scale as *many generations* rather than *many years*, which was too vague.

(ii) Most candidates were challenged when asked to describe how selective breeding is different from natural selection. A few knew that selective breeding takes place over a shorter time scale. The best suggestions highlighted the fact that humans select desirable features rather than stating that humans select individual animals to mate. Less variation and more inbreeding were not included in candidates' answers.

Question 8

(a) (i) Those who included all the reactants and products given in the question were generally able to write the correct balanced equation.

(ii) The meaning of the word *exothermic* was quite well known.

(iii) The most successful responses showed the energy level diagram as a continuous energy-time graph, with the product energy level lower than that of the reactants, and labelled the activation energy and energy change with vertical arrows drawn from the reactant energy level.

(b) Candidates who drew the correct bonding diagram for methanol had checked that each shell had a share in the maximum number of electrons.

(c) Many candidates wrote a correct definition to explain why methanol is not a hydrocarbon.

Question 9

(a) (i) To identify the maximum acceleration, the **X** had to placed unambiguously on the line between 15.0 s and 16.8 s on the speed-time graph, rather than at the ends of the line.

(ii) The correct value for the acceleration was usually calculated from a formula or the gradient of the graph. Some candidates measured the area under the graph.

(b) Some candidates could identify a suitable instrument for measuring a very small distance.

(c) (i) Those who knew the notation for a β-particle and the rules of conservation of mass and charge could complete the nuclear equation.

(ii) Those candidates who were aware that moving charged particles are deflected by an electric field could state the difference in the behaviour of β-particles and γ-rays.

Question 10

(a) Many candidates could identify the stigma and anther.

(b) Most comparisons of size and mass of pollen of insect-pollinated and wind-pollinated flowers were correct. The spikey appearance of pollen in insect-pollinated flowers was less well known.

(c) Those who could distinguish the features of petals from those of whole flowers usually compared the petals of insect-pollinated and wind-pollinated flowers correctly.

(d) (i)(ii) The function of the ovary in plants was less well known than that in humans.

(e) Many candidates could name the zygote cell from its description.

Question 11

(a) (i) Those candidates who correctly explained why chlorine gas is made at the anode knew that chloride ions are attracted to the anode due to their negative charge and give up electrons there. Some also stated that chlorine atoms combine to form chlorine molecules.

(ii) Some knew that hydrogen was liberated at the cathode. Sodium was a popular choice.

(iii) Correct explanations of why *inert* electrodes must be used involved the lack of reaction with the electrolyte or products, rather than giving a general definition of the word *inert*.

(b) There were a few correct ionic half-equations seen. Not all included state symbols, as required by the question.

(c) There were some good 2- and 3-dimensional diagrams of the lattice structure of sodium chloride, with the ions and their charges labelled.

Question 12

(a) (i) The majority of candidates knew that a step-down transformer lowers voltage.

(ii) There were many successful calculations of the number of turns on the secondary coil. Errors commonly occurred in rearranging the formula.

(b) The formula for electrical energy transferred was well known. The correct result was obtained by candidates who successfully converted the unit of time into seconds.

(c) The formula for moment of a force was well known. The correct result was obtained by candidates who successfully converted the unit of distance into metres**.**

(d) A small number of candidates explained the ways in which the design of the heat sink allowed it to remove thermal energy efficiently. They knew that a black surface is a good emitter of heat radiation, and that a large surface area enables efficient convection and radiation. Most responses were more concerned with ways in which heat is transferred from the microprocessor to the heat sink, discussing the absorption and conduction of thermal energy, which did not answer the question.

Question 13

(a) A minority of candidates knew that nitrogen-containing fertilisers are important for plant growth.

(b) (i) A correct balanced equation for the formation of ammonia was sometimes provided. Many candidates used formulae such as H or H_3.

(ii)(iii) A suitable pressure for use in the Haber reaction chamber was suggested sometimes. Correct units needed to be included. The purpose of the catalyst was generally explained well. While most knew that a higher temperature increases the rate of reaction, few appreciated that a moderately high temperature is employed so as not to sacrifice yield too much.

CO-ORDINATED SCIENCES

Paper 0654/42
Theory (Extended)

Key messages

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

Calculations were generally well done with working shown and expressed to a suitable number of significant figures. One 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(b)**.

Inaccuracies in labelling and drawing ray lines was detrimental to a small number of candidates. This was evident in **Question 12(c)**. Ideally, a ruler needs to be used for drawing a label line to identify parts of diagrams as in **Questions 3(b)(iii)**, **12(d)(i)** and **12(d)(ii)**.

Candidates should be encouraged to practise data analysis skills such as extracting data from graphs, charts and tables as well as using and manipulating the data contained within them. Reference to table headings and graph axes aids in understanding and processing data. **Questions 4(a)(i)**, **7(a)(i)** and **8(a)** are examples of questions where these skills are beneficial.

General comments

Candidates should be encouraged to be specific in their responses using suitable scientific language in order to describe and explain phenomena accurately and in suitable depth. There were many examples of vague responses which prevented some candidates from accessing the available credit.

It is important for candidates to 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 credit available or gave irrelevant responses 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 tool 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) (i) Candidates were generally able to identify two visible differences between sperm and egg cells. Very occasionally there were some responses seen such as “size” or “shape” which were too imprecise.

(ii) The candidates that did respond to this question generally scored highly with many identifying the presence of enzymes. Other acceptable answers included mention of the acrosome or the presence of many mitochondria. This question specifically asked for non-visible features and so responses such as “flagellum” were not acceptable.

(b) (i) A very common misconception was that fertilisation occurs in the ovary or the uterus rather than the oviduct. Candidates should be reminded to use the terms for biological parts stated in the syllabus. In this instance oviduct is the preferred term although fallopian tube was also credited.

(ii) Most candidates were able to state two correct parts. The most common incorrect response seen was ovary.

(iii) It was clear that the adaptive features of egg cells were not well known.

(iv) This question proved a little more challenging for many candidates. Some were able to state that gametes contained a haploid nucleus. Fewer were able to state that the chromosomes would be unpaired.

Question 2

(a) This question was generally answered well. A common error was to state the relative mass of electrons as being 1.

(b) (i) This question part was generally answered well. Very occasionally the total number of electrons was given.

(ii) The link between the number of electrons in the outer shell and the group number was understood by the majority of candidates.

(c) The biggest challenge for candidates was to recognise that a molecule of nitrogen contains a triple bond. Candidates that had knowledge of the triple bond were generally able to represent this accurately in a dot-and-cross diagram.

(d) Most candidates were able to provide accurate percentages of oxygen and nitrogen in clean air. Very occasionally these two figures were reversed. Fewer were able to name a gas that had a variable concentration. Often answers vaguely referred to “other gases” rather than water vapour or a named noble gas.

(e) This proved more challenging for candidates. A common error was to try and insert water as one of the products. In addition, there were some responses stating nitrogen oxide as one of the products. Those candidates that wrote the correct formula were mostly able to balance the equation with nearly all of these candidates recognising that oxygen and nitrogen products exist as diatomic molecules.

Question 3

(a) (i) This question required careful consideration. A number of candidates were hesitant to give 0 J as a response. However, a good number of candidates did give the correct response.

(ii) Many correct responses were seen in addition to being expressed to a sensible number of significant figures. Very occasionally some candidates did not square the velocity.

(b) (i) Some responses referred to wave **movement** being parallel to the direction of the wave rather than wave **oscillations**. Occasionally candidates tried unsuccessfully to explain longitudinal waves in terms of compressions and rarefactions.

(ii) This question was generally well answered with most candidates able to express compressions in terms of pressure or particle density.

(iii) The majority of candidates could identify a compression and a rarefaction. Some candidates were not able to gain full credit due to inaccuracies in their labelling such as bracketing too large a part of the diagram.

(c) Too many candidates repeated part of the question in order to explain their answer. Many candidates recognised that solids have strong forces of attraction between the atoms but went on to repeat the stem to explain why solids held their fixed shape. Candidates should provide new information to supplement their answer, for example stating that these strong forces held atoms together in a fixed lattice arrangement.

Question 4

(a) (i) Candidates were able to identify the main trends seen in the data. Occasionally imprecise trends were identified, for example simply stating that number of smokers decreases with age when there was in fact an increase followed by a decrease. To improve, candidates should practise extracting information from graphical material. Axes labels provide important information to help candidates understand the material. Candidates should also be encouraged to quote or manipulate data when appropriate.

(ii) Most candidates were able to calculate the correct percentage of 68 per cent.

(b) Most candidates were able to provide increased awareness or education as a suggestion for the decrease in smoking rates. Occasionally candidates misinterpreted the question and tried to suggest why 50-years-olds smoke less than other age groups.

(c) The main components of cigarette smoke were well known. The effect of carbon monoxide was less well known but the stronger candidates were able to make reference to haemoglobin. A common misconception was to suggest that carbon monoxide prevented oxygen intake into the body rather than into the blood.

(d) There were some excellent and detailed responses seen with many candidates able to give a clear link between the inability of cilia to remove mucus and the increased risk of infection. It was pleasing to see that many candidates referred to mucus trapping pathogens rather than the cilia trapping pathogens.

(e) The vast majority of candidates were able to give two correct risk factors.

Question 5

(a) This question asked for properties other than the formation of coloured compounds. A number of candidates gave this as part of their response preventing them from accessing all the available credit. Candidates should be reminded to read question instructions carefully to prevent this occurring. However, many correct responses were also seen.

(b) (i) Only the strongest candidates identified a correct test and result. The most common response seen was reference to litmus paper being bleached. Other incorrect responses seen were reference to electrolysis and use of cobalt chloride.

(ii) A number of candidates had difficulty calculating the relative molecular masses of the two compounds. There were some inaccuracies in rounding evident in a number of responses, affecting the final value given.

(iii) Candidates should be encouraged to display multistep calculations clearly and with working for all parts of the calculation shown. The most common reason that candidates did not gain full credit was forgetting to convert dm^3 to cm^3, hence a value of 4.8 was often given. Very occasionally the incorrect relative molecular mass of carbon dioxide was given. Error carried forward principle was applied in these instances.

(c) Most candidates were able to explain this in terms of metals possessing a sea of delocalised electrons.

Question 6

(a) (i) Some excellent responses were seen with each step fully shown. A common omission was to forget to include the formula for force = mass × acceleration. Some candidates incorrectly used time multiplied by the mass.

(ii) Many correct responses expressed with an appropriate number of significant figures were seen.

(b) The majority of candidates understood how to calculate pressure. Some candidates forgot to account for the four hooves of the horse and some did not convert cm^2 to m^2 successfully.

(c) There were a number of vague responses to this question with many candidates referring to ease of inducing magnetism. Responses such as these were not awarded credit. Candidates should have referred to the speed at which the metals gain or retain magnetism. Responses referring correctly to temporary or permanent magnetism or hard or soft magnets were credited.

(d) The majority of candidates were able to identify that humans had a narrower audible range than horses with most quantifying their responses.

(e) Correct nuclide notation was challenging for many candidates. Candidates were more successful in representing the beta particle than platinum.

Question 7

(a) (i) A large number of candidates used the values to calculate a percentage rather than a percentage change. Most candidates completed the instructions carefully and expressed this value to the nearest whole number.

(ii) Only the strongest candidates were able to gain access to the full available credit. However, the majority were able to gain at least some credit here. Many responses included reference to nitrate ions being necessary for the synthesis of proteins and growth. Fewer linked nitrate ions to amino acid production.

(b) Candidates must read the question carefully, there was occasional misinterpretation of the question with three genotypes given. A number of candidates muddled the meaning of the term phenotype. A larger proportion than expected were able to identify the type of breeding.

(c) (i) The question asked for uses of carbohydrates other than storage. A number of candidates gave stored as glucose as one of their responses. They must read the question carefully. It was evident that this part of the syllabus was not well known. However, there were a small number of excellent responses with references to sucrose for transport and synthesis of amino acids. The most common correct response was the use as a reactant in respiration to release energy.

(ii) The vast majority of candidates gave the correct elements with a minority substituting hydrogen for water or nitrogen.

Question 8

(a) **A** was commonly identified with a correct explanation involving length of time taken for the cross to disappear. A small number of candidates incorrectly identified **C** and gave the converse as a means of explanation.

(b) The relationship between temperature and reaction rate was well explained and understood. Fewer candidates were able to explain this in terms of more particles having the activation energy required to react.

(c) The relationship between bond making and bond breaking in relation to the absorption or release of energy needs to be better understood. The most common misconception seen was that the breaking of bonds releases energy. Candidates generally referred to the reaction as a whole being exothermic as energy is released with no comparison to amount of energy absorbed.

Question 9

(a) The vast majority of candidates demonstrated they understood the difference between mass and weight.

(b) (i) Candidates had no difficulties in calculating the correct value. A very small number substituted the values to give an incorrect value of 0.04.

(ii) This was generally well answered with many identifying that the fuse rating is below the working current and so would melt or blow. Occasionally candidates needed to be more specific in their responses. Reference to the fuse value being too low was not enough to gain credit.

(c) This area of the syllabus needs to be better known. Very few candidates seemed to know what a thermocouple was and many described a mercury thermometer.

(d) The majority of candidates could describe two differences between evaporation and boiling. This was well understood with many articulate answers seen.

Question 10

(a) (i) Many scientific misconceptions were evident. There was much talk of capillaries narrowing and blood vessels moving away from the skin. Many candidates had a general idea of vasoconstriction but had difficulty expressing their ideas coherently. Candidates should be reminded that it is the arteriole blood vessels that narrow during vasoconstriction and that less blood flows to the skin **surface**.

(ii) Some very good suggestions were seen with many candidates identifying that part **A** is less exposed and covers vital organs.

(b) The majority of candidates gave a correct term. Negative feedback was an acceptable alternative to homeostasis.

(c) The definition of sensitivity was very well known with many candidates giving the definition as stated in the syllabus.

Question 11

(a) The majority of candidates were able to draw the structure of propane. Very occasionally a different alkane was drawn. A more common incorrect answer seen was to not include the necessary number of hydrogen atoms.

(b) The bromine water test was generally well understood. Some responses did not specify that propane would remain orange but rather suggested that the solution would change colour to orange. When describing colour changes, candidates should be encouraged to describe the initial colour and the end colour or if the colour remains the same.

(c) The process of cracking was well understood with many candidates giving succinct and accurate answers. Very occasionally there was some confusion with the process of fractional distillation. The correct conditions were frequently seen. The most likely to be inaccurate was the type of catalyst. Some responses required a little more detail to access the full range of credit available and needed to refer to production of alkenes.

(d) Drawing the structure of a polymer proved more challenging for most candidates. Frequent errors included the inclusion of a double bond, the omission of “n” to denote a large number, the omission of end bonds and brackets, and incorrect structural formulae.

Question 12

(a) (i)(ii) There was a good grasp of the idea of thermal expansion and most candidates could apply this to the scenario given.

(b) There were many accurate responses detailing the transfer of electrons from the fuel to the pipe. Some candidates tried unsuccessfully to explain this in terms of transfer of positive and negative charges.

(c) Candidates should be reminded to draw ray lines with a ruler. This question was generally well answered with only a few candidates drawing incorrect angles or trying to demonstrate refraction.

(d) (i) Candidates generally labelled the coil accurately.

(ii) Candidates generally labelled the slip rings accurately.

(iii) There was a good level of understanding shown about how a turning coil generates alternating voltage with most referring to the coil cutting the magnetic field. Although some candidates needed to express their ideas more clearly by referring to the current reversing every half turn rather than the current simply reversing or changing.

CO-ORDINATED SCIENCES

Paper 0654/43
Theory (Extended)

Key messages

Successful candidates showed evidence of preparation for the examination:

- in biology by learning definitions of terms so that they could apply them to explain the working of living organisms
- in chemistry by learning the principles of atomic structure so that they could work out formulae and predict reactions
- in physics by learning conceptual models such as kinetic theory so that they could explain the mechanism of everyday applications.

General comments

Written answers were well presented, and the standard of English made responses easy to understand, enabling candidates to be credited for communicating their knowledge. The spelling of technical words was good and their meaning rarely ambiguous. Learning of the meaning of scientific terms was apparent in answers to questions such as **4(b)(ii)** explaining the difference between mitosis and meiosis. Those candidates with a grasp of atomic structure showed that they could check the accuracy of formulae and use data to balance the equation in **Questions 2(b)** and **2(c)(ii)**. Being able to apply a model of the behaviour of particles in heated water allowed the explanation of convection required in **Question 12(a)**. Mathematical skills were usually adequate, although mistakes were made when rearranging formulae, especially in the transformer question, **12(c)**. The number of significant figures was usually appropriate in the final answers. Some candidates did not ensure that units of quantities were converted to metres, kilograms, and seconds before use in a formula, as in the calculations in **Questions 3(b)(iii)** and **9(a)(iii)**.

Comments on specific questions

Question 1

(a) (i) Most candidates noticed that as the light intensity increases, the rate of photosynthesis increases. Many went on to state that the rate then stays constant, rather than just describing the shape of the graph.

(ii) The rate limiting factors were usually all identified.

(b) Many explained that high temperature would stop photosynthesis and described how enzymes are denatured. Others thought that the rate increases at 80 °C.

(c) Most could recall the equation for photosynthesis.

(d) The best explanations of why chlorophyll is needed involved the transfer of light energy to chemical energy to synthesise carbohydrates. Many named a carbohydrate while not acknowledging the importance of energy transfer.

Question 2

(a) The relative formula mass of ammonium sulfate was usually correct.

(b) Those who knew the formulae for ammonia and sulfuric acid were often able to write a balanced equation for the production of ammonium sulfate. Others began their equation with: $NH_4 + SO_4$.

(c) (i) Those who could recall the formula could usually calculate the numbers of moles reacting.

(ii) The strongest candidates could explain how they used a simple whole number ratio of moles to balance the equation. Many gained some credit by using their knowledge of acid-base reactions to write the equation.

(d) The clearest answers stated that the conditions used in the Haber process sacrifice some yield and recognised the need for compromise. Many explanations included the fact that increasing the temperature from 200 °C to 450 °C increases the rate of reaction. Some also stated that working at 200 atmospheres rather than 300 atmospheres is safer and less expensive.

Question 3

(a) The difference between a real and a virtual image was generally not well known. Some candidates described the properties of specific images, which did not answer the question.

(b) (i) Most candidates knew the difference between speed and velocity. A few confused velocity with acceleration.

(ii) The formula for acceleration was well known. Errors in dividing by 0.001 were common.

(iii) Mass and acceleration were usually substituted into the formula correctly. Some candidates may need to practise converting grams to kilograms to ensure that they are successful in their conversion. Candidates who showed their working often gained credit for the correct stages in their calculation.

Question 4

(a) (i) Most candidates correctly suggested that carbon dioxide moves across the placenta from the blood of the fetus to the mother's blood.

(ii) The most succinct definitions of diffusion were those based on that given in the syllabus. Reference to the random motion of particles needed to be included.

(iii) There were some good suggestions for features of the placenta that enable efficient gas exchange, including large surfaces, a permeable membrane and good blood supply. Descriptions of the importance of thin walls of blood vessels was sometimes spoiled by reference to thin cell walls or walls one cell thick.

(iv) The names of the parts of the female reproductive system were quite well known.

(b) (i) At least one correct use of mitosis was usually suggested. Candidates need to be able to distinguish between repair of tissue and repair of cells.

(ii) Many candidates knew that cells produced by mitosis have a diploid number of chromosomes whereas those produced by meiosis have a haploid number. Candidates need to ensure that they are clear about which process forms genetically identical cells. Those who specified which process they were describing avoided ambiguity in their answers.

Question 5

(a) (i)(ii)(iii) The vast majority identified correct elements from the list of descriptors.

(b) (i)(ii) The nuclear particles were usually correctly identified.

(iii) A suitable isotope of oxygen was usually represented showing its eight protons.

(c) Most diagrams of the ions were correct. Any showing the suggestion of covalent bonding were not awarded credit.

Question 6

(a) (i) Most candidates knew that a stationary boat would have no kinetic energy.

(ii) Those who knew the formula for kinetic energy usually calculated the correct value.

(b) Many diagrams showed some spreading and curving of the wavefronts to show diffraction. Full credit was awarded if they indicated that the wavelength is unchanged.

(c) Conditions that could change the rate of evaporation were usually stated correctly. Suggestions such as *more heat* were less accurate than *higher temperature*.

(d) Most candidates could apply the formula for pressure. The main challenge was in calculating the gravitational force from the mass.

Question 7

(a) (i) General trends in the deficiency disease data were often correctly described rather than quoting specific items of data.

(ii) Many candidates could calculate the percentage of children with kwashiorkor. Some calculated the percentage with marasmus.

(b) Some candidates knew that the diseases can be treated by increasing protein in the diet. Others suggested calcium.

(c) Some candidates explained that rickets is caused by lack of vitamin D, leading to weak bones. Others simply described the appearance of the person's legs.

(d) Most appeared to be aware of the importance of fibre in the diet. A minority used the word *constipation*.

(e) Most risk factors for coronary heart disease were valid, while some candidates described symptoms of heart disease.

Question 8

(a) The meaning of the word *hydrocarbon* was well known by some. Those who did not identify the double bond in a saturated compound sometimes gave the general meaning of the word.

(b) A few candidates could state a physical property of substances with a simple molecular structure.

(c) (i) Most gave a valid use of ethanol as a solvent, fuel or sterilising agent.

(ii) Many descriptions of fermentation identified the need for sugar and yeast. Candidates needed to mention the importance of water or maintenance of a suitable temperature. A few correctly described the process as anaerobic respiration.

Question 9

(a) (i) There were many correct calculations of the combined resistance of the lamps in parallel, by those who knew the formula and could manipulate its rearrangement. Showing working often gained some credit even if the result was incorrect.

(ii) Candidates who obtained full credit for showing how the current is obtained, wrote the algebraic formula used, $I = V / R$, as well as its substitution.

(iii) Many candidates could apply the formula to calculate the charge passing through the lamp. Fewer stated the correct unit.

(iv) There were some good descriptions of the difference between direct and alternating current.

(v) The useful energy transformation occurring in the generator was often correct. Some candidates thought that chemical energy was transformed in the generator.

(vi) The useful energy transformation occurring in the lamp was often correct.

(b) (i) A good example of a transverse wave was usually given.

(ii) Most indications of a wavelength were drawn carefully on the diagram.

(iii) Most candidates correctly described the wavelength of sound as decreasing if the frequency increases.

Question 10

(a) Many candidates could state at least one source of nitrate ions which causes water pollution. Some suggestions involved polluting material that is not a source of these ions.

(b) Candidates answered this structured description of eutrophication quite well. Anaerobic respiration was the most common error.

Question 11

(a) (i)(ii)(iii) Many candidates identified all three equations correctly.

(b) Most candidates defined the term *oxidising agent* as a substance that donates oxygen to another substance. Fewer gave the more general definition of an oxidising agent gaining electrons in a redox reaction.

(c) Some candidates knew that aluminium oxide is the electrolyte used in the extraction of aluminium and clearly stated that aluminium is made at the cathode and oxygen at the anode. Others answered the question by attempting to explain the migration of ions to each electrode which was not what the question asked.

Question 12

(a) There were a few good explanations of why all the water in the tank is heated by convection. They stated that the density of heated water decreases, causing it to rise and the cold water to sink. Other responses just described the convection current.

(b) (i) Many candidates recognised that it is safe to use an α-emitter in a smoke detector due to the low penetration of α-particles.

(ii) Those who knew the notation for an α-particle and the rules of conservation of mass and charge could complete the nuclear equation.

(c) There were many successful calculations of the number of turns on the secondary coil. Errors commonly occurred in rearranging the formula.

Question 13

(a) Many candidates were aware that graphite's use as a lubricant is due to layers of atoms sliding over each other. Fewer articulated the idea that the layers are held by weak forces.

(b) There were a few observations that graphite and silicon(IV) oxide are both macromolecules.

(c) Most recognised the mixture as an alloy.

(d) Some candidates explained the role of zinc in galvanised steel as a physical barrier against oxygen and water. Fewer described its sacrificial role due to its reactivity being greater than that of iron.

CO-ORDINATED SCIENCES

Paper 0654/52
Practical Test

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

CO-ORDINATED SCIENCES

Paper 0654/53
Practical Test

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

CO-ORDINATED SCIENCES

Paper 0654/61
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental technique and to have carried out experiments similar to the ones shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from a variety of measuring instruments and record the values to the requested accuracy. The bullet points in the planning question are there to help candidates structure their plan into the sections required. Candidates should be able to draw clear and labelled diagrams of assembled apparatus. Candidates should have performed identification tests on the range of substances detailed in the syllabus.

General comments

Candidates from many centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was good, the expected accuracy can often be gleaned from the data already present in a table. The standard of graph drawing was generally high although candidates need to remember that axes need to be large enough that the plotted points cover at least half of the grid. Candidates must read the questions carefully so that they answer what is being asked by the question. Explaining safety precautions is improving with more candidates addressing all three aspects. Undertaking practical work helps the candidates to interpret and evaluate experimental methods and results. Knowledge of identification tests for ions and gases was very limited.

Comments on specific questions

Question 1 Glucose test.

(a) (i) Most candidates chose the correct final colour. Yellow was a common incorrect response.

(ii) Candidates found this very challenging with few referring to colour in their answer. Discussion of possible errors, the decimal nature of the concentrations, it is an unknown substance and change in the conditions e.g. temperature were common incorrect responses.

(b) The majority of candidates chose a suitable piece of apparatus. Beaker, ruler and dropping pipette were common incorrect responses.

(c) Few candidates gave a correct temperature range for the hot water bath; 37 °C was the most common incorrect response. Room temperature and 100 °C were also quite common.

(d) Many candidates chose the correct reagent and its initial colour. Biuret and red were common incorrect responses.

(e) Almost all candidates chose a suitable safety precaution and some explained its use. A significant number omitted what the precaution is protecting and / or what it is protecting against.

(f) Stronger candidates looked at both sets of results to identify the differences and then explained them. Stating what the results should have been, incorrect calculation of percentage and using a different testing solution were common incorrect responses.

(g) (i) Many candidates knew ethanol is part of the test but of these, many did not appreciate the need for water. All testing solutions were seen.

(ii) Many candidates gave a correct observation. Precipitate was a common incorrect response.

(iii) Although many candidates appreciated a fire risk, many did not name the chemical posing the hazard. Fat is flammable and there is no need to heat the experiment were common incorrect responses.

(iv) Candidates found this quite challenging. Not coloured, liquid, not liquid, soluble and not soluble were among a large range of incorrect responses.

Question 2 Growth of germinated seeds plan.

A small number of candidates omitted the question and the vast majority gained at least some credit.

The whole range of credit was seen and stronger candidates gave quite detailed answers with a significant number gaining full or almost full credit.

A small number of candidates discussed the germination of seeds rather than the growth of the shoots of seeds already germinated or varied the light conditions rather than the temperature.

Most listed some apparatus, usually soil or cotton wool. Few considered the need for the shoots to have light or described how the temperature would be changed.

The methods usually had at least two temperatures of hot and cold and had water given to the shoots at the start but few appreciated that the shoots would need to be watered regularly.

Measurements needed to be more specific, they were often vague such as see how much they've grown or measure the growth without specifying how this could be achieved and with what apparatus. Few appreciated that several seeds for each temperature or repeats are needed in order to make the results as valid as possible. Many measured after a few hours rather than after several days.

Most candidates could identify at least one control variable and many identified several.

If candidates decide to draw a graph, then they need to state what will be on each axis and then state how the pattern shown can be used to draw a conclusion.

Stronger candidates were able to link readings and temperatures to state how a conclusion could be made. Citing an expected conclusion e.g. seeds grow more quickly in the warm is not creditworthy.

Question 3 Identification of an unknown substance.

(a) (i) The test for carbon dioxide was well known. The tests for hydrogen and oxygen were amongst the incorrect responses.

(ii) Stronger candidates identified the anion. All common anions, cations and elements were seen as well as carbon, and a significant number omitted the question.

(b) (i) Stronger candidates knew the test for ammonia. Of those that used litmus, many described ammonia bleaching the litmus. All common ion tests were seen and a significant number omitted the question.

(ii) Stronger candidates identified the anion. All common anions, cations and elements were seen and a significant number omitted the question. Ammonia was also a common response.

(iii) Almost all candidates chose a suitable safety precaution and some explained its use. A significant number omitted what the precaution is protecting and / or what it is protecting against.

(c) (i) Stronger candidates identified the cation. Calcium, aluminium and chloride were common responses but most common anions and cations were seen. A significant number omitted the question.

(ii) Many candidates appreciated the role of the distilled water. Common incorrect responses included: to dissolve, neutralise or react with the residue or non-distilled water reacts with the residue.

(iii) Good diagrams were often drawn with a ruler and had clear labels to the filter paper and the filter funnel. Non-creditworthy responses included holes in the filter paper, a filter paper with no funnel, a filter funnel with no filter paper, a flat filter paper or labelling filter rather than filter funnel or funnel.

Question 4 Effect of length of magnesium on temperature rise of a reaction.

(a) The majority of candidates recorded all three temperatures correctly. The most common error was omitting the .0 in the first two readings. A small number gave 30.05.

(b) Most candidates subtracted the values correctly. A small number subtracted successive values in column 3.

(c) (i) Candidates found this challenging and a significant number omitted the question. Common incorrect responses included acid, ammonia, silver nitrate and bleached.

(ii) Candidates found this a little challenging. The results for 10 mm because the temperature rise is the smallest, and 50 mm because the temperature rise is the largest or draw a graph and see if it is a straight line were common incorrect responses and a significant number omitted the question.

(d) Many candidates described the relationship correctly. The most common error was to describe the temperature rather than the temperature rise.

(e) Many candidates could cite at least one control variable. Length of ribbon, time and temperature were common incorrect responses.

(f) (i) Candidates found this very challenging. Parallax error, misreading the thermometer, not stirring, acid dilute or incorrect room temperature were all common incorrect responses.

(ii) Candidates found this very challenging. Incorrect responses included: use stronger acid, repeat and calculate average, more volume, less volume and warmer laboratory temperature.

Question 5 Measuring the spring constant of a spring.

(a) Candidates found this a little challenging with many measuring at 4.3 cm or measuring to the end of the loops.

(b) Many candidates measured the length and subtracted the values correctly. Common incorrect lengths included 11.46 and 11.

(c) Most calculated the value correctly, many as an error carried forward from an earlier incorrect value.

(d) A large number of candidates transcribed the stop-watch reading rather than recording the value to one decimal place.

(e) (i) Many candidates calculated the value correctly, often as an error carried forward from an earlier incorrect value.

(ii) Many candidates calculated the value correctly. Some doubled rather than squaring.

(f) The majority of candidates calculated the value correctly.

(g) Candidates found this more challenging and a significant number omitted the question. Some stated agreement or disagreement but did not explain their answer and many did not appreciate that values can be numerically different but close enough to be within the limits of experimental error.

(h) Candidates found this more challenging than usual. Look directly at the ruler, look parallel to the ruler, measure on a flat surface or lay it flat were common non-creditworthy responses.

(i) Many candidates repeated the question stem and said to make the value more accurate. Other incorrect responses included removing the reaction time error and the period of oscillation changing with time.

Question 6 Cooling hot water.

(a) The majority of candidates drew a correct reading but a significant number omitted the question. 85.0 was a common response.

(b) The units were well known. The most common incorrect response was min.

(c) (i) Although most candidates labelled the axes with the quantity, units were often omitted. The axes were quite often reversed. Some candidates ignored the values at the bottom left-hand side of the graph and started from the origin; as a consequence the plotted points did not cover at least half of the grid. The points were usually plotted correctly although 85.5 was often plotted at 80.5 or 87.5.

(ii) The majority of candidates drew a reasonable curve close to all of the points. However, incomplete erasing of earlier attempts makes lines appear disjointed or feathery. Some did not include 85.5 in their curve.

(d) Candidates found this a little challenging and a significant number omitted the question. **M** was frequently at the incorrect end of the line.

(e) Whilst many candidates calculated the value correctly, many did not round their answer correctly.

(f) (i) Almost all candidates chose a suitable safety precaution and some explained its use. A significant number omitted what the precaution is protecting and / or what it is protecting against.

(ii) Candidates found this challenging. Heating the laboratory or heating the water were common incorrect responses.

CO-ORDINATED SCIENCES

Paper 0654/62
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper. Candidates should have used standard laboratory apparatus and be able to read values from a variety of measuring instruments and record the values to the requested accuracy; this can also often be gleaned from the data already present in a table of results. Candidates should have performed identification tests on the range of substances detailed in the syllabus. Candidates should be able to draw clear and labelled diagrams of assembled apparatus. The bullet points in the planning question are there to help candidates structure their plan into the sections required.

General comments

Candidates from many centres demonstrated good understanding of practical knowledge and techniques. The reading of the instruments was of a good standard and calculations were done well. The standard of graph drawing was generally high although candidates need to remember that axes need to be large enough that the plotted points cover at least half of the grid. Candidates must read the questions carefully so that they answer what is being asked by the question. Undertaking practical work helps the candidates to interpret and evaluate experimental methods and results. Knowledge of identification tests for ions and gases was very limited.

Comments on specific questions

Question 1 Osmosis.

(a) (i) The unit was well known. A small number of candidates gave second/s.

(ii) Most candidates named a suitable piece of apparatus. Beaker, test-tube and dropping pipette were common incorrect responses.

(b) (i) Candidates found this a little challenging with many repeating the observations from the table rather than explaining them.

(ii) Candidates found this quite challenging. Water, glucose, brown and blue were common incorrect responses.

(c) (i) Almost all candidates gave a correct time.

(ii) Stronger candidates appreciated that the substance entering the bag in each case is the same. Same concentration, same temperature and same membrane were common non-creditworthy responses.

(d) Many candidates appreciated that the water was washing something off the bag, stronger candidates chose starch. Removing iodine, make the tubing semi-permeable and removing starch from inside the bag were common incorrect responses.

(e) The majority of candidates understood the effect of temperature on the results. A small number discussed a change of colour.

(f) Benedict's test was well known. A significant number of candidates omitted heating. A small number chose biuret or iodine.

Question 2 Biological drawing.

(a) Almost all candidates drew a large and detailed drawing. A few gave sketchy non-continuous outlines or omitted any centre detail.

(b) (i) Most candidates measured the line correctly. 430 and 4.3 were common incorrect responses.

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

(iii) Most calculated the magnification correctly. Some did not round their value correctly.

(c) (i) Biuret was well known. Iodine, ethanol and Benedict's were common incorrect responses.

(ii) Almost all those who chose biuret in **(c)(i)** gave the correct observation.

Question 3 Identification of an unknown substance.

(a) (i) Candidates found this challenging. Mixing the reactants, speeding up a reaction or repeating the solubility part of the stem were common non-creditworthy responses.

(ii) The test for carbon dioxide was well known**.** The tests for hydrogen, oxygen and various nutrients were amongst the incorrect responses.

(iii) Stronger candidates identified the anion. Many common anions, cations and elements were seen as well as carbon and carbohydrate, and a significant number omitted the question.

(iv) The cation was slightly more well known that the anion in **(a)(iii)**. Many common cations, anions and elements were seen as well as ammonia, and a significant number omitted the question.

(v) Many candidates appreciated the role of the distilled water. Common incorrect responses included: to react with the residue, to dissolve, react, neutralise or remove the residue.

(b) Stronger candidates identified the anion. Many common anions, cations and elements were seen and a significant number omitted the question.

(c) Good diagrams were often drawn with a ruler and had clear labels to the filter paper and the filter funnel. Non-creditworthy responses included holes in the filter paper, a filter paper with no funnel, a filter funnel with no filter paper, a flat filter paper or labelling filter rather than filter funnel or funnel. A significant number omitted the question.

Question 4 Effect of concentration on reaction times.

(a) (i) Most candidates gained full credit. A small number transcribed the results and did not round them to the nearest second.

(ii) Candidates found this challenging. Incorrect responses included difficult to see the end of the reaction, surface area cannot be controlled, less reliable and too reactive.

(iii) Many candidates could state one control variable but few could state two. Many discussed the concentration and volume of the acid or the type of magnesium.

(b) (i) Although most candidates labelled the axes with the quantity, units were often omitted. The axes were sometimes reversed. Scales were often non-linear or such that the plotted points did not cover at least half of the grid. A discontinuity part way through a scale is not appropriate. The points were usually plotted correctly.

(ii) Strong candidates drew a reasonable curve close to all of the points. Some joined the points with a ruler, drew multiple lines or erased earlier attempts incompletely making lines appear disjointed or feathery.

(c) The majority of candidates could give a simple relationship between volume and time although a significant number described rate. Few candidates described the non-linearity of the relationship.

(d) Stronger candidates gained credit. Being easier to measure or pour or restating the stem were the most common non-creditworthy response.

Question 5 Effect of length of a wire on resistance and power of a lamp.

(a) (i) Many candidates knew the symbol for a voltmeter, the most common errors being a rectangular box or running the wire through the meter. Connecting the meter into the circuit caused more difficulties with many connections in series and often nowhere near the lamp. A large number of candidates omitted the question.

(ii) Most candidates read both meters correctly. The ammeter was often read as either 1.8 or 2.0.

(iii) Units were well known. J, W, voltage and Ω were quite often seen in place of V or A and the units were sometimes reversed.

(iv) Candidates continue to find this very challenging. Many still think this is a safety issue to stop electric shocks or that the meters need to reset so the readings don't add up on each other. Accuracy was also often cited with no further explanation.

(b) (i) Most candidates calculated the value correctly. Some did not follow the pattern in the table and so gave their value to too many significant figures.

(ii) Most candidates described the relationship correctly. A small number thought it increased.

(c) (i) Most candidates calculated the value correctly. A small number gave 0.19.

(ii) Many candidates described an observation. Some discussed the changes in power, length or resistance and did not include an observation.

(iii) Candidates found this very challenging and few gained credit. Many stated yes and discussed power decreasing as the resistance decreases but did not address proportionality and so did not either calculate the ratio R : P or see that as one halves in value the other does not**.**

(d) Candidates found this a little challenging. Use a different wire, use a different bulb, use a different circuit were common non-creditworthy responses.

(e) This component was not well known. All common electrical components were seen.

Question 6 Planning

A small number of candidates omitted the question and the vast majority gained at least some credit.

The whole range of credit was seen and stronger candidates gave quite detailed answers with a significant number gaining full or almost full credit.

Many candidates suspended the spring and repeated with springs of different lengths. However, many discussed measuring the extension rather than measuring the initial and the stretched lengths. A significant number described a Hooke's Law style experiment with lengths measured as successive masses are added.

Many candidates identified one control variable, often the mass added to the spring.

Few described how to calculate the extension, repeated each experiment or plotted a graph of the results. Those that did plot a graph did not specify the quantities for each axis.

Some candidates gave a detailed table but it was common for the table to have columns for mass and extension. The raw data should have been the initial and stretched lengths of the springs. Units were often omitted.

Most candidates gave a prediction for their conclusion rather than explaining how they would use the results in order to formulate a conclusion. A prediction is not creditworthy.

CO-ORDINATED SCIENCES

Paper 0654/63
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques and to have carried out experiments similar to the ones shown in the paper and be able to draw apparatus. Candidates should have used standard laboratory apparatus and be able to read values from a variety of measuring instruments and record the values to the requested accuracy. Candidates should have performed identification tests on the range of substances detailed in the syllabus. The bullet points in the planning question are there to help candidates structure their plan into the sections which will gain credit.

General comments

Candidates from some centres demonstrated good understanding of practical knowledge. Candidates need to consider the number of significant figures required by calculations; however, calculations were a strength. The standard of graph drawing was quite high. Candidates must read the questions carefully so that they answer what is being asked by the question. Knowledge of identification tests for ions was limited.

Comments on specific questions

Question 1 The action of catalase.

(a) Most candidates read the time correctly. Some transcribed the value seen on the stop-watch.

(b) (i) Generally the graph was drawn well. Most scales were linear with the plotted points covering at least half of the grid. The plotting of the points was usually accurate. A small number reversed the axes or omitted to include the units.

(ii) Candidates found the curve quite challenging with many lines too far away from the points, drawn dot-to-dot, a ruler used or multiple lines. Not completely erasing an earlier attempt at a curve often leaves two curves or a feathery disjointed line. A small number drew a straight line.

(c) Almost all candidates gave a correct value from their graph; a small number did not indicate their working on the graph. The working is best shown with a horizontal line and a vertical line indicating the correct reading.

(d) (i) Candidates found this quite challenging. Rounding times to the nearest second, inaccurate timing, human reaction times and different sizes of potato were common non-creditworthy responses.

(ii) Almost all candidates could state one control variable and a significant number stated two. Non-creditworthy responses were often vague such as size of potato.

(e) The test for oxygen was quite well known. Incorrect responses included relighting a lighted splint and tests for hydrogen and carbon dioxide.

Question 2 Food tests.

(a) (i) The two food tests were generally quite well known. Common incorrect responses included: reversing the outcomes i.e. purple for biuret and yellow or brown for iodine; colourless was also common for iodine.

(ii) The nutrients were well known. A small number of carbohydrate and fats were seen.

(b) (i) Most candidates recognised Benedict's as a test for sugar but fewer gave the creditworthy reducing sugar.

(ii) The colour for high amounts of reducing sugar was better known than that for small amounts. The colours were sometimes reversed, low amounts was often orange or blue, large amounts sometimes yellow.

(c) The test reagent was quite well known. Common incorrect responses were biuret or both biuret and Benedict's.

Question 3 Identification of an unknown solid.

(a) Stronger candidates appreciated the role of stirring. Mixing the solid and liquid, speeding up a reaction or repeating the solubility part of the stem were common non-creditworthy responses.

(b) (i) The test for carbon dioxide was well known**.** The tests for hydrogen, oxygen and various nutrients were amongst the incorrect responses.

(ii) Stronger candidates chose the correct cation. All responses seen.

(c) Stronger candidates identified the anion and a significant number omitted the question. Common incorrect responses included sulfate, carbonate, hydroxide and chlorine.

(d) Stronger candidates justified the carbonate ion but fewer chose yes or justified the sulfate ion.

Question 4 Decomposition of sodium hydrogen carbonate.

(a) (i) Many candidates recognised the mismatch in significant figures. No repeats and mass increasing were common incorrect responses.

(ii) Most candidates subtracted the values correctly. A small number added the values

(b) Candidates found this very challenging. Many thought the water would react with the solid in the test-tube or cause its contents to shoot out of the tube.

(c) (i) Most candidates recorded the values correctly. A small number reversed the values.

(ii) Many candidates recognised the loss in mass. Many restated the question or stated that there was still some left to decompose.

(iii) The majority of candidates subtracted the correct two values. 0.11 and 0.64 were common incorrect responses.

(iv) The majority of candidates subtracted the correct two values. 0.11, 0.38 and 1.4 were common incorrect responses.

(d) The benefits of a blue Bunsen flame were well known. Some candidates reversed the flames.

Question 5 Planning.

(a) A small number of candidates omitted the question and the vast majority gained at least some credit.

The whole range of credit was seen and stronger candidates gave quite detailed answers with a significant number gaining full or almost full credit.

Many candidates described the basic set up of the electrolysis cell and also used a stopwatch or timer. Few gave the material of the electrodes or collected the gas by a workable method.

Many candidates counted bubbles, although these would be too fast to count, and fewer counted or measured for a fixed time or timed for a fixed number or volume. Many used at least two or three concentrations, and almost no candidates repeated each measurement for validity. If a graph is planned then five different concentrations should be used.

Most candidates identified at least one control variable, temperature being the most common.

Candidates who planned to draw a graph did not usually give the properties for the axes or discuss what could be concluded from a trend line.

Many candidates gave a prediction for their conclusion rather than explaining how they would use the results in order to formulate a conclusion. A prediction is not creditworthy.

Question 6 Resistance of lamp combinations.

(a) Most candidates knew the symbol for a voltmeter, the most common errors being a rectangular box or running the wire through the meter. Connecting the meter into the circuit caused more difficulties with many connections in series.

(b) Most candidates measured both meters correctly. A small number read the ammeter as 0.23 or 0.25.

(c) (i) Candidates continue to find this very challenging. Many still think this is a safety issue to stop electric shocks or that the meters need to reset so the readings do not add up on each other. Accuracy was also often cited with no further explanation.

(ii) Whilst most candidates calculated correctly, many did not give their values to two significant figures.

(iii) Unit of resistance was well known. R, V and J were common incorrect responses.

(d) Whilst most candidates appreciated that the statement was incorrect, stronger candidates showed this by calculation either by showing what the relationship is or by calculating the value of resistance if the relationship were nine and so gained credit. Weaker candidates did not calculate any value.

(e) Whilst many candidates chose the parallel circuit, only stronger candidates could explain their answer either in terms of the brightness of the lamps or by calculating the power for each circuit.

Question 7 Cooling water.

(a) (i) Whilst most candidates appreciated that the reading was 81.0, only stronger candidates looked at the pattern in the table and included the .0 in their value.

(ii) Stronger candidates gained credit. The most popular response was more accurate.

(iii) Units were well known. A very small number of other units were seen.

(iv) Stronger candidates appreciated the need for a uniform temperature. Many thought it was to increase the rate of the reaction.

(b) Almost all candidates calculated the value correctly. 68.5 and 110 were seen a small number of times.

(c) Almost all candidates calculated the value correctly.

(d) The majority of candidates discussed the lid reducing the rate of fall of temperature. A significant number only compared the two beakers with no reference to the lid.

(e) Almost all candidates chose a suitable safety precaution and some explained its use. A significant number omitted what the precaution is protecting and / or what it is protecting against.

(f) Many candidates insulated the beaker**.** Heating the water, cooling the room temperature and adding water were common incorrect responses.

(g) Most candidates identified a control variable; temperature unqualified was a common non-creditworthy response.