CO-ORDINATED SCIENCES

Paper 0654/11
Multiple Choice (Core)

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

General comments

Biology

The majority of candidates successfully selected the correct responses. It was noticeable that the questions involving interpretation of graphs or a Venn diagram were more of a challenge.

Chemistry

Candidates performed very well on **Question 14** and **Question 16**. **Question 18** proved most challenging for the candidates.

Physics

In the physics section candidates found **Questions 31**, **36** and **39** particularly challenging.

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Comments on specific questions

Question 3

While most candidates correctly identified that biuret turns purple in the presence of protein, a significant number chose blue, the starting colour.

Question 6

In this question on the digestive system, many candidates confused absorption and assimilation.

Question 7

About one third of candidates correctly identified phloem and xylem in both stem and root, and an equal number got both wrong.

Question 8

This question involved interpreting a Venn diagram. More than half the candidates incorrectly stated that oxygen was a product of aerobic respiration. Candidates need to be able to interpret data presented in a variety of ways.

Question 11

Candidates found it very challenging to interpret a normal distribution curve when it was used to choose the cows going forward in a breeding programme. Very few correctly selected those animals with the highest milk yield.

Question 13

Many candidates did not appreciate that after oxygen concentration had fallen in a river due to sewage release, it then rose again. This question again required candidates to interpret a graph.

Question 14

Candidates knew well the arrangement of particles in a solid.

Question 16

Candidates easily recognised the dot-and-cross diagram for water.

Question 17

Some of the stronger candidates chose the incorrect **D** rather than the correct answer, **B**. They are expected to be able to deduce the formula of simple compounds from diagrammatic representations.

Question 18

The incorrect **A** and incorrect **C** were chosen more often than the correct answer, **D**. Candidates are expected to know the electrode products for the electrolysis of concentrated aqueous sodium chloride.

Question 19

Some of the stronger candidates chose the incorrect **C** rather than the correct answer, **B**. They are expected to be able to recognise exothermic reactions from temperature change data, and that the greater the temperature increase, the greater the exothermic nature of a reaction.

Question 20

There was evidence that many candidates tried to guess the answer to this question. They are expected to understand that element X was acting as a catalyst, and that the transition elements often act as catalysts.

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Question 22

Some of the stronger candidates chose the incorrect **B** rather than the correct answer, **C**. They are expected to know how to use apparatus for simple paper chromatography, and that the ink spot is applied to a position above the solvent.

Question 23

Some of the stronger candidates chose the incorrect **B** rather than the correct answer, **C**. They are expected to know that elements in the Periodic Table are listed in proton (atomic) number order rather than nucleon number order.

Question 27

Some of the stronger candidates chose the incorrect **A** rather than the correct answer, **C**. They are required to know the uses of fractions obtained from petroleum by fractional distillation.

Question 28

This question on speed-time graphs was well answered.

Question 29

A density calculation was required here, and a large proportion of candidates found the volume by dividing the density by the mass, leading them to choose option **B**.

Question 30

Although most candidates appreciated that decreasing the force from the engine would reduce the work done, weaker students tended to think that increasing the distance moved by the car would have the same effect (option **B**).

Question 31

Candidates found this question particularly challenging. Wind energy was thought by many to be reliable at all times. Possibly nuclear fission was rejected because it was considered to be renewable.

Question 33

Option **B** was more popular here than the correct option **D**, with these candidates not appreciating that a gas at 65 °C must be above its boiling point.

Question 36

A large majority of candidates of all abilities opted for the single resistor, not recognising that the parallel combination had less resistance.

Question 39

Only one in four knew that both the magnetic poles and the current direction must change for the force to be unchanged.

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CO-ORDINATED SCIENCES

Paper 0654/12
Multiple Choice (Core)

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

General comments

Biology

This paper threw up a number of challenges with some of the questions. This was a small cohort of candidates, so results need to be interpreted with care.

Chemistry

No questions proved to be particularly easy or particularly difficult for the candidates.

Physics

The physics question that was found to be the most challenging was **Question 34**.

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Comments on specific questions

Question 1

Candidates found this question very straightforward.

Question 4

A majority of candidates chose an incorrect answer here. The answer chosen suggests that they misread the question, and assumed boiling had started after the amylase was added to the starch solution.

Question 6

While most candidates correctly identified the stomach as producing enzymes, a significant number then chose the gall bladder rather than the pancreas as their second enzyme producing organ. It is important to stress to candidates that the gall bladder simply stores the bile produced by the liver.

Question 7

Only about one third of candidates correctly identified phloem and xylem in both stem and root, and an equal number got both wrong.

Question 8

This question involved interpreting a Venn diagram. More than half the candidates incorrectly stated that oxygen was a product of aerobic respiration. Candidates need to be able to interpret data presented in a variety of ways.

Question 9

In this question, where candidates had to decide which way a root and shoot would grow in a germinating seedling kept in the dark, a majority decided both would grow downwards. It is important to stress that an absence of light does not make a shoot grow downwards, since it responds negatively to gravity, as well as positively to light.

Question 12

Half the candidates incorrectly stated that decomposers did not get their energy from dead plants, while plants got their energy from minerals. This question involved the use of a negative, and candidates need to be particularly careful interpreting such questions. It should be stressed that minerals never provide energy.

Question 14

The incorrect **D** was chosen more often than the correct answer, **B**. Candidates are expected to understand the use of crystallisation as a separation and purification technique, and that fractional distillation is used to separate a mixture of volatile liquids.

Question 17

Stronger candidates often chose the incorrect **D** rather than the correct answer, **B**. They are expected to be able to deduce the formulae of simple compounds from diagrammatic representations.

Question 18

Stronger candidates often chose the incorrect **A** rather than the correct answer, **B**. They are expected to be able to recognise exothermic reactions from temperature change data, and that the greater the temperature increase, the greater the exothermic nature of a reaction.

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Question 20

The incorrect **A** was chosen more often than the correct answer, **D**. Candidates are required to know that solutions that react with acids are basic and have pH values greater than 7.

Question 23

Stronger candidates often chose the incorrect **B** and the incorrect **C** rather than the correct answer, **A**. They are expected to know that an alloy is a mixture of a metal and another element, and to understand the properties of alloys.

Question 25

The incorrect **C** was chosen more often than the correct answer, **D**. Some of the stronger candidates chose the incorrect **A**. They are expected to know that metal oxides, e.g. lime, metal carbonates, e.g., limestone, and metal hydroxides are basic and therefore neutralise acids.

Question 29

A significant proportion of weaker candidates believed that a force could not change the size of a body, but could change its mass.

Question 31

This question on kinetic and gravitational potential energy was found to be very challenging, with the incorrect options **B** and **D** being popular. Even the stronger candidates chose **D**, believing that both forms of energy increase as the ball falls.

Question 32

This question was also found to be challenging by many, who did not appreciate that a gas at 65 °C must be above both its melting point and its boiling point.

Question 33

Often candidates did not recall convection as the process involved here; both conduction and radiation were popular choices.

Question 34

The topic here was the characteristics of the image in a plane mirror, and more candidates thought that it is formed on the surface of the mirror than behind it.

Question 39

Candidates need to ensure that they know that the fuse protects the cable from overheating, rather than the individual appliances.

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CO-ORDINATED SCIENCES

Paper 0654/13
Multiple Choice (Core)

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

General comments

Biology

The majority of candidates successfully selected the correct responses. This was a small cohort of candidates, so results need to be interpreted with care.

Chemistry

Candidates performed very well on **Question 22**. **Question 23** and **Question 25** proved most challenging for the candidates.

Physics

In the physics section question **38** and, particularly question **35** were most challenging.

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Comments on specific questions

Question 1

While all candidates correctly identified that a germinating seedling is growing, most did not also realise that it shows sensitivity. Candidates need to understand that sensitivity is shown by plants as well as animals.

Question 4

Candidates found this question on enzyme activity very straightforward.

Question 6

A slight majority of candidates realised that bile is stored in the gall bladder, but a substantial number believed it is stored in the liver. Attention needs to be drawn to the difference between production and storage.

Question 8

This question involved interpreting a Venn diagram. More than half the candidates incorrectly stated that oxygen was a product of aerobic respiration. Candidates need to be able to interpret data presented in a variety of ways.

Question 9

Many candidates confused the different neurones in this question on a reflex arc.

Question 18

The incorrect **C** was chosen more often than the correct answer, **A**, by stronger candidates. They are expected to understand that using acid of the same concentration results in the same initial rate of reaction.

Question 21

The incorrect **D** was chosen more often than the correct answer, **A**, by stronger candidates. They are required to know that Group VII elements, the non-metallic halogens, exist as diatomic molecules, and that they become darker in colour down the group.

Question 22

Candidates knew well that all metals conduct electricity. Some of the stronger candidates chose the incorrect **D** rather than the correct answer, **B**. They are required to know that the Group I metals have low densities, and so not all metals have high densities.

Question 23

The incorrect **A** and incorrect **B** were chosen more often than the correct answer, **D**. Candidates are expected to know the use of blue cobalt(II) chloride paper as a test for the presence of water.

Question 24

The incorrect **B** was chosen more often than the correct answer, **C**, by stronger candidates. They are expected to know that respiration and combustion of ethanol produces carbon dioxide. They should also know the products of reactions between acids and metals or metal oxides.

Question 25

The incorrect **A**, incorrect **B** and incorrect **D** were chosen more often than the correct answer, **C**. Candidates are expected to know that lime is a metal oxide and therefore basic. They should also understand that limestone is an insoluble substance.

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Question 29

Although a majority of candidates answered this question correctly, a significant number thought that a body that is not subject to a resultant force must be at rest.

Question 31

The topic here was transfer of thermal energy, and many believed the process involved within the water to be conduction.

Question 33

Option **A**, showing the light being refracted away from the normal in the glass, was more popular than the correct option **C**.

Question 34

The incorrect option **A** was the most popular choice; half of the stronger candidates believed that television remote controllers use gamma rays.

Question 35

This question was widely found to be challenging, with every incorrect option being more popular than the correct **D**. Although just over half appreciated that switch Q must be closed, very few understood that switch P must also be closed if **only** lamp X is to be lit.

Question 37

Here almost one in four thought that the fuse protects the individual appliances from overheating, rather than the cable.

Question 38

The pattern of magnetic field lines around a current-carrying wire was not recognised by many, with option **D** proving most popular.

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CO-ORDINATED SCIENCES

Paper 0654/21
Multiple Choice (Extended)

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

General comments

Biology

This paper was generally well answered.

Chemistry

Question 20 proved most challenging for the candidates.

Physics

In the physics section generally candidates found **Questions 29**, **31**, **34** and **37** challenging.

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Comments on specific questions

Question 5

About half the candidates correctly answered this question, a significant number believing that meiosis would be limited by insufficient magnesium.

Question 9

This question was about vasoconstriction and vasodilation in response to environmental temperature. Although most candidates correctly decided whether vasoconstriction or vasodilation was involved, many believed that the capillaries, rather than the arterioles were involved. The difference between where something happens, and where it has an effect needs to be stressed to candidates.

Question 12

This question involved some very simple mathematics regarding energy transfer between levels in a food chain. About a quarter of candidates got the calculation correct. In order to answer correctly they need to understand the different terminologies used in a food chain.

Question 13

Answers here were fairly evenly split between the correct answer, and two others, suggesting that a number of candidates were guessing. The question involved putting the stages of eutrophication in order, which could have been challenging.

Question 17

There was some evidence that many candidates tried to guess the answer to this question. They are expected to be able to deduce the number of moles (of helium) from the stated mass and relative atomic mass. They should also realise that the number of atoms in one g of hydrogen is the number of atoms in one mole. Using this, they should then be able to deduce that there are 0.25 moles of helium, and that this contains $1.5 \cdot 10^{23}$ atoms.

Question 20

This question was found to be challenging. Candidates chose the incorrect **B** more often than the correct answer, **A**. Some stronger candidates chose the incorrect **D**. They are expected to be able to recognise redox reactions from reaction equations. In equation 1 they should recognise that sodium is being oxidised, and in equation 2 that sodium ions are being reduced. They are expected to be able to define and recognise redox in terms of electron transfer, and the most able candidates should be able to deduce there is no electron loss or gain in equation 3.

Question 28

A large majority of candidates were aware that the resultant force on the car was 4.0 N, but a significant proportion of them calculated the acceleration by dividing the acceleration by the mass (option **A**).

Question 29

In this question on Hooke's law many candidates believed that the extension-load graph must be a curve, therefore choosing either option **A** or option **C**.

Question 31

The slightly unusual form of this question about efficiency was found challenging, with option **C** proving a more popular choice than the correct option **D**.

Question 33

Approximately the same number of candidates chose options **B** and **D** here, half of these confusing a transverse with a longitudinal wave.

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Question 34

The topic here was critical angle and total internal reflection. The incorrect option **B** was a considerably more common choice than the correct option **C**. Although both the angles in these options were above the critical angle, only option **C** stated that total internal reflection occurred as a result.

Question 38

Here almost one in three thought that the fuse protects the individual appliances from overheating, rather than the cable.

Question 39

The device shown here was more commonly thought to be an a.c. generator than the d.c. motor that it was.

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CO-ORDINATED SCIENCES

Paper 0654/22
Multiple Choice (Extended)

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

General comments

Biology

This paper was generally well answered.

Chemistry

Candidates performed very well on **Question 26.**

Physics

In the physics section **Question 28** was particularly well answered, and only **Question 32** was widely found challenging.

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Comments on specific questions

Question 2

Candidates found this question very straightforward.

Question 4

In this question candidates had to choose which graph illustrated the amount of starch remaining in a starch amylase mixture incubated to 100 °C. Equal numbers chose the correct answer, and an answer that would have been correct for a mixture incubated at slightly more than body temperature, suggesting that they had not realised that such a high temperature would completely denature the enzyme.

Question 13

The question involved putting the stages of eutrophication in order, and could have been challenging. A majority of candidates correctly identified the first stage, but got confused after that.

Question 18

Candidates chose the incorrect **D** more often than the correct answer, **C**. They are expected to know the electrodes products that form during the electrolysis of aqueous copper(II) sulfate using inert electrodes, as well as the reactions occurring at the electrodes. They should know that hydroxide ions are oxidised at the anode forming gaseous oxygen.

Question 23

There was some evidence that some candidates did not understand the information given in this question. However, there was enough information for them to deduce that Y was an alloy, rather than an ionic compound.

Question 26

Candidates easily recognised the displayed structural formula for ethane.

Question 28

A large majority of candidates understood that it is only the mass of a body that cannot be changed by a force.

Question 29

In this question on Hooke's law, whilst recognising that the extension-load graph must be a straight line, weaker candidates failed to subtract the unstretched length of the spring from its extended length to determine its extension; this led them to choose the incorrect option **B**.

Question 30

The weaker candidates guessed when confronted with calculating the effect of the two changes.

Question 31

Answering this question about evaporation was found to be straightforward.

Question 32

Candidates need to ensure that they understand the process of thermal conduction in a metal. The incorrect options **B** and **D** were both more commonly chosen than the correct option **C**, even by stronger candidates.

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Question 34

The topic here was critical angle and total internal reflection. The incorrect option **B** was almost as popular as the correct option **C**. Although both the angles in these options were above the critical angle, only option **C** stated that total internal reflection occurred as a result.

Question 36

Weaker candidates often took into account only the length doubling, leading them to choose option **C**.

Question 39

It was widely believed that a step-down transformer reduces the current by the same factor as the voltage, causing many candidates to opt for **A**.

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CO-ORDINATED SCIENCES

Paper 0654/23
Multiple Choice (Extended)

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

General comments

This paper was generally well answered.

In the physics section **Questions 32**, **33**, **34** and **35** were widely found challenging.

Comments on specific questions

Question 5

Just over half the candidates correctly answered this question, a significant number believing that meiosis would be limited by insufficient magnesium.

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Question 10

Candidates found this question very straightforward.

Question 12

This question involved some very simple mathematics regarding energy transfer between levels in a food chain. About a third of candidates got the calculation correct. In order to answer correctly they need to understand the different terminologies used in a food chain.

Question 17

There was evidence that some of the stronger candidates guessed at the answer to this question. They are expected to be able to relate mass and volume to the number of moles of a substance, and, using molecular formulae, to be able to deduce the number of moles of each atom within the stated amount of substance.

Question 18

There was evidence that some candidates simply guessed at the answer to this question, and that stronger candidates chose the incorrect **D** rather than the correct answer, **C**. They are expected to know the products formed at the electrodes during electrolysis of concentrated aqueous sodium chloride, and that since metallic sodium is not a product, the concentration of sodium ions in the solution does not change. They should also understand that since chlorine gas is formed from chloride ions, the concentration of these ions decreases during electrolysis.

Question 23

There was evidence that some of the stronger candidates guessed at the answer to this question. They are expected to know the general properties of all metals, e.g., that they conduct electricity and are malleable. They are also expected to know the specific physical properties of Group I metals, e.g., that they are soft and have low densities, and of the transition metals, e.g., that some of these, such as copper, are relatively unreactive.

Question 28

Although a majority of candidates answered this question correctly, a significant number thought that a body that is not subject to a resultant force must be at rest.

Question 29

In this question on Hooke's law, whilst recognising that the extension-load graph must be a straight line, a significant number of candidates failed to subtract the unstretched length of the spring from its extended length to determine its extension; this led them to choose the incorrect option **B**.

Question 30

One in three candidates believed kinetic energy to be directly proportional to speed, rather than to the square of speed.

Question 31

In this question on power many simply multiplied the power in kW by the time, arriving at option **B**.

Question 32

This question was found to be challenging. The topic was critical angle and total internal reflection, and the incorrect option **B** was by far the most popular choice. Although, like options **C** and **D**, this gave an angle greater than the critical angle, only option **C** stated that total internal reflection occurred as a result.

Question 33

Here again candidates had difficulty, with a large number thinking that all virtual images can be produced on a screen.

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Question 34

Two thirds of candidates opted for **A** or **B** as the current-voltage characteristic of a filament lamp. Although both of these showed a positive correlation, **A** was for an ohmic resistor (a very popular choice) and **B** curved in the wrong direction.

Question 35

This question was found challenging by many candidates, with the incorrect option **C** being much more popular than the correct **D**. Although two out of three appreciated that switch Q must be closed, most of these did not understand that switch P must also be closed if **only** lamp X is to be lit.

Question 37

A common misconception was that the fuse protects the individual appliances from overheating, rather than the cable.

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CO-ORDINATED SCIENCES

Paper 0654/31
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 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 marks on any question but very few gained full marks 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.

Candidates need to ensure that their responses answer the question completely. They should be reminded to read the stimulus material and each question carefully and complete all the instructions contained within the question to be able to access the maximum marks available.

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

Comments on specific questions

Question 1

(a) (i) To gain marks the label lines need to be clear. For example, the label line to the lumen needed to end somewhere inside the lumen.

(ii) Valves were the structures present in veins that were not visible in **Fig. 1.1**. Many candidates suggested blood.

(b) Few candidates gained full credit. The idea that capillary walls are only one cell thick was known by some candidates. Other candidates suggested that the capillary was one cell thick. Ideas about the difference in size of the lumens need to be more clearly expressed.

(c) Most candidates gained some credit. The renal vein was the least well known.

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Question 2

(a) The meaning of proton number was not well known. Candidates should ensure that they know the difference between proton number and mass number. Candidates needed to state that the proton number is the number of protons in an atom rather than in an element.

(b) (i) Many candidates identified hydrogen as the gas released when Group 1 metals react with water. Carbon dioxide was frequently suggested.

(ii) Many candidates wrongly suggested that metal **Z** had the greatest proton number. Candidates who correctly suggested metal **X** needed to explain their answer in order to gain maximum credit.

(iii) Many different sequences were suggested. The most popular was **ZYX**, which was the correct response. **XYZ** was a popular incorrect response. Some candidates were able to explain their answer.

(c) (i) Candidates must read the question carefully. Many candidates described the preparation of oxygen rather than the test for oxygen.

(ii) Some candidates referred to a catalyst. Other candidates described the action of a catalyst. To gain full credit candidates needed to do both.

(iii) Many candidates were able to balance the equation. A common error was $4H_2O_2$.

Question 3

(a) (i) and **(ii)** Generally most candidates knew that the types of energy were gravitational potential energy and kinetic energy, but a number of candidates reversed them. Candidates should take care to refer to gravitational potential energy rather than potential energy.

(iii) Many candidates correctly multiplied the force by the distance. Some incorrectly divided force by distance. Candidates should ensure that they know the correct unit is Nm.

(b) (i) Visible light was usually written in its correct position.

(ii) Many candidates gained full credit, showing a good knowledge of the uses of electromagnetic radiation.

(iii) The most popular and the correct answer was radio waves.

(c) Most candidates gained some credit. A common error was to not convert the time into seconds and / or the distance into metres.

Question 4

(a) (i) Most candidates were able to identify either grass or dandelion plant as a producer.

(ii) The rabbit and mouse were both well known as herbivores.

(iii) Most candidates were able to complete the food chain. To gain full credit they also needed to use arrows to link the organisms to show the direction of flow of energy.

(b) This was well answered by many candidates. Many candidates wrote excellent explanations, but these were not necessary.

(c) Some candidates were able to give two reasons and other candidates often gave one correct reason. Popular responses were that there is less food for the snakes and that there is an increased predation of snakes.

(d) The Sun was well known as the principal source of energy for all food webs. Grass was a common error.

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Question 5

(a) Ionic bonding and covalent bonding were the most popular responses. Some candidates reversed them.

(b) (i) Graphite was known by some candidates. Common incorrect responses were solid, lattice and carbon monoxide.

(ii) Candidates found this challenging. They need to ensure that they can explain the differences between elements and compounds.

(iii) Many candidates gave a formula with the correct symbols C, H and O. Fewer candidates showed the correct numbers of each element. A number of candidates included Ar in their formula.

(c) (i) Many candidates identified the cathode and anode. Some candidates got them the wrong way round.

(ii) Bromine was identified by many candidates as the brown gas. There were no common wrong responses.

Question 6

(a) (i) Electrical energy and thermal energy were the correct responses and were often seen. Some candidates placed the words in the wrong place. Solar and kinetic were popular incorrect responses.

(ii) Wind energy was a popular and correct response.

(iii) Many candidates were able to suggest increasing the number of turns on the coil or increasing the current as ways of increasing the turning effect of the motor.

(b) (i) Candidates need to ensure that they know the function of a fuse. Many suggested that a fuse reduced the current in a circuit.

(ii) A 10 A fuse was the popular but incorrect response. Few candidates suggested a 13 A fuse and even fewer were able to explain why.

Question 7

(a) (i) Iodine was the most popular and correct response.

(ii) Some candidates knew both of the correct colours. The correct descriptions were changes to blue-black for a positive starch test and remains orange / brown for a negative starch test. It was insufficient to state that there was no colour change after testing part **B**.

(b) Some candidates gained full credit and many candidates gained partial credit. More candidates correctly placed light in the second gap than placed carbohydrates in the first gap.

(c) Many candidates were able to define diffusion and gain most of the credit. Few candidates referred to the random movement of the particles.

Question 8

(a) (i) Candidates often managed to get two correct responses which was awarded some credit. Few candidates had three correct responses for full credit.

(ii) Many candidates suggested test-tube **H** rather than test-tube **I**.

(b) The test for ammonium ions was not well known. There were a number of candidates who did refer to red or blue litmus and ammonia gas.

(c) (i) Many candidates suggested that the pH decreased. Some gained full credit by using the data in the question.

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(ii) Many candidates were able to find the volume of acid that produces a neutral solution. Some candidates gave clear explanations of how they did this.

(iii) The word equation was not well known. A common error was to have hydrogen as one of the products.

Question 9

(a) (i) Many candidates were able to draw the normal. A few candidates drew a dot or a very short line instead.

(ii) Some candidates drew very accurate reflected rays. A number of candidates drew reflected rays which did not reach any of the spectators.

(iii) A number of candidates were able to label the angle of incidence correctly.

(b) (i) Many candidates correctly answered 0 °C. Candidates also needed to state the unit of their answer.

(ii) Candidates needed to draw clear diagrams. The diagram for liquid water needed to contain about twelve similar sized particles in an irregular arrangement. All or most of the particles drawn needed to be touching other particles.

(c) Most candidates found it challenging to explain the observation. Responses should have referred to a larger area and so a smaller pressure.

(d) The density calculation was completed correctly by many candidates, showing good data handling skills.

(e) Some candidates were able to explain the reason for the rubber floor in terms of friction. A few candidates wrongly suggested that rubber would reduce the friction.

Question 10

(a) The sweat gland and blood vessel were not well known.

(b) (i) This was well answered by many candidates who were able to describe the skin temperature increasing to a maximum after 50 minutes and then decreasing.

(ii) Many candidates gained full credit for suggesting that sweating would occur and that hair on the skin lies flat. A few candidates described the breathing rate increasing. This was not accepted as the question asked about changes in the skin.

(c) (i) The brain was not well known as the organ in the body that coordinates the maintenance of a constant internal environment. A common error was suggesting the skin.

(ii) Homeostasis was not well known.

Question 11

(a) Some candidates correctly stated nitrogen and oxygen and also gave the correct percentage of each. Many candidates knew either oxygen or nitrogen. Many candidates suggested carbon dioxide.

(b) (i) The link between methane and natural gas was not known to many candidates.

(ii) Some candidates knew the limewater test for carbon dioxide. Some described the test for hydrogen gas.

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(c) (i) Some candidates gained credit for describing a hydrocarbon as containing carbon and hydrogen atoms. Few candidates mentioned the idea that a hydrocarbon contained only carbon and hydrogen atoms. Clearer and more detailed descriptions for a saturated compound were required. Candidates often wrote that a saturated compound had a single bond.

(ii) The products of the complete combustion of methane were not well known. Some candidates correctly responded with carbon dioxide. Few candidates suggested water. Hydrogen was a common wrong answer.

Question 12

(a) (i) Infrared was the most popular and the correct response given.

(ii) A few candidates suggested 8 minutes. Many other candidates suggested either 10 minutes or 16 minutes.

(iii) The effect of ionising radiation on living things was well known.

(iv) Some candidates were able to explain that sound waves need a medium to travel through. Many others suggested that sound produced on the Sun cannot be heard on Earth because the frequency is not within the human audible frequency range or that it is too far from the Sun to the Earth.

(b) (i) Some candidates drew very clear ray diagrams.

(ii) The term focal length was known to some candidates.

(c) (i) Many clear and correct circuit diagrams were drawn.

(ii) The resistance was correctly calculated by many candidates.

Question 13

(a) **R** was well known as the place where fertilisation occurs. **Q** was well known as the place where pollination occurs.

(b) Many candidates showed a good understanding of the features of fertilisation and pollination.

(c) Bees or insects were frequently given as an example of an agent of pollination.

(d) Some candidates gained full credit, usually for suggesting watering the seeds and keeping the seeds warm. A number of candidates vaguely suggested controlling the temperature, which was not accepted. Aeration of the soil was rarely mentioned.

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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 most 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 gained credit 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.

Candidates should be reminded to read the stimulus material and each question carefully and complete all the instructions contained within the question to be able to access the maximum marks available.

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

Comments on specific questions

Question 1

(a) (i) The white blood cell was well known.

(ii) Red blood cell was well known. A popular incorrect answer was platelets.

(b) (i) Day 12 was the only response given by candidates.

(ii) Candidates found this challenging. They needed to suggest that the decrease in the number of antibodies was due to the pathogen being destroyed.

(c) Many candidates were able to draw the line decreasing or remaining flat from day 15 to day 20. Fewer showed an increasing and then decreasing line after day 20.

(d) Blood clotting was well known as the function of platelets.

Question 2

(a) (i) Few candidates referred to electrons as having (virtually) no mass.

(ii) Many candidates were able to suggest argon as the element. Fewer explained why.

(iii) The idea that element **Q** has a full outer electron shell was well known.

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(b) (i) Clear and precise answers were needed here in order to answer the question.

(ii) Many candidates found this part challenging. Candidates answering the question usually suggested that the pH of the solution would be acidic.

Question 3

(a) The stopwatch was well known as a device used to measure time precisely.

(b) (i) Some candidates correctly placed **X** somewhere on the horizontal section. Many placed it where the girl was accelerating.

(ii) Many candidates placed **Y** at either t = 0 s or more often t = 110 s.

(iii) This part was well answered by many candidates who were able to explain that the gradient was steeper.

(iv) Many candidates incorrectly used distance = speed · time rather than using the area under the graph.

(c) (i) Most candidates gained at least partial credit and some gained full credit. The commonest errors were either to use a resistor symbol rather than either the switch or cell symbol or to add a lamp into the circuit.

(ii) Calculating the current was completed correctly by many candidates, who showed good data handling skills.

(iii) Both the minimum and maximum frequencies needed to be quoted. Few candidates gave both.

Question 4

(a) Many candidates gained most of the credit. A common error was to write enzymes rather than cells in the first gap.

(b) (i) **B** and **C** were well known as the letters representing respiration. Some candidates also suggested **D**.

(ii) Many candidates were able to draw an arrow linking carbon dioxide in the atmosphere and carbon in plants and to show the correct direction.

(c) Loss of habitat and extinction were the most popular correct answers.

Question 5

(a) (i) Sulfur oxide was not accepted as sulfur dioxide.

(ii) Many candidates gained some credit here – usually for either mentioning acid rain or for giving a consequence of acid rain.

(iii) Carbon monoxide and oxides of nitrogen were not well known as gases that form during the combustion of hydrocarbons in air. Many candidates suggested methane, hydrogen or oxygen.

(b) (i) Chromatography was quite well known as the method.

(ii) Candidates need to be able to describe the process. Many found this challenging.

(iii) Candidates found this challenging, a few candidates were able to draw the results for dye **P**. Candidates needed to get the shape, shading and position correct for each dye.

(iv) Some candidates were able to suggest a possible reason why the impurities in food dyes needed to be removed before the dyes were used to colour food.

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Question 6

(a) (i) Candidates need to ensure that they know the correct formula to calculate the density.

(ii) Most candidates correctly determined the weight of a wooden cube.

(b) (i) Candidates found this challenging. They needed to be able to relate the centre of mass to the instability of the tower.

(ii) Many candidates were able to relate an increase in distance to an increase in work done.

(iii) Gravitational potential energy was well known. A few candidates referred to potential energy. This was not precise enough to be accepted as a correct response.

(c) Many candidates did not double the distance and determined the speed of sound as 156 m / s rather than 312 m / s.

Question 7

(a) (i) Candidates need to ensure that they know both of the correct colours. The correct descriptions were changes to blue-black for a positive starch test and remains orange / brown for a negative starch test.

(ii) Light was well known as the factor being investigated. Sunlight was also accepted but not the Sun.

(b) Most candidates gave general answers in terms of plant nutrition and growth. References to chlorophyll production and photosynthesis were required.

(c) (i) Candidates often mentioned roots but there were few references to root hair cells. Osmosis was rarely mentioned.

(ii) Candidates found this challenging. Few mentioned any of three processes involved (transpiration, evaporation and diffusion). Candidates who did mention evaporation sometimes incorrectly suggested that the evaporation occurred through the stomata.

Question 8

(a) (i) Electrolysis was the correct and most popular response. Many other processes were suggested.

(ii) To gain credit candidates needed to use precise labelling. The label needed to stop at the correct point rather than two or three millimetres away.

(iii) Hydrogen was correctly suggested as a useful gaseous element produced during the process. Chlorine was also an accepted response but not chloride.

(b) (i) Some candidates correctly suggested sodium oxide.

(ii) The idea that alkanes are unreactive and do not react with sodium was not well known.

(c) (i) Seven was the correct and most popular response for the pH. Few candidates gave the colour as green.

(ii) The test for hydrogen gas was quite well known.

(d) (i) Covalent bonding was frequently incorrectly suggested as the type of bonding in sodium bromide.

(ii) Many candidates incorrectly suggested 4 NaBr.

Question 9

(a) (i) Protons and neutrons were commonly suggested as the two types of particle in the nucleus of an atom.

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(ii) Candidates need to ensure that they know the definitions for proton number and nucleon number. Many got this the wrong way round , suggesting that 6 represented the proton number and 3 represented the nucleon number.

(iii) Candidates found this challenging, few gave the simple answer that the proton number was the same. A number stated the correct definition of an isotope.

(b) (i) Visible light was usually placed in the correct position.

(ii) The volt as the unit of e.m.f. was not well known.

(c) Most candidates were able to identify the three states of matter.

Question 10

(a) (i) Many candidates gained full credit here, showing a good understanding of reflex arcs.

(ii) Most candidates correctly suggested automatic and rapid as the two words used to describe a reflex action.

(b) Candidates found this challenging, they needed to be able to describe how impulses are passed along a neurone in the form of an electrical signal.

(c) Brain and spinal cord were well known as the two parts of the central nervous system. Neurones and nerves were sometimes suggested incorrectly.

(d) A gland was not well known as an example of an effector. Bones were often suggested.

Question 11

(a) (i) Fractional distillation was not well known as the process shown. Combustion was often suggested.

(ii) Candidates found this challenging, they needed to be able to explain that fractional distillation involves a physical change because no new substances are produced.

(iii) The uses of refinery gas and bitumen were not well known.

(b) Candidates found this part very challenging. They needed to understand the idea that a pure substance has a single boiling point but a mixture will boil over a temperature range.

(c) (i) Some candidates were able to complete the dot-and-cross diagram. Candidates also needed to show the chemical symbols of the elements.

(ii) Candidates needed to understand that a saturated hydrocarbon contains only single bonds.

(iii) A number of candidates correctly identified ethene as the unsaturated hydrocarbon.

Question 12

(a) Evaporation was well known as the process.

(b) (i) Candidates needed to explain that light is refracted due to a change in speed.

(ii) The angle of incidence was sometimes correctly labelled. Many other angles were suggested.

(c) Most candidates gained at least some credit for identifying one term correctly. Some scored full credit showing a good understanding of the terms.

(d) (i) The speed decreasing was well known. A few candidates suggested that the swimmer would stop or move backwards.

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(ii) Moving at a constant speed was well known. Some candidates suggested that the swimmer would stop.

(e) Candidates needed to explain the link between the molecules moving further apart and expansion of the liquid.

Question 13

(a) Many candidates gained at least some credit usually for correctly identifying part **A** as the petal and giving a correct function.

(b) Candidates needed to mention either pollen or ovule in their description of fertilisation in plants.

(c) Candidates needed to know that a zygote is formed by the fusion of the nuclei of gametes.

(d) Most candidates knew how many parents were needed for both asexual and sexual reproduction.

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CO-ORDINATED SCIENCES

Paper 0654/33
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 most 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 gained credit 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.

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.

Comments on specific questions

Question 1

(a) (i) The septum was not well known as structure **X.** The aorta was often suggested incorrectly.

(ii) A valve was quite well known as the structure that ensures one-way flow of blood. A ventricle was a popular incorrect answer.

(iii) Candidates found this challenging. Few indicated correctly where the blood enters the heart from the lungs.

(b) All four components of blood were well known and many candidates gained most of the available credit. Platelets and plasma were the least well known components.

(c) Xylem and phloem were well known.

(d) Most candidates gained some credit. Diffusion and evaporation were often confused.

Question 2

(a) Many candidates gained full credit.

(b) Many candidates gained full credit. A common error was to give boron 11 electrons.

(c) This part was well answered with candidates drawing clear diagrams.

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(d) (i) Candidates found this challenging and were not able to identify apparatus **F** as a burette.

(ii) Some candidates named hydrochloric acid as the acid. Very few candidates named sodium hydroxide as the alkaline solution.

(iii) Few candidates correctly suggested a pH between 7 and 14. More candidates incorrectly suggested an acidic pH value.

Question 3

(a) (i) Most candidates were able to gain some credit. The commonest error was to suggest that the stone falls with increasing acceleration due to gravity.

(ii) Most candidates were able to complete the calculation to determine the speed of the stone.

(iii) Candidates found this question challenging; most candidates answered with gravity or weight rather than the Earth.

(b) (i) Many candidates were able to explain that the stone slowed down.

(ii) Most candidates were able to determine the remaining kinetic energy of the stone.

(c) (i) Candidates found this challenging; very few gained credit. Very few mentioned a turbine or a generator.

(ii) This was quite well answered. Many candidates were able to describe the contraction of the cables.

(iii) Candidates found the question challenging. The idea that the resultant turning effect on the pylons is zero was not known.

Question 4

(a) (i) Many candidates were able to suggest why the cress seeds in test-tubes **A** and **B** did not germinate. A few candidates were not awarded some of the available credit because of their vague responses. For example, “it was not at the right temperature” was not accepted as “too cold”.

(ii) This question was well answered.

(b) The word equation for respiration was well known. A few candidates mixed up reactants and products.

(c) Many candidates were able to indicate some of the uses of the energy released by respiration. Growth was commonly suggested.

(d) Sensitivity and movement were well known characteristics of living things.

Question 5

(a) (i) Alloy was not well known. Compound was a common incorrect answer.

(ii) This part was well answered. Most candidates gained some credit.

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(iii) Transition element / metal was well known. There was no common incorrect response.

(b) Many candidates got this the wrong way round.

(c) Many candidates were able to describe either oxidation or reduction using substances involved in the reaction. Few managed to describe both ideas.

Question 6

(a) (i) Many candidates were able to describe a sensible method to determine the polarity of the magnet.

(ii) Many candidates gained some credit. Some candidates were not awarded some available credit because the direction of the magnetic field was incorrect.

(b) Candidates needed to be able to describe the relationship between frequency and pitch and between amplitude and loudness.

(c) Both the minimum and maximum frequencies needed to be quoted. Few candidates knew both.

Question 7

(a) Most candidates were able to complete the table correctly by indicating test 1 only. The common error was to suggest test 3 which was light but no carbon dioxide.

(b) Most candidates knew both the test for starch and the positive result.

(c) Many candidates were awarded the majority of the available credit for referring to diffusion and describing oxygen moving from a higher concentration to a lower concentration.

(d) (i) Many candidates identified **D** (chloroplast) as the site of photosynthesis. Popular incorrect answers were the cytoplasm or nucleus.

(ii) Many candidates were able to identify the part they suggested in **(d)(i)**.

(iii) Most candidates correctly named two parts of plant cells that are also present in animal cells. Commonly these were cell membrane and nucleus.

Question 8

(a) (i) The question asked candidates to use their knowledge of the amounts of nitrogen and oxygen in the air to suggest the percentage of the section labelled other gases. Some candidates did this effectively. Others attempted to estimate percentages from the angle shown on the pie chart.

(ii) Some candidates suggested a noble gas. Many other elements were suggested and some compounds.

(iii) A good number of candidates correctly referred to a full outer shell of electrons being responsible for the lack of reactivity.

(iv) The expected answers were sulfur dioxide, carbon monoxide and nitrogen oxides. These were frequently suggested but carbon dioxide was the most popular response.

(b) (i) Electrolyte was well known.

(ii) Hydrogen gas was not well known as the gas produced at the cathode. Oxides of sulfur were commonly incorrectly suggested.

(c) (i) The word equation was not completed correctly by most candidates. Calcium chloride was not well known and few candidates were able to suggest both carbon dioxide and water.

(ii) The simple calculation was usually correct.

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(iii) Few candidates were able to suggest conditions that would reduce the rate of reaction. Candidates need to make sure that they state clearly whether the condition they suggest changing is increased or decreased.

Question 9

(a) (i) Alpha radiation was quite well known. Beta and gamma were frequently incorrectly suggested.

(ii) The idea of background radiation was not well known.

(b) Many candidates showed some constructive working on the graph and some candidates were able to correctly determine the half-life as one hour.

(c) (i) Many candidates chose an ammeter symbol rather than a voltmeter symbol and many placed the component in series rather than in parallel.

(ii) The idea of the current increasing was well known.

(iii) Most candidates correctly described an electric current as a flow of electrons.

Question 10

(a) (i) Most candidates showed good data handling skills and described the pattern in the results.

(ii) Many candidates worked out that the difference was 5000 km^2. Fewer were able to calculate the percentage decrease in the area of land cleared.

(b) The answer needed to include a reference to the combustion of (fossil) fuels. Vague references to using cars or respiration were insufficient to be awarded credit.

(c) (i) Many candidates gained some credit here. There was no common error.

(ii) The spread of disease was commonly given as a harmful effect of untreated sewage. None of the other answers given in the mark scheme were seen.

Question 11

(a) Most candidates were able to explain why ethanol is not a hydrocarbon. The candidates either gave a definition of a hydrocarbon or explained that ethanol contained oxygen.

(b) (i) Many candidates suggested that the hydrocarbons **L** and **P** were alkenes.

(ii) Candidates should ensure that they know the chemical test for an alkene. The most common response was cracking.

(c) (i) Substance **U** was rarely identified as water or steam. Many candidates suggested either oxygen or hydrogen.

(ii) The purpose of a catalyst in a reaction was well known.

(d) (i) Very few candidates suggested fermentation as the process. Distillation was the common response.

(ii) This was well answered. Many candidates used the information in the question to suggest that the gas was carbon dioxide.

(iii) Distillation was well known as the method used to separate ethanol from the aqueous solution.

Question 12

(a) (i) Candidates needed to suggest that the atoms would vibrate faster rather than just move faster.

(ii) Some candidates correctly suggested that a ceramic rod is an electrical insulator.

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(iii) Candidates need to ensure that they are familiar with methods of thermal energy transfer. Many candidates suggested exothermic or kinetic energy or the air, rather than convection and radiation.

(b) (i) Most candidates showed a good understanding of electrical safety.

(ii) This part was well answered. Many candidates correctly suggested 13 A.

(iii) Few candidates knew the function of a fuse. Many suggested that a fuse reduced the current in a circuit.

(c) (i) Many candidates placed visible light in the correct position. Fewer candidates placed infrared in the correct position.

(ii) The definition of frequency was well known.

(d) Most candidates were able to calculate the combined resistance of the two heating elements in series.

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CO-ORDINATED SCIENCES

Paper 0654/41
Theory (Extended)

Key messages

The performance of individuals highlights the value of allowing time to check answers. This would permit the correction of mathematical errors, checking that responses match the requirements of the question in terms of information required and marks awarded, and that questions have not been omitted. Candidates should pay particular attention to questions without an answer line requiring an addition to a diagram on the paper.

General comments

Many candidates had been well prepared for this paper. They were most successful where they had become familiar with the detail of the syllabus especially where definitions and principles have been prescribed. Handwriting, use of English, and mathematical skills were generally good. More care could have been taken by some in their presentation and labelling of diagrams. Candidates should be reminded that labels should use a label line which touches the target item, and no other, and placed in an area where there is likely to be no ambiguity.

Comments on specific questions

Question 1

(a) Many candidates could define anaerobic respiration.

(b) Most knew an advantage of aerobic respiration. Some suffered from the misconception that respiration is a process that requires energy input to the metabolic process.

(c) (i) Increased oxygen consumption was often explained by increased breathing rate or increased respiration. The connection with the increased need for energy for more muscle contraction was established by a few candidates.

(ii) The recovery time was usually read correctly from the graph.

(iii) Many could explain recovery time by the need to repay oxygen debt or to remove lactic acid. The role of anaerobic respiration was sometimes included.

Question 2

(a) The values for the composition of clean air given in the syllabus were usually recalled accurately.

(b) (i) Most candidates knew that a nitrogen molecule has a triple bond and drew the correct electronic structure.

(ii) The high reactivity of nitrogen atoms was often correctly explained in terms of the incomplete valence shell. The best responses linked the strength of the triple bond with the low reactivity of nitrogen molecules.

(c)(i) Most explained that bonds between a metal and a non-metal are ionic and that bonds between non-metals are covalent.

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(ii) The best explanations for the high melting point of ionic compounds mentioned the energy required to overcome the strong bonds between ions. A few correctly described the bond as the attractive force between oppositely charged ions.

(iii) The formula of magnesium nitride was often deduced with reference to charge balance. Some responses gave the formula as MgN^{-}, attempting to explain that charges were cancelled. Explanations involving diagrams of arrows drawn between superscript and subscript were not accepted.

Question 3

(a) (i) The direction of the convection current in the oven was usually correct.

(ii) Some knew that convection was the main method of energy transfer, with radiation often suggested.

(iii) A few descriptions of the conduction process included the increased vibration of particles near the source of heat. Others implied that particles start to vibrate when heat energy is supplied. Many apparently knew that these enhanced vibrations are passed between particles but found this difficult to express.

(b) (i) Successful demonstrations of how the value for resistance is obtained included the formula used and the working in every stage in the calculation.

(ii) Most candidates realised that the combined resistance of the second pair of hotplates would have the same value as the first.

(c) (i) Almost all candidates knew the boiling point of water.

(ii) Most descriptions of the differences between liquid water and steam included some valid points. Responses where most credit was awarded were those where answers were structured to show the differences in terms of the forces between molecules, the distances between molecules, and the motion of molecules. It was not appropriate to compare the speed of molecules in water and steam, as they have different degrees of freedom of motion and, in the context of this question, would be at the same temperature.

Question 4

(a) The blind spot was identified by some. It was often confused with the fovea.

(b) Candidates awarded the most credit could identify the parts of the eye and state that the iris controls how much light enters the eye rather than simply describing its action, and that the lens focuses light on the retina rather than simply producing an image.

(c) Those who gave complete descriptions of the changes that that take place in the eye used the correct terminology for the ciliary muscle relaxing, the suspensory ligaments tightening and the lens becoming thinner.

Question 5

(a) Most knew that limestone reduces the acidity of soil. It was not appropriate to describe it as a fertiliser.

(b) Some candidates selected the correct types of energy to define an endothermic reaction.

(c) (i) Most knew the general equation for neutralisation.

(ii) A few candidates were familiar with the definition of acids and bases in terms of proton transfer.

(d) Many identified the neutral oxide and some the basic oxide. The amphoteric oxide classification was less well known.

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(e) The balanced equation for the reduction of copper oxide was usually written correctly. State symbols also needed to be included. A common error was to show carbon as a gas.

(f) This question requiring an explanation for calcium not being extracted by carbon was answered well.

Question 6

(a) A few candidates showed understanding of induced magnetism. There were many references to charged nails.

(b) (i) The strongest responses defined an isotope as a form of an element with atoms which have the same number of protons and different numbers of neutrons. Many candidates gained credit by stating that isotopes have the same number of protons and different numbers of neutrons, while some described them as different elements.

(ii) Several candidates completed the decay equation correctly. Credit was awarded for using the nuclide notation for the β-particle and for using the atomic number to find the symbol for the daughter nuclide on the Periodic Table.

(c) Few candidates were aware that halving the length of wire halves its resistance and that doubling the cross sectional area halves its resistance again.

(d) There were many who clearly presented all stages in the calculation of the pressure exerted by the block. The most common error was to use mass in the pressure equation rather than calculating the weight of the block.

Question 7

(a) (i) Candidates who gained credit here showed that they understood the role of sodium carbonate in the whole investigation rather than just stating that is an alkali.

(ii) Successful candidates could describe the action of lipase as the breakdown of fats into fatty acids.

(iii) Most explanations stated that the enzyme is denatured at 80 °C. Some answered the question fully by going on to explain the effect on the result so that the indicator would not become colourless as fatty acids would no longer be produced.

(b) (i) It was well known that the conditions in the stomach are very acidic. The locations of amylase secretion were less likely to be identified correctly.

(ii) To kill microorganisms was often given as a reason for acidic conditions in parts of the digestive system. Their role in protein digestion was less well known.

Question 8

(a) Many candidates knew the products of combustion of a hydrocarbon.

(b) (i) The product of oxidation of carbon monoxide was usually stated correctly.

(ii) Many candidates described one of the principal environmental effects of nitrogen oxides produced in this context and cited acid rain or human respiratory disease.

(iii) There were many good explanations of the term *activation energy* as the minimum energy required for reactant particles to react.

(c) (i) Some of those who knew that members of a homologous series have the same general formula were also aware that they have similar chemical properties.

(ii) The correct structure of a butane molecule was often drawn. The correct representation of the structure of another alkane was given some credit.

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Question 9

(a) Most candidates knew the formula for kinetic energy. Some did not notice that the answer line required the answer in kilojoules.

(b) Most responses correctly indicated that velocity has direction. Some confused velocity with acceleration.

(c) (i)(ii) When the formula for work done was correct, the calculation was usually successful and the right symbol for the unit stated.

Question 10

(a) (i) The rate of water uptake was usually calculated correctly.

(ii) The sketch graph usually showed the rate of water uptake increasing with temperature. The reduction in gradient at higher temperature was not always evident.

(iii) Those offering a reason for the increase in rate of water uptake often correctly cited increased evaporation or transpiration. Reference to numbers of open stomata were rare. Most candidates just described the shape of the graph.

(b) The best descriptions of the mechanism that moves water up the xylem referred to the transpiration pull on water molecules held together by cohesion. Fewer referred to the idea of an unbroken column of water. Candidates must ensure that they know the difference between potential gradient and concentration gradient. The mechanism was sometimes said to involve osmosis. Descriptions of transpiration itself or the movement of water into roots were not credited.

(c) (i) Most correctly located chromosomes in the nucleus of a cell.

(ii) Most knew that the chromosomes are genetically *identical*. It was felt that the term *equal* was less precise.

(d) Other roles of mitosis were often provided. Some candidates incorrectly referred to the repair of cells.

(e) There were several ways in which candidates stated that cells produced by meiosis contain half the number of chromosomes of those in cells produced by mitosis. Some gained credit by giving a numerical example.

Question 11

(a) (i) Those candidates who realised that the physical states of the halogens follow a group trend usually predicted that fluorine is a gas. Suggestions for the lighter colour of fluorine tended to be less common.

(ii) Most explanations of the relative molecular mass of fluorine usually recognised that fluorine is diatomic or included the formula.

(b) (i) The syllabus definition of diffusion was often provided. Reference to the random nature of molecular motion was not always included. The best responses referred to the motion of molecules as required by the question, rather than the motion of bulk gases.

(ii) Successful candidates knew that the smaller molecular mass of chlorine would result in a higher rate of diffusion.

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Question 12

(a) (i) Most candidates could calculate distance travelled from the formula. The strongest realised that the time given was for sound to travel twice the depth of the sea.

(ii) To verify the value given for the frequency, candidates needed to rearrange the formula $v=f\lambda$, using compatible units for speed and wavelength, and compare their result with the one supplied. Credit was not given for answers which involved working back from the answer.

(iii) The majority of candidates labelled the correct positions of a compression and a rarefaction without ambiguity.

(b) Some accurate ray diagrams were drawn. Candidates needed to show care in the positioning of plane mirrors at the correct angle and in drawing rays which followed the laws of reflection at the surface of the mirrors.

(c) (i) Several candidates named the slip rings in the diagram of the generator. Split rings and commutators were common suggestions.

(ii) Candidates need to have an understanding of the working of a rotating coil generator. They might have described how an e.m.f. is induced as the magnetic field linking the rotating coil increases and decreases, causing the current to change direction every half turn. Misconceptions included the attraction of electrons by a magnet. Candidates need to be clear about the difference between the generator effect and the motor effect.

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CO-ORDINATED SCIENCES

Paper 0654/42
Theory (Extended)

Key messages

A very 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.

- Candidates should read the stem of the question carefully as this contains useful information for answering the question. **Questions 1(a)(ii)** and **5(c)(i)** specifically required candidates to refer to information in the figures provided to access the maximum credit available.
- It would be beneficial for candidates to practise expressing values in standard form as well as converting units as this proved problematic for some. Forgetting to convert the units was particularly evident in **Question 12(c).**
- Candidates should be encouraged to read the question carefully and to complete all the instructions contained within the question. Highlighting key or command words in the stem would be a useful skill for candidates to practise. Candidates sometimes were not able to gain all the credit available where questions contained more than one instruction namely **Questions 9(a)(ii)** and **11(a)(ii)**.

General comments

The number of marks available for each question on the right-hand side and the number of answer lines provided is a good indicator of the level of response required by the candidate. Extended prose questions of three marks often require a detailed explanation. Candidates should be encouraged to make at least one relevant point for every mark available.

Candidates generally showed good use of English, expressing their ideas in continuous prose. Correct scientific terminology as stated in the syllabus should always be used. Learning the definitions specified in the syllabus earns credit directly as well as being an aid to language used in explanations.

It would be beneficial for some candidates to revise what each of the command words mean to be able to identify what is expected from them in their responses. There were some instances where candidates did not provide a correct response as they had misinterpreted the command word.

Comments on specific questions

Question 1

(a) (i) The vast majority of candidates were able to read the graph correctly to give the value of 6 bubbles.

(ii) It was important to refer to the evidence in the figure provided to access the available marks. Candidates were able to do this well and usually referred to the optimum temperature being 30 °C and enzyme activity decreasing at temperatures above this value. There were many correct references to denaturation.

(iii) This question specified how to increase the number of carbon dioxide bubbles produced. Candidates need to be precise in their responses, some simply referred to sugar rather than increasing the volume or concentration of sugar. Responses that included changing the pH or altering the surface area were not appropriate in this context and were not awarded credit.

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(b) Aerobic respiration was mostly well known among the candidates. Fewer candidates gave correct responses for anaerobic respiration in animals often including that carbon dioxide was produced. Some candidates did not realise that all the types of respiration given in the table would release energy.

Question 2

(a) (i) The meaning of the term homologous series was generally well known. A common misconception was that all members of a homologous group would have the same chemical formula rather than general formula. Responses referring to the possession of a similar formula were not awarded credit. A number of candidates also referred to physical properties and functional groups which were unnecessary for this question.

(ii) The vast majority of candidates were able to give the correct response of alkenes.

(b) Common errors included giving the arrangement of methane and only having one pair of bonding electrons between the two carbon atoms. Occasionally only one electron was shared between each hydrogen atom and the carbon atom.

(c) (i) Most candidates gained full credit on this question part. Some candidates did not include hydrogen as a diatomic molecule and some tried to add water as an additional product.

(ii) Propane was generally given as the compound. Some candidates had more difficulty giving an explanation as to why this would be the case. The most successful often explained in terms of the breaking of the double bond and the addition of hydrogen.

Question 3

(a) (i) Candidates could generally identify the correct position of X-rays and gamma radiation on the electromagnetic spectrum. Some candidates did not read the figure carefully enough and placed X-rays and gamma radiation on the left-hand side of the spectrum.

(ii) Some candidates did not read the question carefully and gave a use of X-rays rather than gamma radiation.

(b) (i) Many candidates did not give three energy transfers but instead listed three types of energy. Those that did recognise that three energy transfers were required generally gained some credit. A common error was to miss out the step including thermal energy and state that energy was transferred directly from chemical energy to kinetic energy and then to electrical energy.

(ii) Most candidates could give a good description of the meaning of 25% efficiency in the context given. Candidates need to give precise responses, some referred to the energy output rather than the **useful** energy output.

(c) Common errors included giving the incorrect element of Sr and using the incorrect symbol for Yttrium.

Question 4

(a) Many of the candidates could describe the process of selective breeding. Most of the candidates could describe the selection of fast horses and mating them. Only the stronger candidates were able to gain full credit for this question part by going on to describe the selection and breeding of the fastest horses from the offspring and then the continuation of this process over many generations.

(b) More candidates could identify a difference between natural selection and selective breeding than identify a similarity. Most candidates were able to identify that natural selection included human involvement.

(c) A number of candidates could adequately describe that adaption involves natural selection by the environment whereas selective breeding does not.

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Question 5

(a) (i) The majority of candidates could state the correct number of molecules. Occasionally two molecules of hydrogen were seen rather than four.

(ii) A number of incorrect answers were seen here including carbon dioxide and hydrogen.

(b) Most of the candidates had a good understanding of the reason for the inclusion of iron in terms of it being a catalyst and so speeding up the rate of reaction. Fewer explained it in terms of lowering the activation energy.

(c) (i) It was important for the candidates to refer to the figure as instructed by the question. Some candidates gave responses explaining what an exothermic reaction was with no reference to the graph. The best responses referred to the energy stored in the reactants and products.

(ii) Only the strongest candidates were able to gain full credit. Most candidates could explain in terms of molecules having increased kinetic energy and increased frequency of collisions. Few candidates were able to explain in terms of **more** molecules having the necessary activation energy. Candidates need to have a clear understanding of the meaning of the term activation energy; many candidates gave a limited explanation, trying to explain that increasing temperature would increase or decrease the activation energy.

(d) Most candidates had the necessary skills to be able to calculate relative molecular mass and volume. It would be beneficial to some candidates to practise the calculation of number of moles of different elements involved in reactions. Step 2 proved the most challenging for candidates, with a variety of incorrect calculations seen.

Question 6

(a) The majority of candidates were able to provide the correct audible range in humans.

(b) (i) Most candidates could use the correct formula to calculate the correct speed. The majority of candidates were able to correctly round their answer.

(ii) Most candidates could use the correct formula to calculate the correct wavelength.

(iii) Few candidates realised that the frequency would not affect the speed of the wave and so the time would remain the same.

(c) Many candidates were able to give a correct speed and an explanation in terms of density or that sound travels faster in liquids than gases. Some responses were too vague and simply referred to there being fewer air molecules.

(d) Many correct responses were seen. Very few candidates muddled transverse and longitudinal waves. Candidates need to make it clear whether they are referring to direction of wave travel or particle oscillation. There were some vague responses such as “transverse waves move in parallel and longitudinal waves move in a perpendicular motion” . Very few candidates chose to amplify their responses with a diagram. Candidates were able to gain credit from a fully annotated diagram.

(e) The differences between the forces between the molecules and their motion could be well described by most candidates. Occasionally candidates tried to describe the speed of the molecules in water and ice rather than their ability to move.

Question 7

(a) (i) Most candidates could correctly identify and label the liver. Common incorrect answers included the gall bladder and the stomach. The question asked for where bile was **produced**, which is in the liver. Bile is **stored** in the gall bladder.

(ii) Most candidates could correctly identify the pancreas.

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(iii) The majority of candidates were able to give a correct response. Rarely some candidates gave incorrect responses of the oesophagus or small intestine.

(b) (i) Candidates should be reminded to read all the stimulus material carefully. Candidates needed to realise that lipase was present and so would break down the fats in milk to produce fatty acids which would increase the acidity. Many candidates gave the name of incorrect acids.

(ii) Nearly all the candidates were able to calculate the correct value of 41 seconds.

(iii) Candidates needed to know the function of bile to be able to access some of the credit contained in this question. Some candidates incorrectly referred to bile as being an additional enzyme. Of the candidates that knew the function of bile most could correctly describe the emulsification of fats increasing the surface area. The stronger candidates could fully explain by giving additional information on the ability of lipase to break down fat to fatty acids at a faster rate.

Question 8

(a) Candidates need to take care in their responses that they refer to chloride and sodium **ions** rather than **atoms**. Some candidates were not clear enough in their responses and although they identified that the structure was incorrect, they were unable to specify why the diagram was incorrect. The best responses referred to the number of ions and their alternating pattern.

(b) (i) Most candidates identified that both salts needed to be soluble. Fewer explained this in terms of these salts being able to provide lead and chloride ions.

(ii) Most candidates could give a correct word equation. The most common error was to omit the name of the other product in this reaction (sodium nitrate).

(c) (i) A large variety of colours were provided for this question. Some candidates tried to apply the colour in terms of acidity or alkalinity. A common misconception was to give the colour of white rather than the correct answer of colourless.

(ii) A number of candidates suggested that chloride ions gained electrons. A large number of candidates referred to chlor**ine** ions rather than chlor**ide** ions. Few candidates tried to explain this using an ionic equation.

Question 9

(a) (i) The correct response of radiation was commonly seen. Occasionally candidates stated a type of energy.

(ii) For candidates to gain credit for this question part they needed to provide a comparative statement. Some simply described the colour black as being a good absorber of radiation rather than being a better absorber of radiation than white.

(iii) As in **a(ii)** the statement needed to be comparative. Candidates should be encouraged to read each question carefully and highlight any command words. There were several candidates that stated that the train would be hotter but did not provide an explanation and were unable to gain credit.

(b) Most candidates were able to apply a correct formula and calculate the correct value of 270 000 N.

(c) (i) Most candidates were able to show how the value of 4.7 A was calculated.

(ii) Some candidates completed the first part of this question and were able to calculate the resistance but did not carry on to calculate the combined resistance. Some candidates used an incorrect value for the current. Candidates were able to gain credit if they were able to use this value correctly.

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Question 10

(a) (i) Most candidates could complete the definition of the term osmosis. The second gap proved to be the most challenging for candidates to fill, with a range of incorrect answers seen. The most common of which being concentrated.

(ii) The vast majority of candidates gave succinct and accurate descriptions usually referring to large surface area.

(b) Stronger candidates were able to give the correct response of cohesion. A number of candidates muddled cohesion with adhesion. A number of candidates gave incorrect responses relating to covalent bonding and a number chose to omit this question.

(c) (i) Some candidates were able to deduce the correct units. Common incorrect answers such as ml and mm^2 were seen. Some candidates misunderstood the question and provided a value rather than a unit.

(ii) Candidates found this question very challenging and it was clear that the reason why increasing humidity decreases the rate of transpiration was not well known. Only the strongest candidates could explain this phenomenon in terms of increased water vapour outside the leaf reducing the rate of evaporation. Very few related this to decreased movement of water up the xylem by transpiration pull.

Question 11

(a) (i) Some good responses were seen with many candidates giving reasonable observations. Candidates should be reminded to read the question carefully. This question asked for the observations that would be seen. A few candidates gave descriptions of the reaction but not the observations. Responses such as these were ignored.

(ii) Many candidates identified that the reaction would be more vigorous. Fewer explained why in terms of position in the group. Candidates should be reminded to complete all the instructions contained within the question to gain the maximum credit available.

(b) (i) The majority of candidates showed a good understanding of how to calculate the number of protons, neutrons and electrons in different isotopes. Occasionally some candidates muddled the number of neutrons and the number of electrons.

(ii) A number of candidates were able to state that by using a different isotope no difference in the reaction would be seen. Of these the majority were able to give a correct explanation in terms of number of electrons.

Question 12

(a) The majority of candidates gave the correct response of weight. An alternative response of gravity was also accepted.

(b) (i) The majority of candidates were able to correctly label the slip rings. Occasionally some candidates labelled the brushes.

(ii) Candidates found this question part very challenging. Candidates need to have detailed knowledge of how a generator works. Many candidates described irrelevant material relating to magnetic fields and current. Candidates should be encouraged to read the question carefully as this question only referred to the involvement of slip rings in providing an alternating voltage.

(iii) Most candidates could draw an appropriate sine curve. Occasionally inaccuracies in frequency and / or amplitude were seen where candidates were not careful enough in their drawing. A few candidates drew lines other than sine curves.

(c) The most common error were difficulties in calculating the correct time. A number of candidates did not convert the time into seconds. Occasionally the incorrect units were given with Q and Ohms commonly seen.

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(d) Occasionally there were some inconsistencies in drawing the correct angles seen.

Question 13

(a) The majority of candidates gave blood or plasma in their responses. Hormones travel dissolved in the blood plasma. Responses referring to the transport in blood cells were not credited.

(b) (i) Many good responses were seen with most candidates able to relate this to increased release of energy for flight or fight response.

(ii) A number of good responses were seen. Candidates needed to be precise, some referred to increased concentration of glucose in the blood which was already given in the question. The effects of adrenaline on the body are stated in the syllabus.

(c) (i) The majority of candidates could name the mechanism given in the example.

(ii) Some excellent responses were seen with many candidates able to describe the functioning of the liver and pancreas in reducing blood glucose concentration. Some candidates thought that the liver produced insulin. Only a small number of candidates muddled insulin with glucagon. A few candidates muddled glycogen with glucagon.

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CO-ORDINATED SCIENCES

Paper 0654/43
Theory (Extended)

Key messages

Candidates would benefit from taking care to read the question thoroughly. They should ensure that they are clear about whether a statement, description or explanation is required, and they should know the difference between the meaning of these command words. When considering the requirement of a question they could check whether their answer adds to the information supplied in the stem of the question.

General comments

The most successful candidates for this paper appeared to be familiar with the definitions and terms used in the syllabus. They employed the detail of the syllabus to help with their use of English in expressing their knowledge and ideas. Many showed competence in manipulation of numbers. To ensure credit for all steps of a calculation, candidates are advised to state the formula they are using and show the stages in its rearrangement and substitution. Correct answers were obtained by those who understood that the formulae work with a compatible set of units based on the metre, kilogram and second. Hence the units of data supplied in the question must sometimes be converted.

Comments on specific questions

Question 1

(a) (i) The equation for aerobic respiration was usually written correctly.

(ii) The product of anaerobic respiration in muscles was well known.

(iii) The products of anaerobic respiration in yeast were less well known.

(b) Most candidates could state two other characteristics of living organisms.

Question 2

(a) The equation for the formation of ammonia was often constructed correctly. Some unsuccessful attempts were based on reactants such as N, 3H or H_3.

(b) A few candidates identified sodium hydroxide as a substance that displaces ammonia from ammonium chloride. Many suggestions were acids or metals.

(c) (i) The syllabus definition of diffusion was often provided. Reference to the random nature of molecular motion was not always included. The best responses referred to the motion of molecules as required by the question, rather than the motion of bulk gases.

(ii) A few candidates were aware that collisions between molecules decrease the rate of diffusion.

(iii) The majority of candidates were able to verify the value for the relative molecular mass of ammonia.

(iv) There were many good answers explaining that rate of diffusion decreases with increasing molecular mass, which referred to the relative speeds of molecules or the position of the ring of ammonium chloride.

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Question 3

(a) Candidates must ensure that they have a good understanding of the principles of electromagnetic induction. They might have described how an e.m.f. is induced as the magnetic field linking the coil increases and decreases, causing the voltage to reverse when the magnet changes direction. Misconceptions included the attraction of electrons by a magnet. There was confusion between the generator effect and the motor effect.

(b) (i) Some candidates suggested a micrometre screw gauge or an abbreviated name or another device suitable for measuring distances of this order.

(ii) A very few candidates knew that doubling the diameter quadruples the cross-sectional area of the wire, which therefore has a quarter of the original resistance.

(c) Some candidates calculated that $1 \cdot 10^{12}$ atoms of the isotope remain. Fewer deduced that the decay would therefore take three half-lives.

(d) (i) A few descriptions of the conduction process included the increased vibration of particles near the source of heat. Others implied that particles start to vibrate when heat energy is supplied. Many apparently knew that these enhanced vibrations are passed between particles but found this difficult to express. Some repeated the information in the question by describing the transfer of thermal energy.

(ii) Many candidates were aware that expansion is caused by the increase in distance between atoms. Some explanations referred to the increased amplitude of vibration of particles near the source of heat. Others mentioned increased frequency which did not help their argument. Again, some implied that particles start to vibrate when heat energy is supplied.

Question 4

(a) (i) Those candidates who knew which processes occur in the xylem and in the phloem could complete the table correctly.

(ii) Many candidates knew that substances move up the stem during transpiration. Some knew that substances moved down the stem from source to sink during translocation without recognising that substances also move upwards. Some attempted a more complicated response, neglecting the reference to movement in a plant **stem** at the beginning of the question.

(b) (i) Some candidates knew that a sugar, or specifically sucrose, is transported during translocation. Fewer referred to the transport of amino acids.

(ii) The role of the xylem in supporting the plant stem was quite well known.

Question 5

(a) (i) Many candidates suggested that hearing the explosion or seeing the flash is evidence for an exothermic reaction. Heat was not accepted as an observation.

(ii) Some candidates knew that white anhydrous copper sulfate turns blue on hydration. Others were allowed credit for describing colourless water changing to a blue solution.

(iii) Many correctly suggested that evaporating the water would reverse the reaction and the colour change.

(b) (i) The O=O bond was often identified as a bond which is broken. Candidates also needed to identify the H–H bond to gain credit. Many candidates gave ambiguous descriptions of the bonds such as “the bonds between hydrogen and oxygen”.

(ii) The O–H bond was sometimes identified as the bond which is formed. Some descriptions such as “the H–O–H bonds” were too vague to be awarded credit.

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(iii) Many candidates knew that the bond in the H_2 molecule is covalent. Others just described it as a single bond, which added little to the information in the question.

(c) (i) Most candidates correctly explained that heat energy is given out in an exothermic reaction.

(ii) Some explained that chemical energy stored in the products being less than that in the reactants shows that the reaction is exothermic. Others were confused when they attempted to include the activation energy in the explanation.

(iii) There were many good explanations of the term "activation energy" as the minimum energy required for reactant particles to react. Others inappropriately used the term activate in their explanation of the term.

(iv) A few candidates correctly indicated the difference in energy between the reactants and the peak of the curve. Many labelled the height of the curve, the slope of the curve or a single point.

Question 6

(a) (i) The speed-time graph was usually drawn correctly. Some plots ended too soon, 8 seconds from the start.

(ii) The calculation of acceleration was usually done well.

(b) Some candidates correctly calculated the distance between the cat and the pivot. Few wrote down an equation showing the equality of clockwise and anticlockwise moments from which they could have calculated the unknown distance.

(c) There were many who clearly presented all stages in the calculation of the density of the cheese. The most common errors made by those who knew the density formula were to use weight in the formula rather than calculating the mass of the cheese, and in converting the mass units.

(d) Most candidates could state two differences between evaporation and boiling.

Question 7

(a) Enamel and dentine were often identified as parts of the tooth. Fewer candidates could identify the pulp.

(b) There were a few good descriptions of the process of tooth decay. Some knew that bacteria or acid are responsible. Few knew that acid is a product of respiration by bacteria. Misconceptions included sugar dissolving enamel and bacteria "eating" the tooth.

(c) Most descriptions of the role of teeth in mechanical digestion included their action in breaking food into smaller pieces. Some implied a reduction in the size of molecules.

(d) There were some good descriptions of the role of enzymes in chemical digestion in the mouth. Many included the role of amylase, and the best discussed the breakdown of starch into simple sugars. A few explained this as the conversion of large insoluble molecules into smaller soluble molecules.

Question 8

(a) (i) Some of those who knew the relative reactivities of the halogens could predict the formation of bromine and iodine solutions and suggest their colours.

(ii) Some could use relative reactivities to explain the observations using aqueous bromine. Others misread the question and, rather than giving explanations, repeated descriptions of the observations. There was some confusion in the use of the words iodine and iodide.

(b) (i) There were some good explanations of the redox reaction. The most succinct stated that bromine is reduced as it gains electrons and iodide ions are oxidised as they lose electrons. Some candidates gained credit for knowing that redox involves the transfer of electrons but were unclear about the direction of the transfer.

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(ii) Bromine was often correctly identified as the oxidising agent.

Question 9

(a) (i) Many candidates knew the relationship between power, current and voltage and calculated the current through the motor.

(ii) The relationship between charge current and time was less well known. Those who knew the formula found the correct answer if they noticed that the time had to be converted to seconds.

(iii) The parts of the motor were well known; precise labelling was required to gain the available credit.

(b) Most candidates could quote the formula for kinetic energy. The correct answer was obtained by those who were able to rearrange the formula to get an expression for speed.

Question 10

(a) The percentage increase in MRSA infection cases was often calculated correctly. The most common error was to quote the number as a percentage of the 2008 total rather than as a percentage of the 2006 total.

(b) (i) Most candidates quoted the syllabus definition of mutation as a change in a gene or chromosome. Some described it as an abnormality in the whole organism.

(ii) There were a few good descriptions of the evolution of MRSA bacteria which used the principles of natural selection. They stated that bacteria without the resistance die, while those with resistance survive and reproduce, passing on the resistant allele to their offspring. Candidates needed to notice from the stem of the question that MRSA is the term used to describe the resistance rather than a type of bacterium. Others discussed the role of humans treated with antibiotics.

(c) Some candidates could explain that the offspring produced by asexual reproduction of bacteria without the resistance would also not have the resistance. Their answers clearly stated that there was no genetic variation between parent and offspring as well as between individuals.

Question 11

(a) (i) The correct general formula for alkenes was often suggested.

(ii) The structures of ethane and ethene were usually correct.

(b) (i) Many candidates could calculate the number of moles of propane from its volume. Progress could be made by using the equation to find the number of moles of carbon dioxide produced. Credit was gained by many who used the molar volume to find the volume of the number of moles of carbon dioxide they had calculated.

(ii) The greenhouse effect and its role in global warming were often correctly suggested as effects on the environment caused by carbon dioxide emission. Several candidates incorrectly involved ozone in their description.

(c) Many candidates were aware that the double bond enables alkenes to undergo addition reactions. A few correctly described one of the addition reactions quoted in the syllabus.

(d) (i) The questions on polymerisation proved challenging to most candidates.

A few candidates could state a difference between addition and condensation polymerisation. Suggestions included the fact that condensation polymerisation usually involves more than one monomer. A by-product was sometimes correctly named. A general statement was seldom given. Other responses betrayed a lack of knowledge of polymerisation itself.

(ii) The section of a nylon molecule was completed correctly on a few scripts.

(iii) There were slightly more correct formulae for the other compound formed even from candidates who had not succeeded in completing the diagram of the molecule.

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Question 12

(a) Most candidates could explain why the cut in the installation is an electrical hazard.

(b) (i) The meaning of compression was usually stated correctly in terms of proximity of particles. Some described frequency modulation.

(ii) Wavelength was described correctly by most candidates. Some tried to explain a change in wavelength.

(iii) There were some concise comparisons of longitudinal and transverse waves that referred to the direction of oscillation and the direction of wave or energy propagation. Descriptions were ambiguous when wave propagation was termed movement of waves. Responses that compared horizontal and vertical motions were not awarded credit. Diagrams gained credit when the directions of oscillation and propagation were labelled.

(c) The image in the mirror was often described correctly.

(d) Good suggestions explaining the suitability of the shiny, light surface compared the reflection or absorption of thermal energy rather than implying that all thermal radiation is reflected or none is absorbed.

Question 13

(a) (i) Most candidates knew that insulin causes the increase in blood glucose concentration.

(ii) Exercise was often correctly suggested as causing the decrease in blood glucose.

(iii) There were some excellent descriptions of the restoration of blood glucose concentration. They stated that the pancreas secretes glucagon which causes the glycogen that is stored in the liver to be converted to glucose. There was some confusion between the roles of the substances glucagon, glycogen and insulin.

(b) The control of blood glucose concentration was usually correctly described as negative feedback or homeostasis. Terms such as “glucose regulation” did not add enough to the information in the question.

(c) Most candidates could describe the features of a hormonal control system. The description of the method of information transfer in nervous control systems needed to include the term “electrical impulses”.

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CO-ORDINATED SCIENCES

Paper 0654/51
Practical Test

Key messages

To achieve well in this examination, candidates need to have a thorough grounding in practical work during the course. Candidates should have as much personal experience of carrying out experiments themselves, as possible.

Drawings of apparatus should be done with a pencil and ruler and should be labelled. Candidates are expected to have used standard laboratory apparatus and must be able to read values from a variety of measuring instruments and record the values to the requested accuracy.

Centres are provided with a list of required apparatus well in advance of the examination date. Where centres wish to substitute apparatus, it is essential to contact Cambridge Assessment to check that the change is appropriate and that candidates will not be disadvantaged. Any changes must be recorded in the Supervisor's report.

General comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical biology, chemistry and physics techniques.

The majority of candidates entering this paper were well prepared and able to demonstrate some ability and understanding across the whole of the range of practical skills being tested. All parts of every practical test were attempted and there was no evidence of candidates running short of time. The majority of candidates were able to follow instructions correctly and record observations clearly.

The gathering and recording of data presented few problems for any candidates. There was evidence of some candidates not having the use of a calculator.

Comments on specific questions

Question 1

(a) Only the stronger candidates suggested that the beans had been liquidised so that the enzyme would be released, or to break open the cells. Another acceptable answer, seen far less frequently, was that the surface area of the beans would be increased by liquidising them.

(b) (i) Almost invariably, candidates recorded a time in the correct box in the table for the first trial.

(ii) The times for the second and third trials were usually present, and the majority of candidates recorded these times to the nearest second, as instructed.

(iii) The average time per trial was usually calculated correctly, but the answer was not always rounded to the nearest second.

(c) Most candidates completed the diagram correctly, to show the oxygen gas produced by the reaction being collected by a syringe, or into a measuring cylinder over water.

(d) The test for oxygen gas was well-known. This test was occasionally mixed up with the test for hydrogen gas.

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(e) The testing of the liquidised beans for their nutrient content was well done. If an incorrect colour change was observed, candidates could still score some credit if their stated nutrient content matches the incorrect change. Candidates should be reminded that if the test using Benedict's solution gives a positive result, then they have to state that reducing sugar is present. The word "sugar" on its own is not enough.

(f) The test for the presence of fat in a liquid was well-known. The most common error was the addition of ethanol / alcohol without stating that water is added, as well.

Question 2

This was the second time that a complete planning question has been set on this paper. The question discriminated well, with the full range of marks being awarded to candidates.

The question involved planning an experiment to investigate whether different coloured light affected the rate of photosynthesis in an aquatic plant.

The majority of candidates took the hint given, and drew a labelled diagram of the apparatus they would use. All that was required here was to show some pond weed in a container of water.

Of the marks that could be awarded for a suitable method, most candidates scored at least some credit by describing the use of all three light sources separately. Few candidates suggested repeating the experiment to obtain more than one set of results for each coloured light source.

Most candidates stated that they would count the bubbles produced by the pondweed or measure the volume of oxygen gas produced. Far fewer candidates stated that either the bubbles or the volume of gas collected, should be measured for a fixed time, or equally acceptable, the time taken to collect a fixed number of bubbles or a set volume of gas should be measured.

The majority of candidates suggested one sensible control variable for this investigation. The most common acceptable answers seen were to use the same plant each time, to place the lamp the same distance from the plant and to carry out each experiment at the same temperature.

The final credit for explaining how the readings taken could be used to make a comparison about the rate of photosynthesis and the colour of the light incident on the aquatic plant was seldom awarded because candidates had carried out an incorrect procedure. All that was required was that the greater volume of gas / number of bubbles collected corresponds to the colour of light that gives the greater rate of photosynthesis.

Question 3

(a) (i) Credit was almost always awarded here.

(ii) Most candidates completed the table by adding a full set of reaction times for the different numbers of marble chips. Most sets of results showed the correct trend, namely that the times for the reaction decreases on going down the table. Occasionally, the instruction to record the times to the nearest second was ignored.

(b) (i) The rates for each value of time were usually calculated correctly, but the instruction to record the rates to two significant figures was often ignored.

(ii) The relationship between the rate of reaction and the total surface area of the marble chips was usually stated correctly.

(c) (i) Most candidates correctly stated one variable which is kept constant in the experiment. Candidates who stated that the room temperature should remain constant were not awarded the credit.

(ii) Candidates found this part more demanding. Only the stronger candidates could suggest a reason why varying the number of marble chips is not a fair way of changing the total surface area. Most candidates did not realise that the marble chips would not all be exactly the same size.

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(iii) Many candidates correctly suggested that a major source of error in this experiment was deciding when the limewater had turned milky and trying to time to the same degree of milkiness for each reaction.

Question 4

(a) (i) Although the initial temperature of the water was almost always recorded, many candidates ignored the instruction given and did not quote their reading to the nearest 0.5 °C.

(ii) Most candidates gained full credit here. The temperature of the mixture was recorded, and candidates stated that the mixture was colourless. The description "clear" for the appearance of the liquid was not accepted.

(iii) The temperature change which occurred on adding compound **H** to the water was usually calculated correctly. Many candidates did not gain credit here because they did not include a plus or minus sign, as instructed, to show whether the temperature had increased or decreased.

(iv) Most candidates concluded that the reaction was endothermic, but far fewer made the obvious observation that compound **H** was soluble in water.

(b) (i) The observation that there was no reaction when first nitric acid and then barium nitrate was added to the solution was usually stated. This was not always followed up with the conclusion that **H** was therefore not a sulfate.

(ii) Candidates met with more success here. The white precipitate obtained when acidifying and adding a few drops of silver nitrate usually produced the response that **H** was a chloride.

Question 5

(a) (i) Most candidates recorded the length, width and height of the rectangular block they had moulded from the modelling clay provided. In most cases the lengths were recorded to the nearest 0.1 cm, as requested.

(ii) The calculation of the volume of the block posed little problem and most candidates scored this mark. A result quoted to any number of significant figures greater than 1 was accepted.

(b) (i) Most candidates stated a valid reason as to why the volume they had calculated was not accurate. The non-uniform nature of the moulded sides, however expressed, was the most popular correct response.

(ii) Almost all candidates suggested using a measuring cylinder to give a more accurate value for the volume of the block.

(c) (i) Candidates followed the sequence of instructions and balanced the block of modelling clay on the rule. The value obtained for the distance *x* from the centre of the block to the 50.0 cm mark on the rule was usually within the tolerance allowed. Occasionally, the scale reading of the block on the rule at balance was stated, instead of the distance of the centre of the block from the centre of the rule.

(ii) The mass of the modelling clay was usually calculated correctly from the equation given. Candidates were not awarded credit if the final answer was incorrectly rounded.

(d) (i) Most candidates gave a sensible reason as to why the mass of the block they had just calculated was not accurate. The difficulty in obtaining an exact balance of the metre rule was usually quoted.

(ii) The density of the block was usually calculated correctly by the substitution of the mass and volume of the block into the given equation. Most candidates had carried out the experiment with care and had obtained a value for the density of the modelling clay within the tolerance limits set. This was an accuracy mark.

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Question 6

(a) The current and the potential difference across the resistance wire were usually recorded in the table. Credit was awarded when the values of current and voltage were quoted to the resolution of the scale of the ammeter and voltmeter used. The current values should be to at least two decimal places and the potential difference value to at least one decimal place.

(b) The resistance of a 10.0 cm length of the wire was usually calculated correctly.

(c) Most candidates completed the results table by recording values of current and voltage for the four other lengths of wire requested and also calculating the resistances of these different lengths of wire.

(d) (i) Candidates did not always choose horizontal and vertical scales that made use of at least half of the given grid. Despite the instruction given in the stem of the question to start the axes from the origin, some candidates ignored this.

There was much less evidence of the use of scales that increased in inconvenient increments, such as 3 or 7. Choosing such scales makes the points much harder to plot by the candidates and more difficult for Examiners to check the candidates' plotted points.

(ii) There were many excellent, carefully drawn, best-fit lines produced by candidates. However, there were still too many graphs where the candidate's attempt at a best-fit line resulted in all points which did not lie on the drawn line, being on the same side of the line.

There were also some graphs where the points were joined dot-to-dot. The concept of best-fit is clearly still not well understood by all.

(e) (i) The justification of the conclusion proved to be far more challenging. The majority of candidates thought incorrectly that because the resistance of the wire increased as its length increased, that this was sufficient to deduce that the two quantities were directly proportional. Only the stronger candidates were able to show or state that the quantities were directly proportional because their graph was a straight line passing through the origin or that ratio of resistance to length was constant, within the limits of experimental accuracy. Another acceptable justification was that doubling the length doubled the resistance of the wire etc.

(ii) Stronger candidates stated that to have more confidence in their conclusion to **(e)(i)**, they would extend their investigation and take more readings of current and voltage for more lengths of the wire.

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CO-ORDINATED SCIENCES

Paper 0654/52
Practical Test

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

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Paper 0654/53
Practical Test

Key messages

To achieve well in this examination, candidates need to have a thorough grounding in practical work during the course. Candidates should have as much personal experience of carrying out experiments themselves, as possible.

Drawings of apparatus should be done with a pencil and ruler and should be labelled. Candidates are expected to have used standard laboratory apparatus and must be able to read values from a variety of measuring instruments and record the values to the requested accuracy.

Centres are provided with a list of required apparatus well in advance of the examination date. Where centres wish to substitute apparatus, it is essential to contact Cambridge Assessment to check that the change is appropriate and that candidates will not be disadvantaged. Any changes must be recorded in the Supervisor's report.

General comments

The aim of the examination is to enable candidates to display their knowledge and understanding of practical biology, chemistry and physics techniques.

The majority of candidates entering this paper were well prepared and able to demonstrate some ability and understanding across the whole of the range of practical skills being tested. All parts of every practical test were attempted and there was no evidence of candidates running short of time. The majority of candidates were able to follow instructions correctly and record observations clearly.

The gathering and recording of data presented few problems for any candidates. There was evidence of some candidates not having the use of a calculator.

Comments on specific questions

Question 1

(a) (i) All candidates recorded a full set of results for adding 1 cm^3 of hydrogen peroxide to the yeast suspension. The maximum available credit here was often not gained because the instruction to record the values of the volume of the liquid and foam to the nearest 0.5 cm^3 was ignored.

(ii) All candidates recorded a full set of results for adding 2 cm^3 of hydrogen peroxide to the yeast suspension. The additional available credit here was usually gained because most candidates' results showed a greater volume of liquid and foam produced by the larger volume of hydrogen peroxide.

(b) Candidates did not always choose horizontal and vertical scales that made use of at least half of the given grid.

There was much less evidence of the use of scales that increased in inconvenient increments, such as 3 or 7. Choosing such scales makes the points much harder to plot by the candidates and more difficult for Examiners to check the candidates' plotted points.

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There were many excellent, carefully drawn, best-fit lines produced by candidates. There were still too many graphs where the candidate's attempt at a best-fit line resulted in all points which did not lie on the drawn line, being on the same side of the line.

There were also some graphs where the points were joined dot-to-dot. The concept of best-fit is clearly still not well understood by all.

The instruction to label each best-fit line was often ignored.

(c) Most candidates deduced that the rate of the reaction increased when the volume of hydrogen peroxide used increased.

(d) Candidates were usually able to identify a source of inaccuracy in obtaining the volume readings of liquid and foam in this experiment; the most common acceptable answer was that the foam was moving when they were attempting to measure the volume of liquid and foam.

Suggesting an improvement to match the inaccuracy quoted, proved to be more difficult. The use of two people, one to give the reading and one to record it, or repeating the measurements and averaging, were not often seen.

Question 2

(a) Most candidates recorded the correct observations when biuret solution and iodine solution were added to test-tubes containing the yeast solution. The conclusions usually matched the observations recorded correctly. If an incorrect colour change was recorded for either of the tests, candidates were able to gain the conclusion credit if their conclusion matched the incorrect colour change.

(b) (i) A majority of candidates correctly drew the assembled apparatus that should be used to test for carbon dioxide gas by bubbling it through limewater. Occasionally the credit was not awarded because the delivery tube was not below the surface of the limewater.

(ii) The credit for labelling the apparatus was often not awarded because many candidates did not label the delivery tube.

(iii) The observation to confirm the presence of carbon dioxide was usually correct.

(c) The reason for testing the liquid used to make the yeast suspension with biuret solution and iodine solution before adding the yeast was not well known by the majority of candidates. Candidates did not realise that the liquid itself might contain protein or starch, so the test was carried out to eliminate this possibility.

Question 3

(a) This was the second time that a complete planning question has been set on this paper. The question discriminated well, with the full range of marks being awarded to candidates.

The question involved planning an experiment to investigate the effect of temperature on the rate of the reaction between dilute sulfuric acid and magnesium ribbon.

The majority of candidates took the hint given and drew a labelled diagram of the apparatus they would use. All that was required here was a labelled diagram which showed some means of collecting the hydrogen gas evolved or the change in mass of the reactants, a thermometer and some means to change the temperature of the reactants.

Of the credit that could be awarded for a suitable method, most candidates scored at least some credit. Candidates either collected the hydrogen gas evolved in a certain time, placed the apparatus on a balance to measure the decrease in mass in a certain time during the reaction or measured the time for the magnesium to disappear.

Candidates were expected to give values of the different temperatures they would use to carry out the investigation. Most candidates listed two different temperatures, but few listed five or more temperatures. Although some credit was gained by giving two stated temperature values,

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candidates should be made aware that this is not a large enough number of temperatures to reach a valid conclusion. Occasionally, candidates did not understand the brief they had been given and used continuous heating of the reactants. This was not awarded credit.

The majority of candidates suggested one sensible control variable for this investigation. The most common acceptable answers seen were to use the same length of magnesium ribbon each time, the same volume of acid and the same concentration of acid.

Candidates needed to make it clear in whichever method they chose, that to compare the rates of reaction, they would measure the volume of gas given off in the same time, or the mass loss in the same time, or the time for all the magnesium ribbon to disappear.

The stronger candidates could explain correctly how they would find the rate of reaction from their time measurements.

(b) Most candidates listed one source of error in their experiment, but far fewer listed two sources of error, as requested. Of those candidates who identified one or two sources of error, only the stronger candidates could explain an improvement they would make to reduce the effect of the named error.

Question 4

(a) Most candidates carried out the tests on solution **H** and obtained a correct observation for each test. The conclusions made from their observations about the anion in solution **H** proved to be more troublesome. Only a small number of candidates concluded that since there was no reaction when dilute hydrochloric acid was added to solution **H**, then **H** is not a carbonate. About half the candidature concluded correctly that since there was no reaction when dilute nitric acid followed by silver nitrate solution was added to solution **H**, then **H** was not a chloride. A majority of candidates correctly concluded that the white precipitate formed when dilute nitric acid followed by barium nitrate solution was added to solution **H**, then **H** was a sulfate.

(b) Many candidates concluded correctly that when sodium hydroxide solution was added to solution **H**, the green precipitate formed indicated the presence of iron(II). On heating, many candidates observed that damp litmus paper turned blue, but incorrectly identified the cation in **H** as ammonia instead of ammonium.

(c) Candidates were asked to heat **J**, which was a solid sample of **H**, and record their observations. A minority of candidates recorded that there was a smell of ammonia. Far fewer candidates observed the presence of moisture forming around the cooler upper parts of the test-tube.

Question 5

(a) (i) Most candidates placed the cup on the space provided on the examination paper with its open end facing down and drew around its circumference with a pencil. The diameter of the cup was usually measured correctly and recorded to the nearest 0.1 cm.

(ii) Again, most candidates placed the cup on the space provided on the examination paper with its closed end facing down and drew around its circumference with a pencil. The diameter of the bottom cup was usually measured correctly and recorded to the nearest 0.1 cm.

(b) The vertical height of the cup was measured, and the height recorded to the nearest 0.1 cm by the majority of candidates.

(c) (i) The average of the two measured diameters was calculated correctly by the majority of candidates. Answers expressed to any number of significant figures were allowed here.

(ii) Most candidates substituted their values of the average diameter and the height of the cup correctly into the equation given and obtained an answer for the volume of the cup. The full credit available was often not gained because the volume of the cup was not expressed to 3 significant figures, as requested.

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(d) (i) The sequence of instructions given for candidates to use a measuring cylinder to determine the volume of water that the cup could hold was usually followed correctly. Most candidates obtained the required volume of water correctly by subtraction.

(ii) The idea of reading a measuring cylinder at right angles to the scale reading is becoming much better understood. Answers such as read the scale at eye level or to the bottom of the meniscus were also credited. Answers merely stating "to avoid parallax" were not awarded credit, unless the candidates stated how this could be done.

(e) (i) A majority of candidates suggested a sensible practical difficulty in determining an accurate value of the volume of the cup in the first method used. Candidates usually made reference to the difficulty in measuring the vertical height of the drinks cup.

(ii) Almost all candidates suggested a sensible practical difficulty in determining an accurate value of the volume of the water that the cup could hold in the second method used. Candidates usually made reference to the difficulty in filling the cup to the brim with water or that water was often spilled on transfer from the measuring cylinder to the drinks cup.

Question 6

(a) (i) Most candidates recorded a value of the distance from the illuminated object to the screen when the image had been focused. In most cases the value was within the tolerance allowed.

(ii) The focal length of the lens was usually calculated correctly by substitution into the given equation. The credit awarded here was an accuracy mark, which showed the Examiner that the candidate had carried out the experiment with precision and care. Many candidates' values for the focal length of the lens were within the expected range of 14.0 cm to 16.0 cm.

(b) (i)(ii) Candidates were required to repeat the procedure in **(a)** using a different value for the distance from the lens to the illuminated object. The comments expressed in **(a)** apply equally here.

(c) The average value for the focal length of the lens was usually calculated correctly and was also expressed to an appropriate number of significant figures.

(d) Despite carrying out the experiment, candidates found difficulty in stating one precaution that they would take to obtain accurate results in this experiment. Of those candidates who obtained credit here, the most popular precaution stated was to repeat and average the results. Other acceptable responses rarely seen are to carry out the experiment in a darkened room, and to move the screen slowly or to and fro until the sharpest focus of the image is obtained.

(e) Most candidates stated additional values of object distance that could be used to plot a graph. Three or more values were usually given, but the full available credit was often not awarded because candidates suggested a distance smaller than the focal length they had calculated. In this case, the image would not be formed on the screen because it would be virtual.

(f) Most candidates were able to draw a line to indicate the image distance on the diagram. Although most candidates used a ruler to draw the line and show the required distance accurately some did not and were not awarded credit because the ends of their line did not reach the appropriate points on the screen or at the lens.

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Paper 0654/61
Alternative to Practical

Key messages

Although this is an Alternative to Practical paper, candidates are expected to be familiar with experimental techniques, 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. Candidates should be able to draw labelled diagrams of assembled apparatus. 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 required.

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 linear and covering 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

(a) (i) Most candidates converted the times to seconds correctly and placed them in the correct place in the table. A small number copied the readings from **Figure 1.1**.

(ii) Most candidates calculated the average correctly; a small number added the values but omitted to divide by three.

(iii) The majority of candidates could identify at least one variable. Common non-creditworthy responses included: beans unqualified, concentration unqualified and water.

(b) Candidates found the diagram challenging. Many diagrams included delivery into a sealed test-tube. It is recommended that diagrams be labelled.

(c) The test for oxygen gas was quite well known, some candidates who had the splint relighting did not have it glowing initially. Common incorrect responses included relighting a lighted splint and pops with a lighted splint.

(d) The food tests were quite well known. Common errors included: brown, black and purple, sugar and carbohydrate for Benedict's test; blue, black or purple and starch for biuret test.

(e) Many candidates omitted water from the reagents needed. Emulsion with no colour and precipitate were often given for the observation. Sudan III is not a recommended test for fats due to its toxicity.

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Question 2

This is the second time there has been a seven-mark planning question on the paper.

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

Few candidates placed the aquatic plants into water.

Many candidates used three separate light sources. A small number used all three light sources together and some used only one light source in one experiment. Few repeated the procedure to improve reliability.

Many candidates either collected the oxygen gas and measured its volume or counted the bubbles but few did this in a fixed amount of time. The most common non-creditworthy part of the plan was "measure the rate of reaction", candidates need to explain what needs to be measured in order to do this.

Many candidates could identify at least one control variable, usually light intensity.

Most stronger candidates were able to link readings, colour and rate together in the conclusion.

Question 3

(a) (i) The majority of candidates recorded the time correctly. Common incorrect responses included 28 and 30.

(ii) The gas test was well known. The most common incorrect response was oxygen; hydrogen, chlorine and calcium carbonate were also seen quite often.

(iii) Stronger candidates were able to describe washing or replacing apparatus and discarding or replacing chemicals. A significant number of candidates listed the apparatus and chemical used.

(b) (i) Most candidates calculated the value correctly and gave a value to two significant figures.

(ii) Most candidates described the relationship correctly. Some described time rather than rate.

(c) (i) The majority of candidates named a control variable. Some gave limewater unqualified and acid unqualified.

(ii) Candidates found this question challenging. Same amount of acid and acid getting weaker were common incorrect responses.

(iii) Candidates found this very challenging. Many discussed reaction time or chips being different sizes.

Question 4

(a) (i) The majority of candidates read the temperature correctly. Common incorrect responses included 23 and 24.

(ii) The majority of candidates read the temperature correctly. Common incorrect responses included 18.1, 18.2 and 19.

(iii) Whilst most candidates subtracted the values correctly many omitted the minus sign.

(iv) Many candidates recognised the endothermicity of the change but few appreciated that **H** had dissolved. Common non-creditworthy responses included: **H** reacts and a colourless liquid is formed.

(b) (i) Candidates found this challenging. The most common response was anions present.

(ii) Candidates found this challenging. The most common response was no anions. Some listed several ions.

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(c) Candidates found this challenging. Common incorrect responses included acid, ammonia, silver nitrate and bleached.

Question 5

(a) (i) Most candidates measured the block correctly. 5, 3 and 2 were common responses.

(ii) Almost all candidates calculated the volume correctly.

(b) (i) The majority of candidates appreciated the irregularity of the block. Rounded values and inaccurate measuring were common non-creditworthy responses.

(ii) Stronger candidates suggested displacement. Using a balance was the most common response, some wanted to straighten the edges.

(c) (i) Most candidates read 68.6 correctly but some either gave this as the answer or divided by 50.

(ii) Most candidates calculated the value correctly.

(d) (i) Candidates found this challenging. Irregular block unqualified, parallax and poor measurement were common responses.

(ii) Most candidates calculated the value correctly.

Question 6

(a) (i) The majority of the candidates read the scale correctly. Incorrect responses included: 0.32, 0.3, 0.36.

(ii) The unit of resistance was well known. The most common incorrect response was *R*.

(iii) Most candidates calculated the value correctly. A small number inverted the calculation.

(b) Whilst the majority of candidates calculated the value correctly, several did not record the value to the same number of significant figures as the rest of the data in the table. 1.512 and 1.5 were common non-creditworthy responses.

(c) (i) Although most candidates labelled the axes with quantity and unit, many reversed them. Some did not start the axes at 0,0. The points were usually plotted correctly.

(ii) The majority of candidates drew a straight line. Some curves were seen. Some lines were feathery and some drew multiple lines.

(d)(i) Candidates found this very challenging. Common incorrect responses included: linear, straight line and straight line through all the points.

(ii) Many candidates gave a creditworthy improvement. Using a better circuit and comparing resistances were common non-creditworthy responses.

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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. 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, calculations were well executed and food tests were well known. The standard of graph drawing was generally high. 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.

Comments on specific questions

Question 1

(a) Food test colours for positive results were well known. The colours for the negative results were less well known and sometimes omitted. Some candidates reversed the colours for Benedict's and biuret.

(b) The nutrients were generally well known. Reducing was frequently omitted.

(c) The majority of candidates named the test correctly; biuret was the most common incorrect response.

(d) Most candidates identified a control variable. Common non-creditworthy responses included: concentration unqualified, food sample.

(e) Confirmation of reagents or positive test colours was not well known. Improved accuracy and reliability were the most common non-creditworthy responses.

(f) (i) The fat test was quite well known, however many candidates omitted water from the reagents needed. Emulsion with no colour and precipitate were often given for the observation.

(ii) The opaqueness of the milk was quite well known. Common incorrect responses included: milk not mixing or dissolving with the reagents and milk contains protein.

Question 2

(a) Most candidates gained partial credit and many gained full credit. A few gave sketchy non-continuous outlines.

(b) (i) Most candidates measured the line correctly. 420 was a common incorrect response.

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(ii) Most 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.

Question 3

(a) (i) The majority of candidates named a suitable piece of apparatus. Common incorrect responses included: beaker, balance and droppers.

(ii) The majority of candidates read the thermometers correctly. Many candidates gave 35 instead of 35.0.

(iii) Candidates found this challenging with small range and inaccuracy being the most common incorrect responses.

(b) (i) Generally the graph was drawn well. Some started the temperature axis at 0 and so their plotted points did not cover at least half of the graph paper. The plotting of the points was usually accurate. A small number had non-linear scales. It is important that both axes are labelled with the value where they cross at the start of the graph.

(ii) The curve was drawn quite well although there were several sketchy lines. The maximum should have been between plotted points.

(iii) Most candidates read the maximum from their graph correctly but a significantly large number did not mark this temperature on their graph. A vertical and a horizontal line from the maximum is the clearest way to mark this.

(iv) Many candidates named one of the two products. Water was the most common incorrect response. Several candidates gave incorrect formulae rather than names.

(v) Many candidates named the type of reaction correctly. Common incorrect responses included: oxidation, reduction, endothermic, replacement and chemical.

(c) Candidates found this very challenging. Many discussed the value being easier to see or easier to see the difference.

Question 4

(a) Candidates found this very challenging. Those that chose copper sulfate often had a white precipitate. Many chose barium nitrate.

(b) (i) Most candidates identified one control variable and many two**.** Non-creditworthy responses included: concentration unqualified, time and volume unqualified.

(ii) Most candidates gave the correct order of concentration but many could not do this in terms of the observations as asked in the question. Many stated faster or slower rate of reaction.

(c) Candidates found this challenging. Tests were frequently reversed, sodium hydroxide and copper sulfate were common incorrect responses. Most had precipitates formed, however the colours were often incorrect. The whole range of colours was seen.

Question 5

(a) Most candidates recorded the balance reading correctly. 47.8, 47.81 and 48.0 were common incorrect responses.

(b) Most candidates read the thermometer correctly. 18 and 19 were common incorrect responses.

(c) Candidates found this quite challenging with most stating to mix.

(d) (i) Almost all candidates subtracted the values correctly. 39.5 was seen often.

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(ii) Almost all candidates subtracted the values correctly.

(e) (i) Almost all candidates calculated the value correctly.

(ii) Almost all candidates calculated the value correctly.

(f) (i) Almost all candidates calculated the value correctly.

(ii) Many candidates calculated the value correctly. Some found rearranging the equation challenging. A small number gave the answer as a fraction instead of a decimal.

(g) Many candidates gave one reason, usually heat loss. Stronger candidates gave a second reason. Accuracy and use of a burette or pipette were common non-creditworthy responses.

(h) Stronger candidates cited an improvement, usually insulation or lid. Common non-creditworthy responses included same temperature, repeat and use a more accurate thermometer.

Question 6

This is the second time there has been a seven-mark planning question on the paper.

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

Many candidates did not label the wire in their circuit diagram and so it was difficult for the circuit diagram to gain full credit. The voltmeter was often connected in series. There was often a beaker with electrodes rather than a piece of wire.

Some candidates measured the resistance instead of measuring the voltage and the current. Few repeated the readings for increased reliability. Few suggested three or more different lengths or a minimum of five if a graph was to be drawn.

Stronger candidates could identify one control variable. Length was a common incorrect response.

Some candidates gave a detailed table but it was common for at least one key column to be omitted and often two. A table should have columns for the results, (length, voltage and current), in addition to the manipulated data, resistance.

Most candidates gave a prediction for their conclusion rather than explaining how they would use the results in order to formulate a conclusion.

A small number of candidates described an experiment to investigate a different variable, often thickness of the wire, rather than length.

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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, 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. Diagrams of apparatus are improving. Candidates must read the questions carefully so that they answer what is being asked by the question. Undertaking practical work helps the candidates to state observations and to interpret and evaluate experimental methods, techniques and results. Knowledge of identification tests for ions was limited.

Comments on specific questions

Question 1

(a) Most candidates read the volumes correctly. Incorrect responses included 16 and 27.

(b) Generally, the graphs were drawn well. Most scales were linear but some were too small and the plotted points did not cover at least half of the grid. The plotting of the points was usually accurate. Many drew two good best-fit curves but many drew two straight lines. Some drew point-to-point lines or drew feathery curves. Some did not label the curves. A small number reversed the axes.

(c) Many candidates described the relationship correctly. The most common incorrect response described the relationship in terms of time instead of rate.

(d) Most candidates chose goggles and a small number chose gloves; however, only stronger candidates explained the safety precaution.

(e) Candidates found this challenging with many stating that it was the volume at the start or that measuring cylinders were used.

(f) (i) Many candidates gained credit. Common non-creditworthy responses included: look directly, look straight, keep it flat, look closer, white paper behind scale, look parallel to the scale and other people check reading.

(ii) Syringe was quite well known, however, many candidates listed this with an inappropriate piece of apparatus. Conical flask, pipette, barometer and measuring cylinder were common non-creditworthy responses.

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Question 2

(a) Food tests were generally well known. Common incorrect responses included: for biuret – blue, green, red and carbohydrate, sugar and for iodine – blue black, red, sugar and no sugar.

(b) (i) Some candidates drew a clear and labelled diagram. Many diagrams included delivery into a sealed test-tube or measuring cylinder.

(ii) Candidates found the labelling challenging. The delivery tube was frequently unlabelled or labelled as tube or pipe.

(iii) The test for carbon dioxide was well known. 'Bubbles' was a common incorrect response.

(c) Stronger candidates appreciated the need to check that the liquid did not contain a nutrient before the yeast was added. Check the yeast for nutrients was a common response and many answers were vague in terms of checking for purity or contamination.

Question 3

(a) This is the second time there has been a seven-mark planning question on the paper.

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

Stronger candidates drew clear labelled diagrams of the assembled apparatus. Some drew separate pieces of apparatus not assembled. Some drew open beakers or flasks but described collecting the gas formed. Some did not label their diagrams.

Many candidates used at least two temperatures, five are required if a graph of results is to be drawn. Some candidates continually heated the reaction.

Most candidates identified at least one control variable, volume of acid being the most common.

Most candidates measured volume or mass loss; however, few appreciated the need to know the time span for these measurements so that comparisons could be made.

Many candidates gave a prediction for their conclusion rather than explaining how they would use the results in order to formulate a conclusion.

(b) Some candidates appreciated the problem of maintaining temperature and some discussed mis-readings or mis-measurements. Many gave non-creditworthy vague answers in terms of being more accurate or using more accurate apparatus or described good experimental practices such as leaving the thermometer in the solution at all times. Many discussed flaws in the experiment rather than errors.

Question 4

(a) Many candidates found this challenging. Incorrect reagents included ammonia, sodium hydroxide, litmus, halogens, nitrate test and reversing silver nitrate and barium nitrate. The observation was quite well known. A significant number gave reaction.

(b) Many candidates found this challenging and omitted one or both of the conclusions. Iron(II) was better known than ammonium ion. Incorrect responses included reaction, no reaction, cation, anion, copper and alkali.

(c) (i) Many candidates gained credit. Non-creditworthy answers included safer, heat resistant and to reduce heat loss.

(ii) This was quite well answered by stronger candidates. Common incorrect responses included: sodium hydroxide, acid, zinc and silver nitrate.

(iii) This was quite well answered by stronger candidates. Common incorrect responses included: sodium hydroxide, ammonia and heat.

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(iv) This was quite well known by stronger candidates. A range of answers were seen including iron, sulfate, cation, bromine and copper.

(v) Candidates found this quite challenging. Copper and electrolysis were common incorrect responses.

Question 5

(a) (i) Most candidates measured the diameter correctly. The small number of incorrect responses included: 7.5, 0.7 and 70.

(ii) Most candidates measured the diameter correctly. Incorrect responses included 5, 48 and 5.8.

(b) Most candidates measured the height correctly. Incorrect responses included 8, 0.8 and 84.

(c) (i) Most candidates calculated the value correctly. A small number omitted to divide by two.

(ii) The majority of candidates calculated the value correctly. Some doubled d_{AV} rather than squaring or omitted to multiply by h. A significant number did not give their answer to three significant figures.

(d) (i) Most candidates calculated the value correctly. An incorrect response was 223.

(ii) Many candidates discussed the reading being at eyelevel; very few discussed the meniscus. Common incorrect responses included: wider lines, by each cm^3 and reading parallel to the level or straight.

(e) (i) Candidates found this a little challenging. Many discussed the sides being sloping or repeated the question.

(ii) Stronger candidates gained credit. Many discussed either parallax, the measuring cylinder being too small or the cup not having measurements on it.

Question 6

(a) (i) Most candidates measured the length correctly. Incorrect responses included: 60, 59.5, 6, and 5.9.

(ii) Most candidates calculated the value correctly. Incorrect responses included: 12, 11.9 and 60.

(iii) Most candidates calculated the value correctly. A small number either did not multiply by 30 or did not divide by d_A.

(b) Most candidates calculated the value correctly. A small number either did not multiply by 40 or did not divide by d_B.

(c) Most candidates calculated the value correctly. A small number omitted to divide by two or gave their answer to too many or too few significant figures.

(d) Candidates found this very challenging. Non-creditworthy responses included: use the same ruler, fix the distance of the screen, use a more accurate ruler or repetition of bullet two from the procedure.

(e) Many candidates gained credit. Many gave less than three values and it was common for at least one of the values not to be larger than the focal length calculated in **(c)**.

(f) Candidates found this challenging. Many drew a diagonal line from the top of the lens to either the bottom of the screen or the bottom of the dotted line underneath the screen or stopped the line at the edge of the lens instead of at its centre.

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